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Exe Estuary Wildlife Refuge Monitoring Programme – Final Report

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Footprint Contract Reference: 459
Date: 17/09/2021
Version: Final
Recommended Citation: Saunders, P. & Liley, D. (2021). Exe Estuary Wildlife Refuge Monitoring Programme – Final Report. Unpublished report by Footprint Ecology.

Summary

This is the final overarching report detailing the results 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 cover two key parts of the estuary (at Dawlish Warren and at Exmouth), providing intertidal feeding and roosting habitat for wintering water birds, for which the Estuary is internationally important. The refuges are voluntary in that recreational users and other people are requested to avoid entering them while the refuges are 'active'.

This report presents data from monitoring carried out between period February 2018 and February 2021. Both refuges came on-line in mid-September 2018, and the Dawlish refuge now operates year-round, whilst the Exmouth refuge is only active (i.e. excluding people on a voluntary basis) 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 involved two different fieldwork elements: core counts (prolonged detailed observations) and vantage point counts (snapshot counts conducted much more frequently). As well as detailing the results of the three-year monitoring study, the report also makes comparisons with the findings of the previous Exe Disturbance Study, carried out between 2009 and 2011 (prior to the identification of the refuge areas).

Key findings of the report include:

Overview of bird numbers

- Higher counts were made at the two Exmouth Core Count locations during the autumn/early winter period, when the Exmouth refuge was active, before declining over the course of December and January (Core Count data, see Figure 2). The largest wader counts at the Dawlish Core Count locations were generally made between mid-autumn and early winter, but with atypically large numbers recorded from Dawlish Warren in February 2021.
- There was evidence that the maximum numbers of wildfowl recorded in and around the Exmouth refuge, when the refuge was active, showed an annual increase over the three years of the study.

Species present within each refuge

- Vantage Point Counts recorded 19 species of wildfowl and wader from the Exmouth refuge, comprising 9 species/subspecies of wildfowl and 10 wader species. The refuge supported very large numbers of wildfowl on occasion, and notable Vantage Point Counts were made for: Pale-bellied Brent Goose (maximum count comprising 352.9% of the 5-year mean WeBS count for the entire estuary), Mallard (119.7%), Dark-bellied Brent Goose (93.1%), Pintail (57.4%), Shelduck (80.0%), Wigeon (43.3%), and Mute Swan (39.5%). The

refuge was also used by waders, with notable counts from the Vantage Point data for species such as Bar-tailed Godwit (43.3% of the 5-year mean WeBS count for the entire estuary), and Turnstone (25.7%).

- 21 species of wildfowl and wader were recorded during from the Vantage Point counts at the Dawlish Refuge (from Cockwood), with 9 wildfowl and 12 waders recorded. Notable Vantage Point counts were made for: Ringed Plover (82.4% of the 5-year mean WeBS count for the entire estuary), Knot (67.1%), Dark-bellied Brent Goose (50.1%), Goldeneye (33.3%), Shelduck (29.8%), and Oystercatcher (29.8%).

Relative proportions of birds inside compared to outside the refuges

- The Vantage Point Counts included a large area of the estuary outside the refuges and counts were split to record the number of birds (within the Vantage Point Count area) that were inside and outside the refuge. Many more waders were counted outside the Exmouth refuge compared to inside throughout the survey period, irrespective of whether the refuge was active or not. When the refuge was active, however, a higher relative number of waders were recorded inside the refuge than when it was inactive.
- Counts of wildfowl inside and outside the Exmouth refuge were much higher during the refuge's active period, being approximately two and a half times higher overall inside the refuge compared to outside during the active period and approximately one and half times as high inside than outside during the inactive period. There was no evidence of a higher relative number of wildfowl inside the refuge when it was active.
- The total number of both waders and wildfowl counted inside the Dawlish refuge was always (usually much) higher than the number counted outside the refuge boundary.

Number of recreation events

- The Exmouth Core Count locations, incorporating areas in and outside of the Exmouth refuge, were much busier than those at Dawlish across the entire study period. Dog walking was the most commonly recorded activity at the Exmouth Duck Pond, with slightly smaller numbers recorded at Exmouth North. Dog walking was far less commonly observed at Dawlish. Watercraft dominated observations throughout at the two Dawlish Core Count locations. Exmouth Duck Pond was also a key location for recreational watersports, and bait digging was also frequently recorded.
- Peak levels of recreation activity at the Exmouth Core Count locations were recorded during the summer, although many activities still occurred when the refuge was active during autumn and winter. Activity levels at the Cockwood Core Count location, and to a lesser extent Dawlish Warren, showed a marked seasonality, with activity peaking in the summer and autumn.

Changes in levels of use since the Exe Disturbance Study 2011

- Core Count data suggest that bait digging, motor vehicles, and the number of people observed working on boats have all declined across the entire study area in the period between the 2011 and current studies.
- The data also suggests that birdwatchers, canoeists, and large motorboats at Cockwood have shown large increases in the same period, alongside smaller increases in the

number of dog walkers and RIBs. All other watercraft-related activities at Cockwood have however declined.

- At both the Duck Pond and Exmouth North the data suggest a decline in the numbers of dog walkers, walkers and RIBs. The rate of observation of canoeists, jet-skis, and windsurfers at the Duck Pond have however increased, whilst both the number of kitesurfers and people accessing a boat or the water have halved. At Exmouth North the rate of observation of RIBs and windsurfers has declined sharply, but the figure for small sailing boats at that location has increased by 40%. The rate of observation of birdwatchers at Exmouth North has also increased by a large amount, and it is the only location where the number of dogs off lead has increased.

Changes in level of use inside the refuge areas since the Exe Disturbance Study 2011

- Vantage Point Count data allow us to compare changes in the use of the Exmouth Duck Pond recording area between 2011 and the current study. Excluding those activities not recorded in the 2011 study, during the Exmouth refuge's active periods the number of canoes on the water, windsurfers, and 'other' (i.e. non-categorised) activities was higher overall (both in and outside the refuge) during the current study than in 2011. Conversely, the number of bait diggers, dog walkers, kids playing, kitesurfers, small sailing boats, and walkers (without a dog) was lower compared to 2011 (both in and outside the refuge).

Incursions into the refuges

- The data show a reasonable level of compliance with the refuges since their activation, although incursions (when the refuges were active) were still logged in all years of the study. Over the three years of the study, 67 incursions in total were recorded into the two refuges (when they were active) during the Core Counts and 139 were recorded during the Vantage Point Counts. The largest number of incursions were observed at the Duck Pond/within the Exmouth refuge, with the lowest number observed from Exmouth North.
- Dog walking comprised the most frequently recorded incursion activity overall across the refuges, with crab tiling/bait digging, walking, and fishing from shore also frequently recorded (although note that crab tiling is not subject to the voluntary restrictions). Incursions by windsurfers and kitesurfers were also recorded, albeit less frequently and exclusively into the Exmouth Refuge, in each year, whilst incursions from birdwatchers, canoeists, small motorboats, RIBs, picnickers, and "other" activities were noted less than annually.
- Most of the incursions recorded from the Vantage Point Counts were in close proximity to the refuge boundary. A total of 23 incursions across the 3 years involved people more than 50m from the refuge boundary (i.e. well inside the refuge), and 8 of these were crab tilers (for whom the voluntary exclusion does not apply).

Changes in the number of incursions over the study period

- In the final year of the study hardly any incursions occurred within the Exmouth Refuge during its' active period. There has also been a decrease in the small number of sporadic incursions occurring within the Dawlish refuge since its' activation.

- The Vantage Point Count data showed a year on year decrease across the three years in the number of observations involving recreational activity inside the refuges when they were active (although no such pattern was evident from the Core Counts).
- The relative proportion of walkers and bait diggers accessing the Dawlish refuge decreased over the study period, whilst the proportion of dog walkers accessing the refuge showed greater interannual variation.
- The proportion of dog walkers, walkers, bait diggers, and water-based activities accessing the Exmouth refuge varied across the three years of the study, although a larger relative proportion of water-based activities were observed inside the refuge during its inactive period, compared to when it was active, in the first and second years of the study.

Sizes of groups entering refuges and duration of incursions

- Incursion group sizes varied, but generally comprised 1 to 5 individuals. Larger group sizes were however noted on occasion.
- Incursions within the Exmouth refuge, at the Duck Pond, incorporated the largest number of dogs (on and off lead).
- Most incursions within the refuges were of relatively short duration, although incursions from some activities (e.g. bait digging) often lasted much longer.

Ranger visibility during incursions

- The majority of observed incursions occurred when the ranger team wasn't present.
- Nevertheless, a relatively large proportion of the incursions by dog walkers (44%) and anglers (45%) occurred during survey periods when the rangers were noted as present (for at least part of the count). Smaller numbers of incursions by birdwatchers, walkers, RIBs, kitesurfers, and windsurfers also occurred during periods when the rangers were noted as present.

Distribution of recreational activity

- The southern half of the Exmouth refuge and the Duck Pond shoreline supported a large volume of recreational activity during the refuges' inactive period, whilst the smaller numbers of observations in proximity to the Dawlish refuge were mostly spread along the main channel running north of the Dawlish refuge.
- During the refuges active periods the majority of observations were made outside of the refuge boundaries, with a dense concentration of observations in the main channel immediately north of the Dawlish refuge boundary and on the perimeter of the Exmouth refuge at the Duck Pond. A small number of observations were nevertheless made inside both of the refuges during their respective active periods.

Effect of disturbance on the number of birds present

- The number of birds present at the end of each Core Count generally showed a negative relationship with the number of potential disturbance events recorded during the count (i.e. the preceding 105 minutes). In other words, when there had been higher levels of human activity there were fewer birds present in and around the refuges.

- A temporal effect was also noted at Exmouth North, with fewer activities and more birds recorded in the final year of the study and more events and fewer birds recorded in the first year.

Responses to different activity types

- At Dawlish Warren crab tiling and walking were two of the more frequently recorded activities and led to a behavioral response (i.e. birds walking away or flushed) in >40% of cases. Passing trains were observed on many more occasions than any other activity type there, and led to a short or major flight on >35% of occasions. The majority of watercraft observations caused no response from the birds present.
- At Exmouth, dog walking was the most frequently observed activity and led to a behavioural response in the birds present in >70% of cases (with c.45% of these comprising short or major flight response). Of the other more frequently recorded activities (i.e. 10 or more observations), walkers, kitesurfers, and windsurfers led to a high proportion of behavioural responses, with the former causing a major flight (such that birds were displaced >50m) in c.55% of observations and windsurfers doing so in 60%.
- Of the less frequently recorded activities at Exmouth, canoeists, fisherman, paddleboarders, and small watercraft all led to a disproportionately high frequency of behavioural responses from the birds present.

Events that flushed birds

- In general, across all the Core Counts (i.e. regardless of whether the refuge was active or not), small wader species and wildfowl were proportionately the most commonly flushed bird groups and also those with the largest numbers of individual birds caused to take flight. Most instances of flushing resulted in approximately 10% to 90% of any birds present taking flight. Wildfowl generally flew a much greater distance than waders when flushed, and larger waders flew farther than smaller wader species. Most species soon resumed their previous behaviours after individual disturbance events, however.
- People accessing boats or the water, and windsurfers, caused a larger proportion of the birds present to take flight. Windsurfers, in particular, appeared to flush a disproportionately high percentage of birds, although several other activities each led to at least 40% to 60% of the birds present being flushed.
- Canoeists, dog walkers, RIBs, trains, and windsurfing activity resulted in some large flocks being flushed, with dog walkers causing several hundred birds to fly on several occasions. Canoeists and windsurfers, in particular, flushed larger numbers of birds more frequently, but dog walkers caused birds to flush more frequently overall (when adjusted for the prevalence of that activity in the dataset).

Disturbance events within the refuge

- 1,617 wildfowl and 123 waders were seen to be flushed more than 50m (a major flight) by refuge incursion events across the study period.
- The data suggest that the number of potential disturbance events recorded per hour halved in the year following activation of the two refuges, with the number of birds flushed per hour decreasing by approximately 75%, although the latter figure rose slightly

in the final year of the study. The mean number of flight responses per hour remained similar throughout each year of the study and the rate of incursions into the refuges increased ever so slightly. Furthermore, while the total number of potential disturbance events decreased when the refuges were active the number of behavioral responses seen at most of the Core Count locations increased.

- These results indicate that the relatively small number of incursions which are still taking place when the refuges are active can nevertheless result in a marked behavioural response from the birds present (i.e. causing them to flush/take flight).

The results broadly show that the refuges are well used by the birds, with some high counts and (for some species) a high proportion of the SPA population using the refuges. Recreational use in and around the refuges includes a wide range of activities, but in general relatively few incursions were recorded when the refuges were active. Nevertheless, a proportion of those occurring comprised activities well within the refuge (i.e. not just skirting the edge). Activities such as bait digging, windsurfing, kitesurfing, small motorboats, dog walking, walking, and fishing were recorded well within the refuges on occasion and these, when present, had a marked effect on the birds present, with a high proportion of such events resulting in birds being flushed (and potentially leaving the refuge).

The refuges therefore have a role to play in providing mitigation and are part of a package of measures that includes wardening, codes of conduct, awareness raising, and the provision of alternative sites for recreation. It is this package of measures together that ensures the long-term resilience of the estuary and the effectiveness of mitigation.

The study has collated data over a three-year period, including the Coronavirus pandemic. Access patterns have changed, and will continue to do so, and we therefore recommend that monitoring (Vantage Point Counts) should continue into the future. The monitoring results should be used to ensure the long-term effectiveness of the refuges, checking for continued compliance and highlighting any need to refine the design, promotion, and wardening of the refuges.

Contents

Acknowledgements

This report was commissioned by the South East Devon Habitats Regulations Partnership. We are grateful to Neil Harris for overseeing the work and to the steering group for useful input and discussion prior to the work commencing. We are also grateful to a range of individuals and organisations, including Alison Slade (Natural England) and the RSPB, for providing useful comment on the draft report.

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

All images Footprint Ecology.

1. Introduction

1.1 This is the final, overarching, report detailing the results of a three-year monitoring programme of two voluntary wildlife refuges on the Exe Estuary. Monitoring covered the period February 2018 to February 2021. The report follows (and builds upon) two previously issued, interim, reports that covered the periods February 2018 to March 2019 (Saunders & Liley, 2019) and April 2019 to March 2020 (Saunders & Liley, 2020).

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 a Site of Special Scientific interest (SSSI) and is also classified as a Special Protection Area (SPA) and listed as a Ramsar site.

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.*

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. The Exe Estuary SPA is afforded strict protection through the Habitats Regulations[1] and these place particular duties on local authorities and government bodies.

1.8 It is necessary for local authorities to rule out adverse effects on integrity for European sites at for housing growth or other developments at both the Plan-level and for individual planning applications. 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 (Clarke, Sharp, & Liley, 2008; Liley, 2008; Liley & Sutherland, 2007; Randall, 2004; Ross et al., 2014; Saunders, eta l., 2000; Stillman et al., 2009).

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

[1] Conservation of Habitats and Species Regulations 2017, as amended. Note that the most recent amendments (the Conservation of Habitats and Species (amendment) (EU Exit) Regulations 2019[1]) take account of the UKs departure from the EU.

coastal sites. Disturbance has been identified by Natural England as a generic issue across many European Marine Sites (see Coyle and 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 (Bright, et al., 2003; Fitzpatrick & Bouchez, 1998; Stillman & Goss-Custard, 2002; Thomas, Kvitek, & Bretz, 2003; Yasué, 2005);
- Increased energetic costs (Nolet, et al., 2002; Stock & Hofeditz, 1997);
- Avoidance of areas of otherwise suitable habitat, potentially using poorer quality feeding/roosting sites instead (Burton,et al., 2002; Burton, Rehfisch, & Clark, 2002; Cryer, et al., 1987; Gill, 1996); and,
- Increased stress (Regel & Putz, 1997; Thiel, et al., 2011; Walker, et al., 2006; Weimerskirch et al., 2002)

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, its 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 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.

Aims of this study

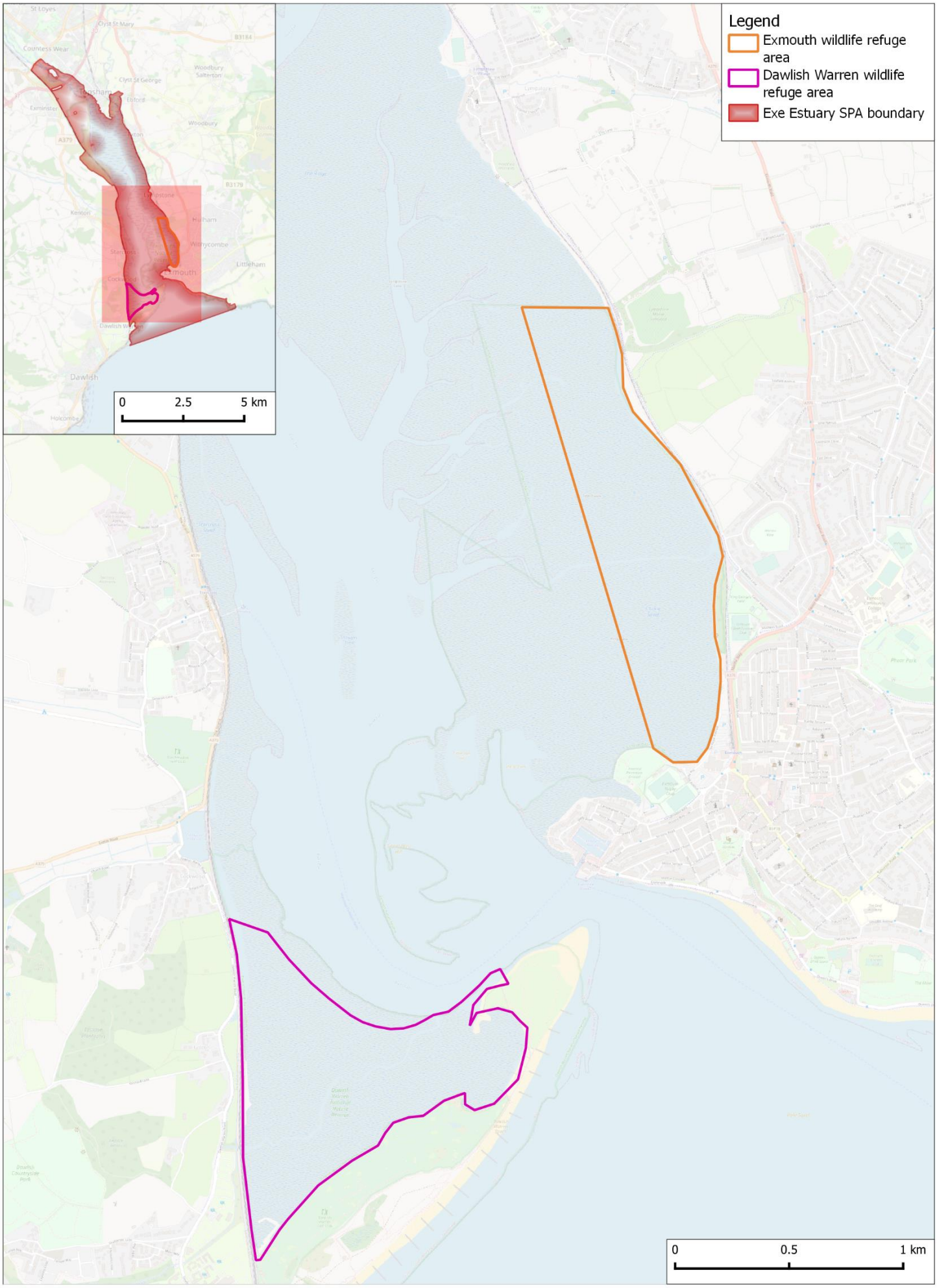
1.16 The creation of refuges such as these is a relatively novel approach in the UK to managing recreation pressure, and there are some potential challenges. It may be that the refuges are still vulnerable to disturbance from activities around the periphery, or from people straying into the refuges (which 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. This report documents such monitoring, which has been planned to dovetail with previous data collection (the Exe Disturbance Study 2011) and run over a number of years. The results

and key messages from the data will be fed back to users, and those responsible for overseeing the refuges, to ensure their success.

Map 1: Exe Estuary wildlife refuge areas and their location within the Exe Estuary SPA (inset map). The red bounding box identifies the extent of the main map depicted within the inset.



2. The Coronavirus pandemic

2.1 The latter stages of the three-year study played out against the backdrop of the ongoing Coronavirus pandemic, with peaks in both cases and mortalities seen across the UK during spring 2020 and winter 2020/21. The pandemic led to restrictions being imposed upon non-local travel at several points subsequent to March 2020, which consequently affected public access to the coast during the final year of the study.

2.2 The survey visits conducted during early winter 2020/21, in particular, were carried out in the wake of a number of earlier restrictions, which were introduced and/or subsequently retracted (and occasionally reinstated) over time. The surveys followed the strengthened enforcement of the "rule of six" in mid-September (only a recommendation previously) and several, disparate, local lockdowns (although none of the latter affected areas local to the study site). These restrictions were further refined following the introduction of the Tier system in mid-October.

2.3 Between the 5th November and 2nd December a short national lockdown was instituted. During the lockdown schools, colleges, and universities were allowed to remain open, but overnight stays were not permitted (unless for work) and non-essential retail, hospitality venues, and gyms were closed. Furthermore, individuals were only allowed to exercise 'in [their] local area'.

2.4 This will have had implications for recreational access; with hospitality venues and gyms closed, potentially more people will have accessed the countryside in their leisure time (plus individuals who were furloughed and/or not working)[2]. However, with individuals allowed to exercise only in their local area, visits from individuals from further afield may potentially have decreased. Importantly, the South East Devon Habitats Regulations Partnership (henceforth SEDHRP) ranger team were also furloughed for several weeks in early spring 2020.

2.5 Over the course of mid to late December 2020 a series of increasingly severe restrictions were imposed upon individual Local Authorities, based upon rises

[2] The People and Nature survey results indicate two-fifths of the population are spending more time outside than before Covid-19 and around a third of adults have been exercising more in the outdoors :https://www.gov.uk/government/statistics/the-people-and-nature-survey-for-england-monthly-interim-indicators-for-december-2020-experimental-statistics/the-people-and-nature-survey-for-england-monthly-interim-indicators-for-december-2020-experimental-statistics. accessed 10/4/21.

in cases and mortality within their areas of jurisdiction. This culminated in another national lockdown, commencing 4th January 2021. Of particular relevance to the study, the Exeter Port Authority consequently issued a guidance notice on 5th January 2021 indicating that it did not consider that general boat maintenance constituted either sport or physical activity (permitted under Government guidance during the lockdown).

2.6 The split timeline provided overleaf in Figure 1 identifies the timings of the imposed Coronavirus restrictions in England between March 2020 and March 2021. The restrictions did not ultimately affect data collection (all survey visits were still carried out), but it should be noted that the project rationale and survey methodologies detailed in this report were not specifically designed to monitor the impacts of the pandemic on site use.

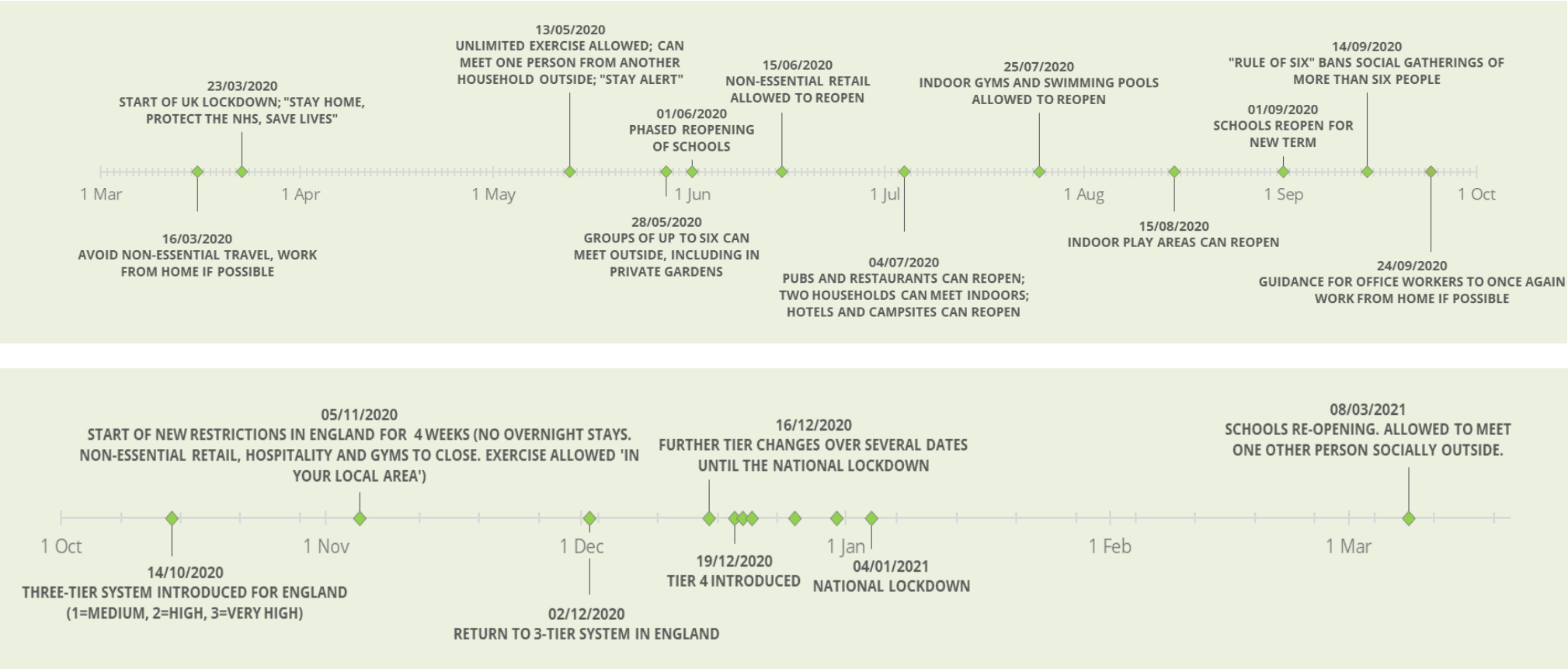


Figure 1: Timeline of imposed Coronavirus pandemic restrictions in England between March 2020 and March 2021

3. Methods

3.1 For the purposes of reporting, the study period detailed in this report has been split into three 'survey years' comprising:

- February 2018 to March 2019, inclusive;
- April 2019 to March 2020, inclusive, and;
- April 2020 to February 2021, inclusive.

3.2 During the study two different monitoring approaches were 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.

3.3 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

3.4 This approach is one that builds on the previous Exe Disturbance Study (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, 2018; Liley & Fearnley, 2011; Liley & Fearnley, 2012; Liley, et al., 2017; Liley, Stillman, & Fearnley, 2010; Liley, et al., 2015; Ross & Liley, 2014; Ross et al., 2014).

Recording elements

3.5 Each Core 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.

3.6 These different elements are described in more detail below, but in summary the bird counts provide a detailed level of use within the Core Count 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.

Core Count recording areas

3.7 The four Core Count survey locations used are shown in Map 2. Two were located at Dawlish Warren (one by the bird hide and the other at Cockwood Steps) and two on the perimeter of the Exmouth refuge (one at the Duck Pond and another north of Exmouth). The Core Count recording area comprised 500m arcs surrounding these four locations, with each of the four arcs incorporating areas of the estuary in and outside of the refuge boundaries. The relative area of the 500m arc which was in and outside of the refuges varied between the four survey locations, and it is also important to note that the Core Count surveys did not exhaustively cover the entire expanse of the refuge areas.

3.8 The 500m recording areas were 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 Core Count watch point. Each was selected to be at a point where any disturbance caused by the presence of the surveyor could be minimised/avoided, although the size and substrate of the recording area varied at each location/between visits due to differences in topography/hydrology, etc.

Bird count

3.9 At the start and end of each Core Count survey a count was made of the birds present within the pre-defined 500m recording area (see Map 2). The count included all waders, gulls, terns, wildfowl, grebes, divers, and herons/egrets present, and provided information on changes in species composition and numbers across the survey period.

Diary

3.10 All recreation events (and other potential disturbance events, such as trains, overflying aircraft, contractor work, birds of prey, etc.) which occurred during the following 1 hour and 45 minutes were recorded in a diary format. All observed events that could affect birds within the 500m recording area, and also those that occurred outside the 500m recording area but which could affect the birds present, were recorded. This was due to the fact that activities above the Mean High Water Mark (MHWM), and events outside the recording area (e.g. overflying aircraft), 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.

3.11 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

3.12 Any event recorded in the diary was categorised as a 'potential disturbance event' if:

- It coincided with birds being present within the 500m recording area; and,
- It occured within 200m of the birds present; or,
- There was a behavioural response recorded from the birds within the 500m recording area (i.e. seen to become alert, change position, or were flushed) despite the event occuring >200m from the birds concerned.

3.13 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.

3.14 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.

3.15 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).

3.16 Major flights (i.e. birds caused to fly >50m) were considered to comprise an extreme behavioural response, and are referred to as such throughout the report. This is due to the increased time lost to feeding, roosting, etc, and any associated energy costs, when flushed birds are caused to fly further and/or displaced from potentially preferred feeding/roosting locations by the flush event.

3.17 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

3.18 Additional information provided context and background and included tide times, tide coverage, weather, and whether or not the SEDHRP rangers were visible to the surveyor during the survey period.

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

3.19 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

3.20 Alongside the prolonged, detailed, Core Count surveys 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. The aim of these counts was to supplement the Core Count work set out above with a simpler approach that ensured much wider coverage (i.e. the entirety of the refuge areas). The Vantage Point Counts were quick and easy to do, and, as such, collection of a large sample was feasible, with the data collected by Footprint Ecology supplemented with data from the SEDHRP ranger team. Prior to commencement of the surveys, the rangers were provided with full training to ensure that the methods used by all surveyors were consistent.

Vantage Point Count recording areas

3.21 The Vantage Point Counts took place at three locations; Cockwood, Lympstone, and the Exmouth Duck Pond (see Map 3). Together they provided a view of a wider area of the estuary and incorporated the entirety of both the Dawlish and Exmouth refuge areas within their combined fields of view. The Cockwood survey point recording area encompassed the full extent of the Dawlish refuge and a smaller, adjoining, area outside it. The other two survey points incorporated the entire area within the Exmouth refuge and large expanses of the adjoining estuary. The Lympstone recording area incorporated a smaller proportion of the Exmouth refuge than recording area viewable from the Duck Pond Vantage Point.

Count of recreation activities

3.22 A count was made of any people or activities within the relevant Vantage Point recording area during each Vantage Point Count survey. The location of each observation was mapped, using the same standard codes as in the Core Counts, allowing for subsequent spatial analyses of their position relative to the refuge area boundaries.

Bird count

3.23 A count of birds within the Vantage Point Count recording 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 the counts will therefore be approximate in some cases (for example when there were birds roosting on the distant saltmarsh to the south of the Cockwood Vantage Point).

3.24 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. 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.

Survey timings, etc

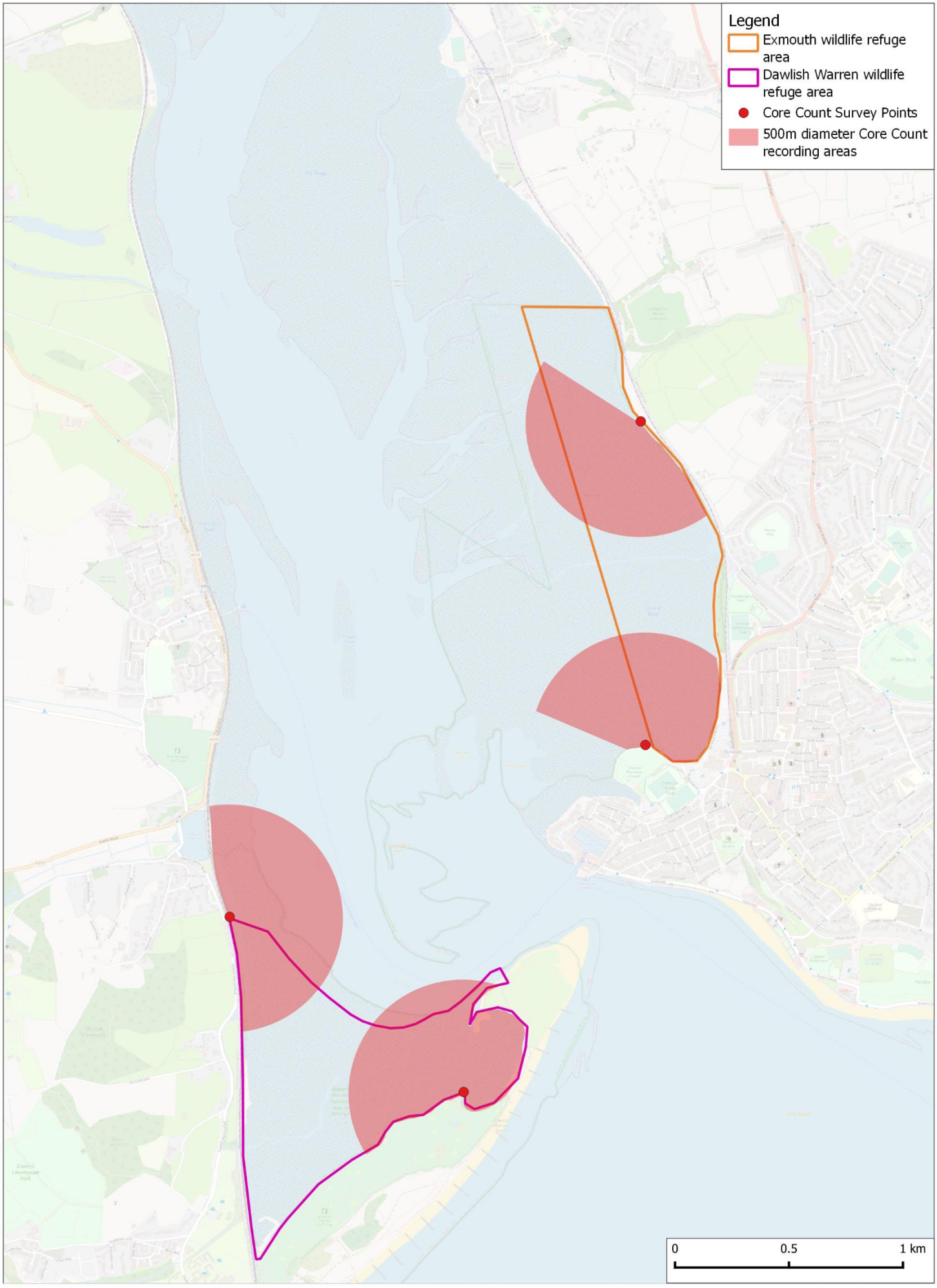
3.25 The Vantage Point Counts took up to 15 minutes to carry out, and were simple to complete, providing an easily replicated approach. We aimed for repeat counts from multiple dates and times. While not recording levels of disturbance

per se (i.e. birds being flushed), with a reasonable sample spread over time, the Vantage Point Count data provided information on:

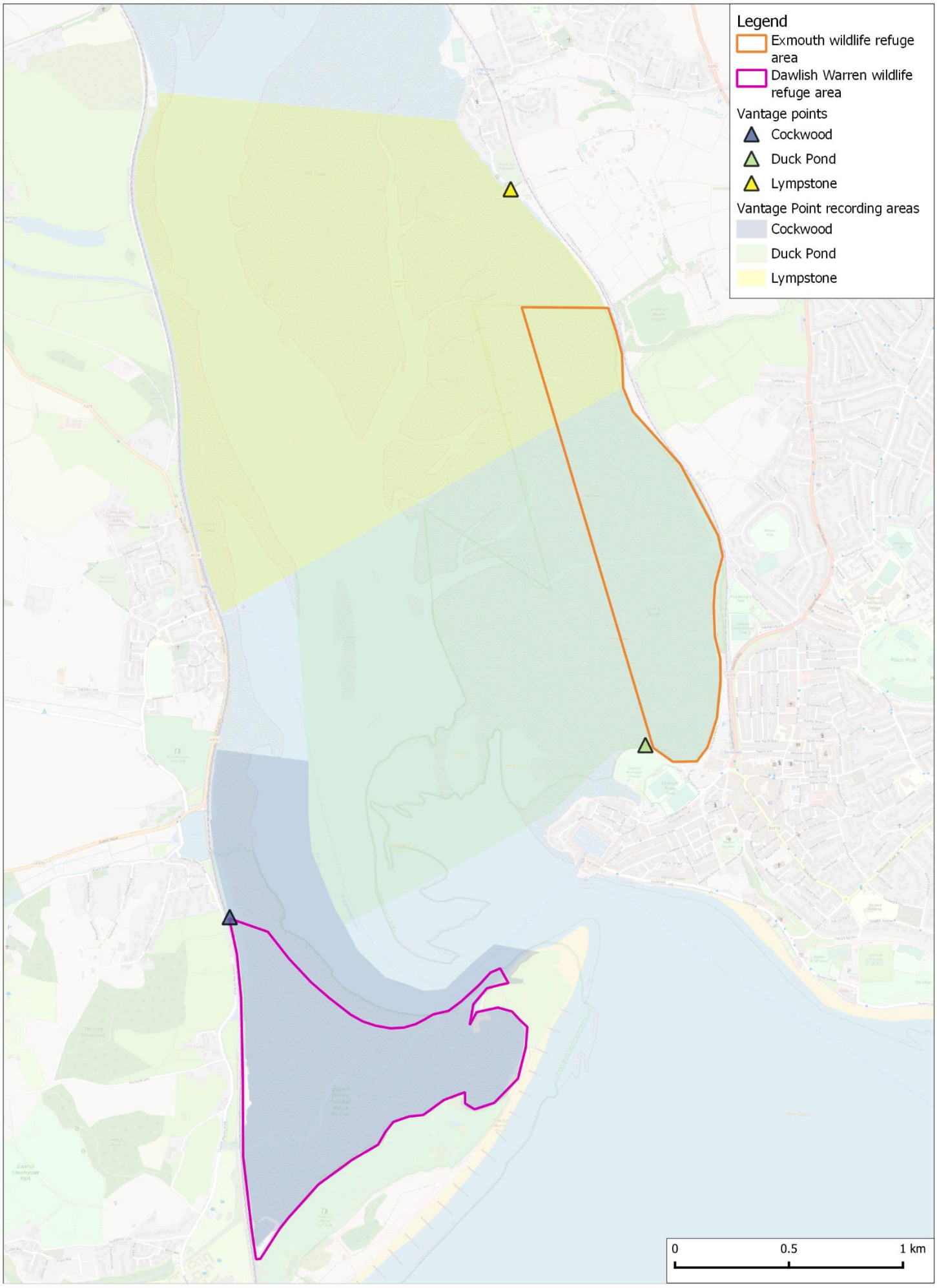
- Which activities took place within the refuges;
- How frequently they occured;
- How the numbers of birds in the refuges varied (e.g. when the estuary was busy, when there were events within the refuges, etc.); and,
- Whether or not the SEDHRP rangers were visible to the surveyor.

3.26 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 and associated recording areas



Map 3: Exe Estuary Vantage Point locations and approximate fields of view



Timing across the study period of both count types

3.27 The temporal spread of counts and total fieldwork undertaken between March 2018 through to the end of February 2021 are summarised in Appendix 1. In total, 138 Core Counts were undertaken, involving 34 each at Dawlish Warren and Exmouth North, and 35 each at Cockwood and Exmouth Duck Pond. At each of the Exmouth locations, 21 of the counts were made during the period that the refuge was active, with 14 made at the Duck Pond and 13 made at Exmouth North during the refuge's inactive period. 3 of the counts carried out at both Cockwood and Dawlish Warren were done so prior to the point at which the Dawlish refuge became active.

3.28 In total, 152 Vantage Point Counts were undertaken by Footprint Ecology across the entire study period, with a further 117 carried out by the SEDHRP rangers. 87 counts were made at Cockwood, with 98 counts made at the Duck Pond (51 of which were made during periods when the Exmouth refuge was active) and 84 at Lympstone (36 of which were made when the Exmouth refuge was active).

Data analyses and presentation

3.29 The Core Counts and the Vantage Point Counts provide slightly different information, with the Core Counts providing detailed, prolonged, observation and the opportunity to record how birds respond to the presence of people. The Vantage Point Counts involve many more counts, essentially 'snapshots' for a moment in time, but with less detail. For different analyses we use the most appropriate data, but sometimes present both. The type of data used/presented is however clearly stated throughout.

3.30 The data collected were analysed using Minitab statistical software packages, with graphs and tables produced using Microsoft Excel and R. 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 circles).

3.31 Comparisons are also made with data collected as part of the Exe Disturbance Study 2011, where possible, in order to identify any changes in site use or bird numbers/behaviour in the intervening period.

4. Bird use of the refuges

Overview of bird numbers

4.1 Bird numbers within the 500m recording areas from the three years of Core Counts are summarised by date in Figure 2 and Figure 3, with wildfowl and waders accounting for most of the birds counted, although Cockwood also regularly supported large numbers of gulls. A total of 50 waterbird species were recorded across the four survey locations, including 12 species (and one additional subspecies) of wildfowl and 18 species of wader.

4.2 The higher counts at the two Exmouth locations were made each year during the autumn/early winter period, when the refuge was active, before declining over the course of December and January. The two Exmouth locations regularly supported large numbers of wildfowl, with frequent counts of more than 1,000 ducks and geese made in the period September to November in each year, and slightly less frequent counts of more than 2,000 birds. Outside of the autumn/early winter period the Exmouth locations supported relatively low bird numbers in each year.

4.3 The data depicted in Figure 2 suggest that wildfowl numbers within the Duck Pond recording area have increased over the three years of the current study, and also indicate that wildfowl numbers in the Exmouth North recording area have potentially stabilised at a higher level over the same period.

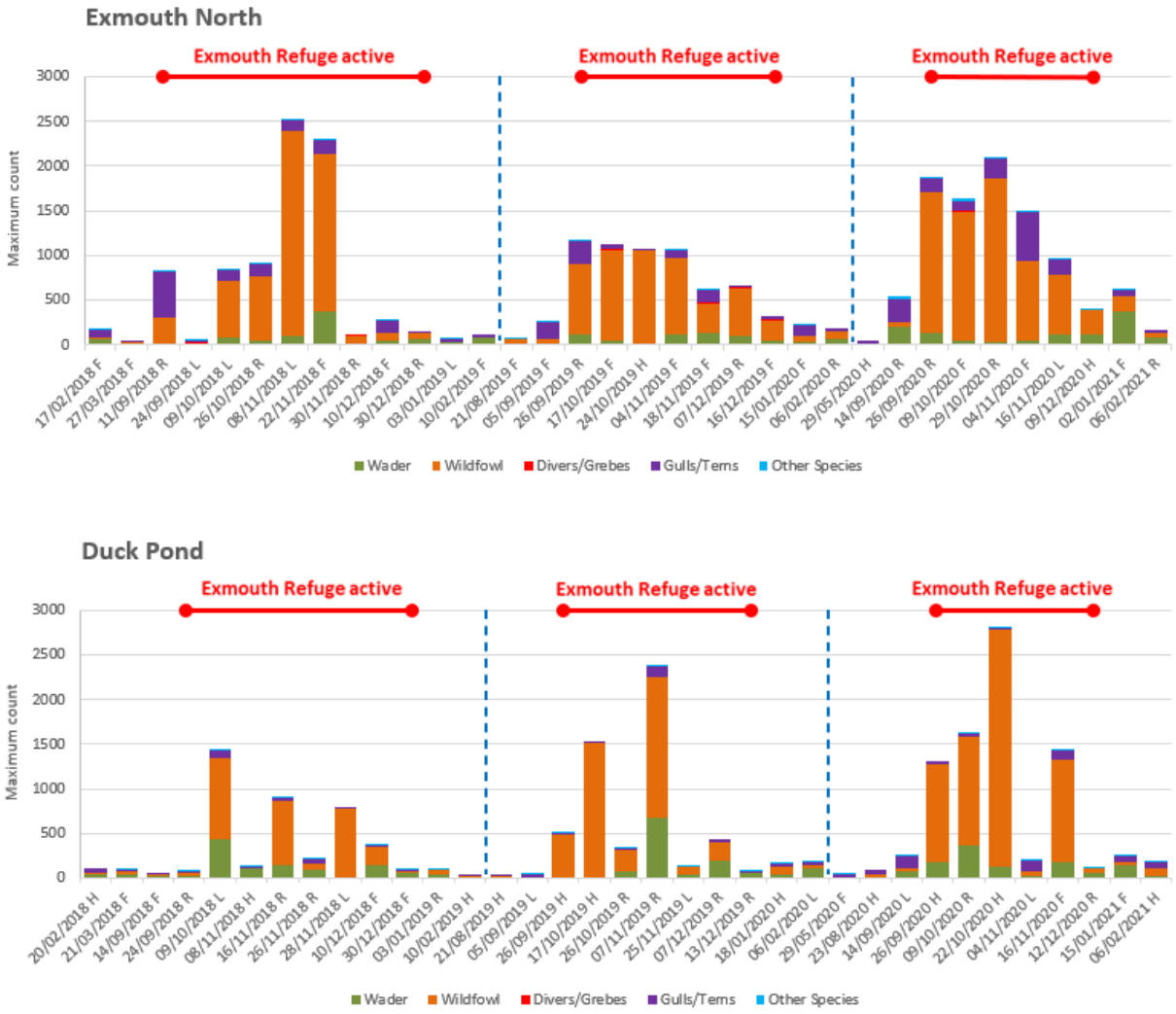


Figure 2: Maximum bird counts for each Core Count at Exmouth North and Exmouth Duck Pond (maximum taken from the count at start and at end of visit, for each species), by date and location. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling. The dashed lines indicate the time periods covered by the two previously issued interim reports.

4.4 At the Dawlish Warren and Cockwood Core Count locations, waders generally accounted for a larger proportion of the birds within the relevant recording areas, in comparison to the two Exmouth survey locations. The largest wader counts were generally made between mid-autumn and early winter, although atypically large numbers were recorded from Dawlish Warren in February 2021. Several hundred individual wildfowl were still regularly recorded from the two localities however (peaking between October and November), with Figure 3 suggesting that their numbers increased over the three years of the current study.

Figure 3: Maximum bird counts for each Core Count at Cockwood and Dawlish Warren (maximum taken from the count at start and at end of visit, for each species), by date and location. Note the axes are different in each of the two graphs. Letters next to the dates indicate tide states: L = low; H = high, R = rising, F = falling. The dashed lines indicate the time periods covered by the two previously issued interim reports.

Key findings: overview of bird numbers

Higher counts were made at the two Exmouth Core Count locations during the autumn/early winter period, when the Exmouth refuge was active, before declining over the course of December and January. The largest wader counts at the Dawlish Core Count locations were generally made between mid-autumn and early winter, but with atypically large numbers recorded from Dawlish Warren in February 2021.

There was evidence that the maximum numbers of wildfowl recorded in and around the Exmouth refuge, when the refuge was active, showed an annual increase over the three years of the study.

Species present within each refuge

Exmouth refuge

4.5 The importance of the Exmouth survey locations for wildfowl during the autumn/early winter is reflected in some notable totals recorded during Core Counts. For example, large numbers of Dark-bellied Brent Geese were recorded from both the Duck Pond recording area (max. count of 1,174 on 22/10/20) and Exmouth North recording area (max. count of 996 on 08/11/18). These two locations supported even larger numbers of Wigeon, with max. counts of 1,633 made at the Duck Pond (on 22/10/20) and 1,345 at Exmouth North (on 09/10/20). The Exmouth locations supported lower numbers of waders in comparison to those at Dawlish, but Core Counts at the Duck Pond recording area still regularly included good numbers of Oystercatcher (max. count of 585 on 07/11/19) and Curlew (max. count of 232 on 09/10/20) in particular.

4.6 Table 1 provides the maximum count for each wildfowl species from the Vantage Point Counts (across both Vantage Points in each year of the study) solely from inside the Exmouth refuge, stratified by when the refuge was active. It also gives the proportion of the 5-year mean BTO Wetland Bird Survey (WeBS) data[3] for the entire Exe Estuary SPA that each count represents. The latter figure provides context and an indication of the total

[3] This is a national survey involving monthly counts undertaken by volunteers, see https://www.bto.org/our-science/projects/wetland-bird-survey for details.

estuary population that can occur in or around the refuge at a given point in time.

4.7 These data show that the maximum counts within the Exmouth refuge comprised at least 25% of the SPA 5-year mean for the following species/subspecies: Pale-bellied Brent Goose (352.9%), Mallard (119.7%), Dark-bellied Brent Goose (93.1%), Shelduck (80.0%), Pintail (57.4%), Wigeon (43.3%), Bar-tailed Godwit (43.3%), Mute Swan (39.5%), and Turnstone (25.7%).

Table 1: Maximum counts of wildfowl and wader species inside the Exmouth refuge (and proportion of 5-year mean WeBS count for the Exe Estuary SPA) taken from Vantage Point data, stratified by survey year and refuge activity status. The largest count for each species in each of the three survey years is highlighted in grey.

Species (5yr mean WeBS SPA count)	2018/19		2019/20		2020/21	
	Refuge active	Refuge inactive	Refuge active	Refuge inactive	Refuge active	Refuge inactive
Dark-Bellied Brent Goose (1,955)	730 (37.4%)	169 (8.7%)	1,820 (93.1%)	77 (3.9%)	548 (28.0%)	78 (4.0%)
Pale-Bellied Brent Goose (17)	0 (0%)	0 (0%)	60 (352.9%)	0 (0%)	0 (0%)	54 (317.7%)
Mallard (355)	425 (119.7%)	50 (14.1%)	300 (84.5%)	30 (8.5%)	40 (11.3%)	43 (12.1%)
Pintail (244)	20 (8.2%)	0 (0%)	140 (57.4%)	0 (0%)	80 (32.8%)	0 (0%)
Red-breasted Merganser (37)	0 (0%)	2 (5.4%)	4 (10.8%)	0 (0%)	1 (2.7%)	4 (10.8%)
Shelduck (275)	35 (12.7%)	41 (14.9%)	220 (80.0%)	3 (1.1%)	80 (29.1%)	4 (1.5%)
Teal (1,325)	0 (0%)	0 (0%)	3 (0.2%)	0 (0%)	2 (0.2%)	0 (0%)
Wigeon (5,082)	1,000 (19.7%)	13 (0.3%)	2,150 (42.3%)	20 (0.4%)	2,200 (43.3%)	8 (0.2%)
Mute Swan (114)	45 (39.5%)	0 (0%)	17 (14.9%)	12 (10.5%)	6 (5.3%)	40 (35.1%)
Black-tailed Godwit (1,626)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	100 (6.2%)	0 (0%)
Bar-tailed Godwit (185)	80 (43.3%)	2 (1.1%)	5 (2.7%)	1 (0.6%)	10 (5.4%)	0 (0%)
Curlew (1035)	85 (8.2%)	14 (1.4%)	30 (2.9%)	11 (1.1%)	34 (3.3%)	4 (0.4%)
Dunlin (3,428)	0 (0%)	30 (0.9%)	90 (2.6%)	200 (5.8%)	20 (0.6%)	0 (0%)
Lapwing (1,023)	0 (0%)	0 (0%)	7 (0.7%)	0 (0%)	0 (0%)	0 (0%)
Oystercatcher (2,125)	350 (16.5%)	171 (8.1%)	300 (14.1%)	24 (1.1%)	70 (3.3%)	180 (8.5%)
Redshank (720)	10 (1.4%)	7 (1.0%)	62 (8.6%)	40 (5.6%)	10 (1.4%)	2 (0.3%)
Turnstone (233)	0 (0%)	0 (0%)	35 (15.0%)	60 (25.7%)	40 (17.2%)	0 (0%)
Greenshank (36)	0 (0%)	3 (8.3%)	0 (0%)	1 (2.8%)	0 (0%)	0 (0%)
Whimbrel (99)	0 (0%)	2 (2.0%)	0 (0%)	12 (12.1%)	0 (0%)	0 (0%)

4.8 Excluding gulls, non-wader and non-wildfowl species were generally recorded in very low numbers across the three years of the study. Nevertheless, Core Counts at Exmouth North recorded the largest numbers of both Little Egret (31 on 09/10/20) and Great Crested Grebe (19 on 17/10/19).

Dawlish refuge

4.9 Notably high counts of wildfowl species from the Dawlish Core Count recording areas included Wigeon (max. count of 684 at Dawlish Warren on 15/10/20), Dark-bellied Brent Geese (max. count of 530 at Dawlish Warren on 09/11/19), and Shelduck (max. count of 404 at Cockwood on 06/10/20). High counts of wader species from the Core Counts included Oystercatcher (max. count of 1,285 at Dawlish Warren on 27/09/19), Dunlin (max. count of 865 at Dawlish Warren on 04/02/20), Curlew (max. count of 348 at Cockwood on 26/08/20), Redshank (max. count of 272 at Cockwood on 21/09/18), Ringed Plover (max count of 90 at Dawlish Warren on 26/08/20), Sanderling (max count of 132 at Dawlish Warren on 27/05/19), Grey Plover (max. count of 180 at Dawlish Warren on 04/02/21), and Bar-tailed Godwit (max. count of 108 at Dawlish Warren on 21/01/21).

4.10 Vantage Point Counts for the Dawlish refuge were solely made from Cockwood. with Vantage Point Count data summarised in Table 2. The totals provided are only for those birds within the refuge and are again compared to the WeBS data for the entire Exe Estuary SPA (5-year mean for each species). These data show that the maximum counts within the Dawlish refuge comprised at least 25% of the SPA 5-year mean for the following species: Ringed Plover (82.4%), Knot (67.1%), Dark-bellied Brent Goose (50.1%), Goldeneye (33.3%), Shelduck (29.8%), and Oystercatcher (29.8%).

Table 2: Maximum counts of wildfowl and wader species inside the Dawlish refuge (and proportion of 5-year mean WeBS count for the Exe Estuary SPA) taken from Vantage Point data, stratified by survey year and refuge activity status. The largest count for each species in each of the three survey years is highlighted in grey.

Species (5yr mean WeBS SPA count)	2018/19		2018/19	2019/20
	Refuge active	Refuge inactive	Refuge active	Refuge active
Dark-Bellied Brent Goose (1,955)	550 (28.1%)	10 (0.5%)	980 (50.1%)	40 (2.1%)
Goldeneye (3)	1 (33.3%)	0 (0%)	0 (0%)	0 (0%)
Pintail (244)	0 (0%)	0 (0%)	1 (0.4%)	0 (0%)
Red-breasted Merganser (37)	7 (18.9%)	2 (5.4%)	4 (10.8%)	4 (10.8%)
Shelduck (275)	23 (8.4%)	6 (2.2%)	82 (29.8%)	23 (8.4%)
Teal (1,325)	6 (0.5%)	0 (0%)	3 (0.2%)	0 (0%)
Wigeon (5,082)	300 (5.9%)	0 (0%)	460 (9.1%)	270 (5.3%)
Canada Goose (1,250)	0 (0%)	12 (1.0%)	0 (0%)	0 (0%)
Mute Swan (114)	0 (0%)	2 (1.8%)	2 (1.76%)	4 (3.5%)
Black-tailed Godwit (1,626)	0 (0%)	0 (0%)	1 (0.07%)	1 (0.1%)
Bar-tailed Godwit (185)	20 (10.8%)	1 (0.6%)	20 (10.8%)	3 (1.6%)
Curlew (1,035)	32 (3.1%)	91 (8.8%)	108 (10.4%)	60 (5.8%)
Dunlin (3,428)	260 (7.6%)	0 (0%)	400 (11.7%)	0 (0%)
Lapwing (1,023)	0 (0%)	1 (0.1%)	0 (0%)	0 (0%)
Oystercatcher (2,125)	400 (18.8%)	84 (4.0%)	632 (29.8%)	250 (11.8%)
Redshank (720)	40 (5.6%)	100 (13.9%)	30 (4.2%)	5 (0.7%)
Turnstone (233)	11 (4.7%)	2 (0.9%)	1 (0.4%)	2 (0.9%)
Greenshank (36)	0 (0%)	3 (8.3%)	1 (2. 8%)	0 (0%)
Whimbrel (99)	0 (0%)	8 (8.1%)	2 (2.03%)	0 (0%)
Ringed Plover (182)	0 (0%)	0 (0%)	150 (82.4%)	0 (0%)
Knot (149)	0 (0%)	0 (0%)	100 (67.1%)	0 (0%)

4.11 Excluding gulls, non-wader and non-wildfowl species were generally recorded in very low numbers. Nevertheless, a single (semi-resident) Slavonian Grebe was recorded during the Cockwood Core Counts between February 2018 and December 2020 at least, and a peak count of 2 Great Northern Divers was made during a Core Count from the same locality on 18/02/18.

Key findings: species present within each refuge

Vantage Point Counts recorded 19 species of wildfowl and wader from the Exmouth refuge, comprising 9 species/subspecies of wildfowl and 10 wader species. The refuge supported very large numbers of wildfowl on occasion, and notable Vantage Point Counts were made for: Pale-bellied Brent Goose (maximum count comprising 352.9% of the 5-year mean WeBS count for the entire estuary), Mallard (119.7%), Dark-bellied Brent Goose (93.1%), Pintail (57.4%), Shelduck (80.0%), Wigeon (43.3%), and Mute Swan (39.5%). The refuge was also used by waders, with notable counts from the Vantage Point data for species such as Bar-tailed Godwit (43.3% of the 5-year mean WeBS count for the entire estuary), and Turnstone (25.7%).

21 species of wildfowl and wader were recorded during from the Vantage Point counts at the Dawlish Refuge (from Cockwood), with 9 wildfowl and 12 waders recorded. Notable Vantage Point counts were made for: Ringed Plover (82.4% of the 5-year mean WeBS count for the entire estuary), Knot (67.1%), Dark-bellied Brent Goose (50.1%), Goldeneye (33.3%), Shelduck (29.8%), and Oystercatcher (29.8%).

Relative proportions of birds inside compared to outside the refuges

4.12 Figure 4 depicts bird count data inside and outside the refuge area boundaries, with data from when the Exmouth refuge was active and inactive (and prior to the Dawlish refuge being active) presented separately. All Vantage Point Count data are used, including different tide states and times of year. At all sites the Vantage Point Counts covered an extensive area of intertidal habitat and included large areas of habitat outside the refuges. As such, it is possible to compare the number of birds inside to outside the refuges when they are active compared to inactive. For the Dawlish refuge such comparisons are of less relevance as there was only a limited time window when the refuge was not active, at the start of the study.

4.13 The data are also summarised in Table 3, where the median values and total counts are given. The initial rows of the table summarise all Vantage Point Counts, while the lower rows exclude those visits made at high tide. In both Figure 4 and Table 3, the Exmouth counts reflect the data from both Vantage Points (Exmouth Duck Pond and Lympstone) on the eastern side of the estuary.

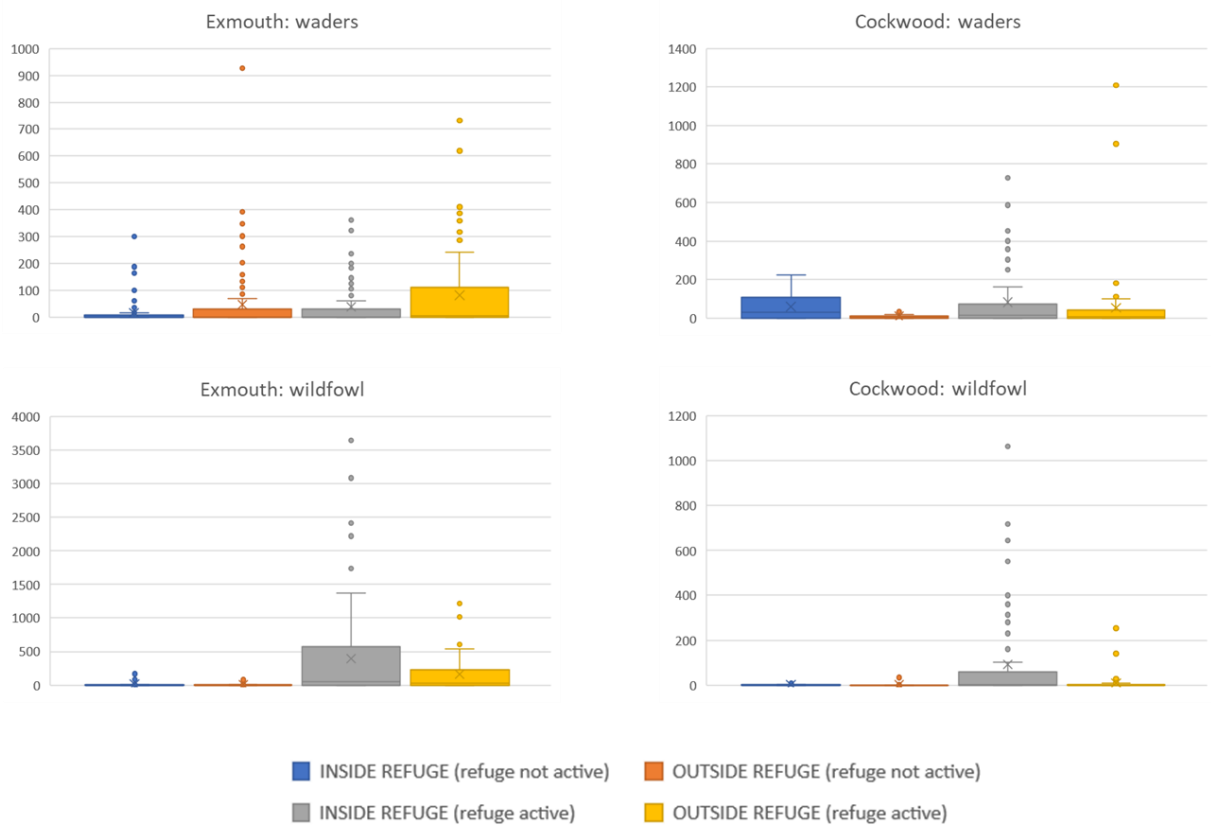


Figure 4: Vantage Point Count bird data, comparing counts from inside and outside the refuges.

Table 3: Summaries of bird counts from vantage points (i.e. within the fixed Vantage Point Count recording area), split inside and outside the refuges, when refuges were active and when not active. Grey shading reflects the higher median and higher total in each row. Ratio is the total birds inside:outside.

Refuge	Species	Refuge active?	Birds INSIDE refuge			Birds OUTSIDE refuge			Ratio
			Median	Total	n	Median	Total	n	
All counts									
Exmouth	Waders	Active	0	3,233	87	0	7,050	87	1:2.2
Exmouth	Waders	Not	0	1,426	95	0	4,331	95	1:3.0
Exmouth	Wildfowl	Active	48	34,193	87	28	14,312	87	1:0.4
Exmouth	Wildfowl	Not	0	1,211	95	0	724	95	1:0.6
Dawlish	Waders	Active	16	5,724	69	7	3,731	69	1:0.7
Dawlish	Waders	Not	32	1,066	18	3	145	18	1:0.1
Dawlish	Wildfowl	Active	2	6,298	69	0	598	69	1:0.1
Dawlish	Wildfowl	Not	0	43	18	0	38	18	1:0.9
High tide counts excluded									
Exmouth	Waders	Active	8	2,904	51	34	6,352	51	1:2.2
Exmouth	Waders	Not	1	1,073	60	14	4,036	60	1:3.8
Exmouth	Wildfowl	Active	78	20,603	51	39	7586	51	1:0.4
Exmouth	Wildfowl	Not	0	631	60	0	634	60	1:1.0
Dawlish	Waders	Active	56	3,448	30	20	838	30	1:0.2
Dawlish	Waders	Not	46	738	12	11	135	12	1:0.2
Dawlish	Wildfowl	Active	18	3,674	30	2	567	30	1:0.2
Dawlish	Wildfowl	Not	0	31	12	0	38	12	1:1.2

4.14 The data show that, at Exmouth, many more waders were counted outside the refuge compared to inside throughout the survey period, irrespective of whether the refuge was active or not. When the refuge was active, however, a higher relative number of waders were recorded inside the refuge than when it was inactive. When the Exmouth refuge was active a total of 3,233 waders were counted inside compared to 7,050 outside (i.e. a ratio of 1:2.2), whilst 1,426 waders were counted inside the refuge compared to 4,331 outside (ratio of 1:3.0) when it was inactive.

4.15 Counts of wildfowl inside and outside of the Exmouth refuge were much higher during the period that the refuge was active. Counts were approximately two and a half times higher overall inside the refuge compared to outside during the active period (34,193 versus 14,312; ratio 1:0.4), and approximately one and half times as high inside than outside during the inactive period (1,211 versus 724; ratio 1:0.6).

4.16 The total number of both waders and wildfowl counted inside the Dawlish refuge from the Cockwood Vantage Point was always higher (and usually much higher), than those outside the refuge boundary. A total of 5,724 waders and 6,298 wildfowl were recorded inside the refuge once it became active, whereas 3,731 waders and 598 wildfowl were recorded outside (giving respective ratios of 1:0.7 for waders and 1:0.1 for wildfowl). Comparisons of the ratios when the Dawlish refuge was active compared to inactive are however limited due to the small amount of data (at a specific time of year) for when the refuge was inactive.

Key findings: relative proportions of birds inside compared to outside the refuges

The Vantage Point Counts included a large area of the estuary outside the refuges, with the counts split to record the number of birds (within the Vantage Point Count area) that were inside and outside the refuge. Many more waders were counted outside the Exmouth refuge compared to inside throughout the survey period, irrespective of whether the refuge was active or not. When the refuge was active, however, a higher relative number of waders were recorded inside the refuge than when it was inactive.

Counts of wildfowl inside and outside the Exmouth refuge were much higher during the refuge's active period, being approximately two and a half times higher overall inside the refuge compared to outside during the active period and approximately one and half times as high inside than outside during the inactive period. There was no evidence of a higher relative number of wildfowl inside the refuge when it was active.

- The total number of both waders and wildfowl counted inside the Dawlish refuge was always (usually much) higher than outside the refuge boundary.

5. Human activity

Number of recreation events (Core Count data)

5.1 Core Count data are summarised in Figure 5 to Figure 8, which depict the overall totals for the two sides of the estuary from all Core Counts made across the three years of the study. The data reflects all observations of people and events that could disturb birds, both inside and outside the refuges, across the entire annual cycle. 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).

5.2 Figure 5 and Figure 6 depict diary data across the entire study period from the two Exmouth Core Count locations, with Figure 7 and Figure 8 depicting that from the two Exmouth Core Count locations. 553 and 828 individual activity events were observed at the Exmouth Duck Pond and Exmouth North, respectively, over the three years of the study, although 82 of these comprised passing trains at Exmouth North, as well as 200 observations of cyclists along the adjacent (largely screened off) path. Conversely, Cockwood and Dawlish Warren respectively recorded 759 and 387 events in the same period, although 393 of those at Cockwood comprised passing trains.

5.3 Therefore, although a similar number of observations were made from the two refuges overall, when only considering recreational events with potential to cause disturbance (i.e. excluding passing trains and screened off cycle-paths) it can be seen that the Exmouth Core Count locations were generally much busier than the Dawlish Core Count locations. Note that in order to aid interpretation, all train observations and the 200 observations of cyclists along the Exmouth North path have been excluded from Figure 5 to Figure 8.

5.4 Excluding the busy train line at Cockwood, watercraft dominated observations throughout at the two Dawlish Core Count locations, with RIBs comprising the most commonly recorded activity event at each locality (totals of 72 at Cockwood and 90 at Dawlish Warren, respectively). Observations of 71 large motorboats were also made at each of the two locations, with 71 small motorboats recorded at Cockwood and 48 at Dawlish Warren also. The preponderance of watercraft observations was also reflected in the number of people observed working on boats; 10 at Cockwood and 26 at Dawlish Warren. In contrast, no large watercraft were

recorded from either of the Exmouth Core Count locations, with only a small number of RIBs, rowing boats, and small sailing boats noted.

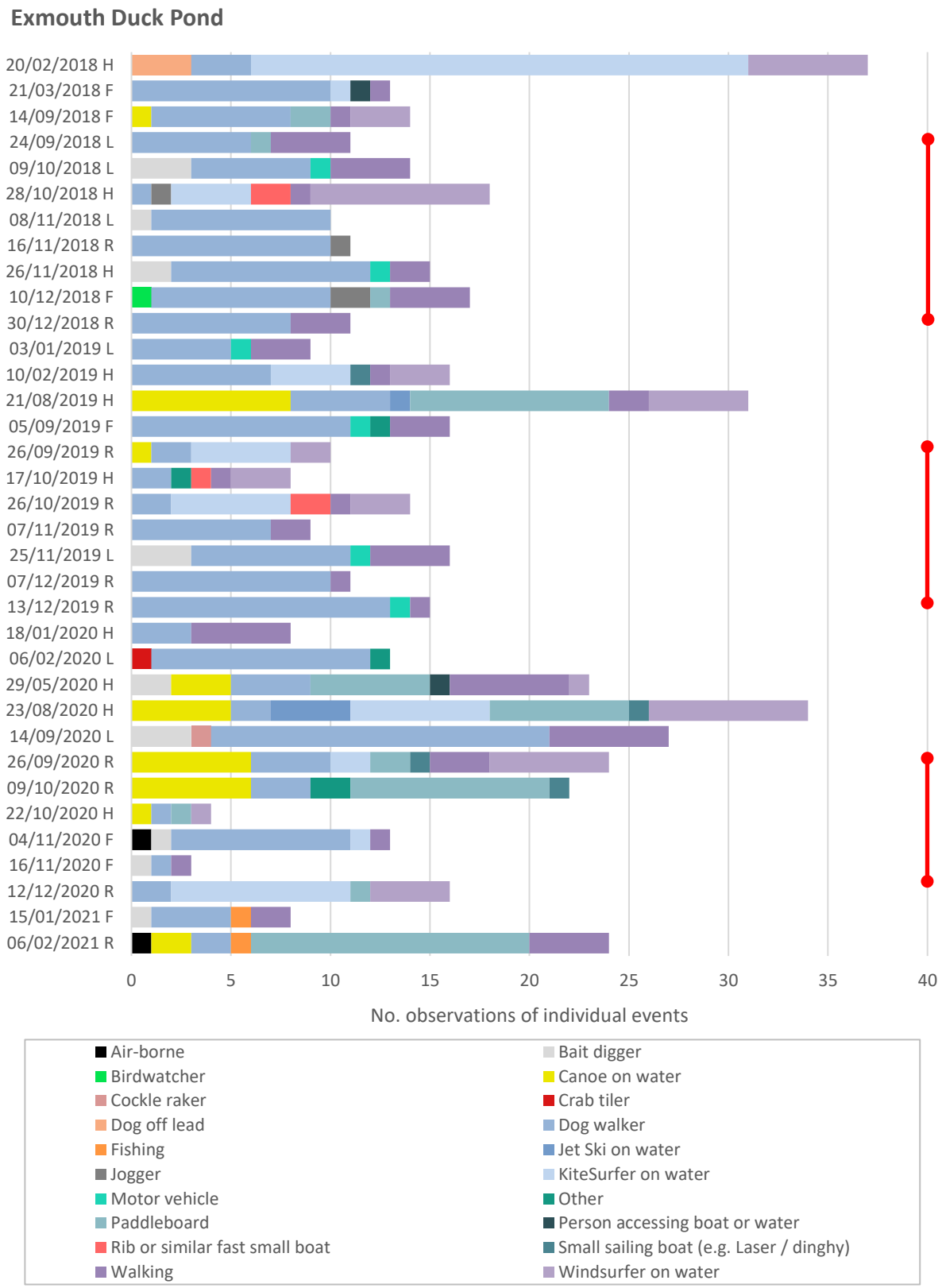


Figure 5: Diary data from the Exmouth Duck Pond Core Counts, by date. The red vertical lines indicate when the Exmouth refuge was active. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling.

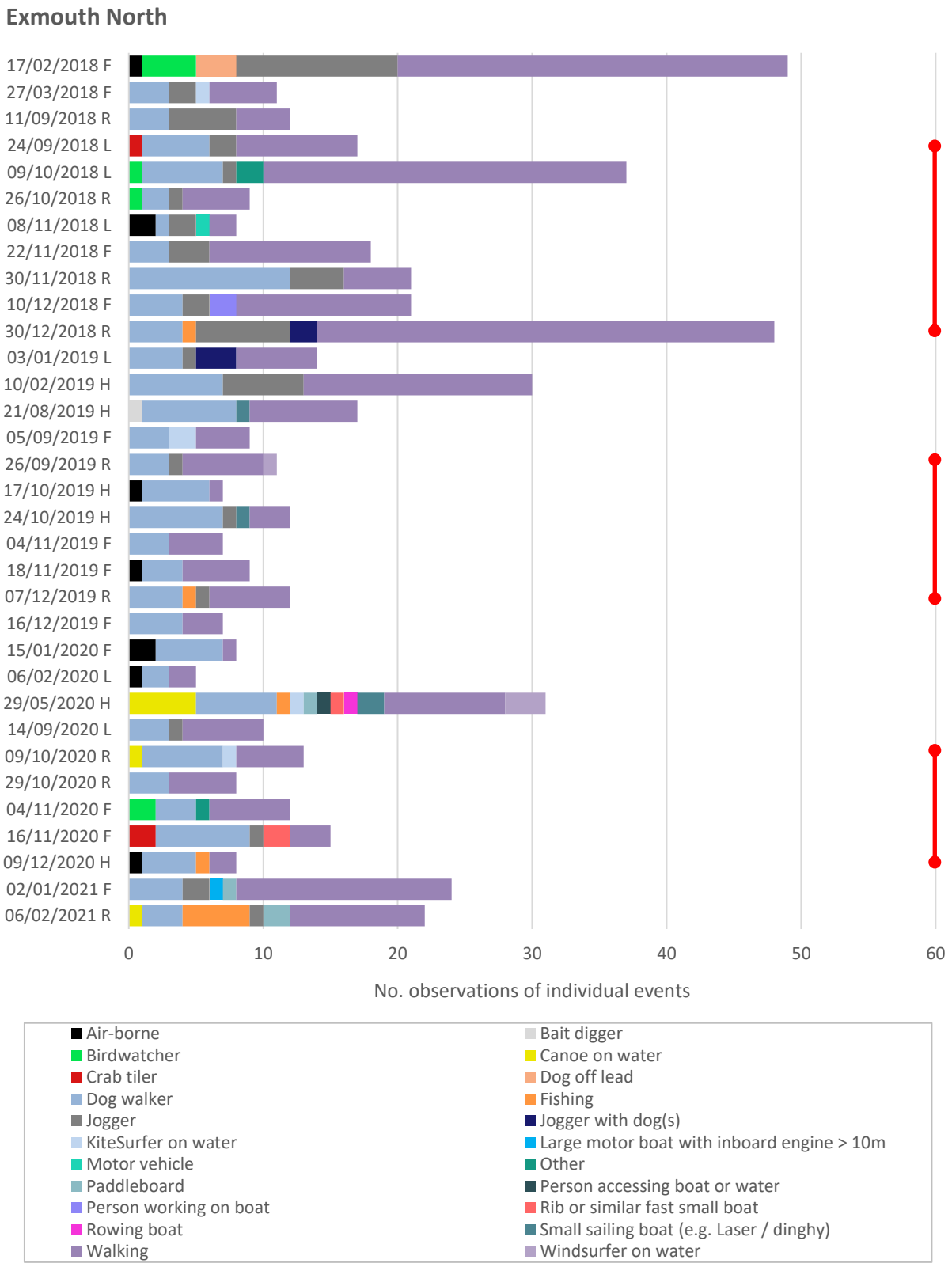


Figure 6: Diary data from the Exmouth North Core Counts, by date. Note that the figure excludes trains and cyclists recorded on adjacent (largely screened off) areas to aid interpretation. The red vertical lines indicate when the Exmouth refuge was active. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling.

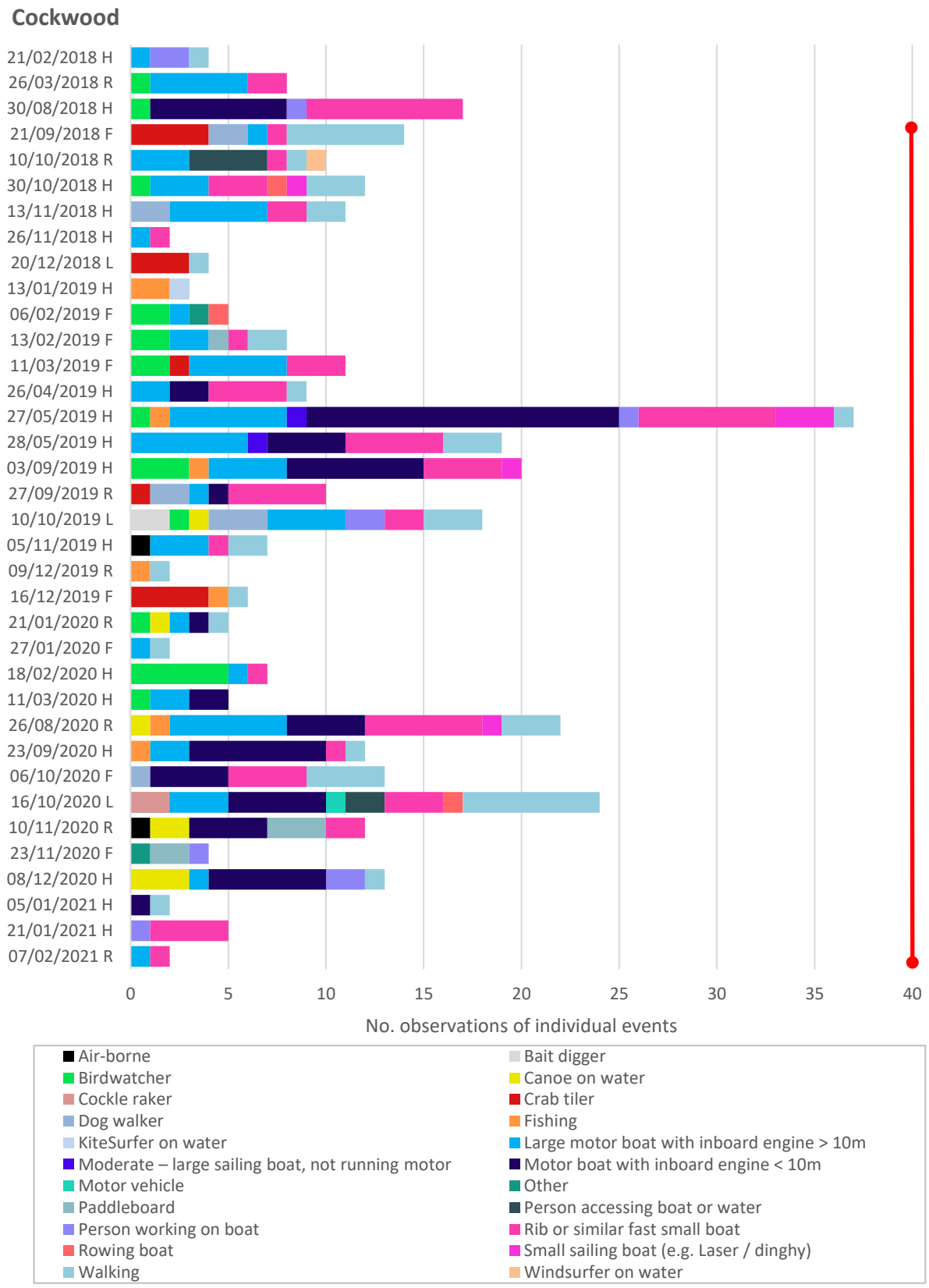


Figure 7: Diary data from the Cockwood Core Counts, by date. Note that the figure excludes recorded on adjacent areas to aid interpretation. The red vertical lines indicate when the Dawlish refuge was active. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling.

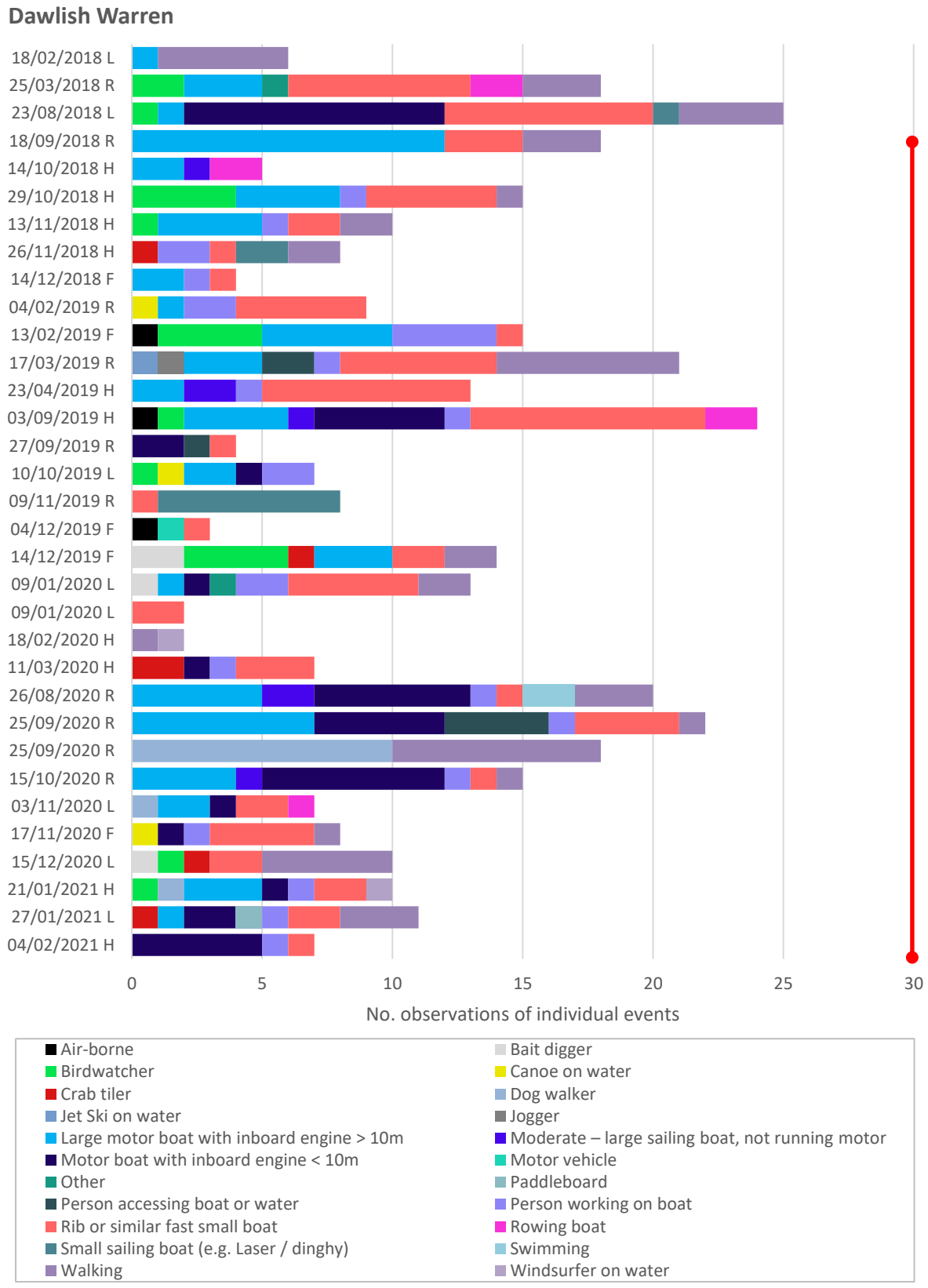


Figure 8: Diary data from the Dawlish Warren Core Counts, by date. The red vertical lines indicate when the Dawlish refuge was active. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling.

5.5 Aside from watercraft, crab tiling was one of the most frequently recorded activities within the Dawlish Core Count areas, with 13 observations made at Cockwood and 6 at Dawlish Warren. In contrast, only 4 observations of crab tiling were made in combination from the two Exmouth Core Count localities. The presence of birdwatchers was also notable, with 21 and 20 recorded in total at Cockwood and Dawlish Warren, respectively.

5.6 Dog walking was the most commonly recorded activity at Exmouth Duck Pond throughout the study period, with a total of 214 observations made. A slightly smaller number of dog walkers (139) were recorded at Exmouth North, although both this and the figure for the Duck Pond dwarf the combined total of 22 dog walkers recorded at the two Dawlish Core Count locations over the entire study period. Walking was the most frequently observed activity at Exmouth North (273 observations in total).

5.7 The Duck Pond was notable for being the key Core Count location for recreational watersports, with 64 observations made of kitesurfing (5 or fewer recorded at all other sites), 55 of paddleboarders (1 to 6 recorded elsewhere), 54 of windsurfers (fewer than 5 at all other locations), and 33 canoes on the water (fewer than 8 at the three other localities). The Duck Pond was also an important location for bait digging, with the 17 observations made there contrasting with the 1 to 4 records from each of the other three sites.

5.8 The data for the two Exmouth Core Count locations suggest that peak observations are concentrated at times outside of the Exmouth refuge's active period, but that many activities still occur when the refuge is active. The obvious dip in the number of observations made at the Duck Pond on several dates in late October and November 2020 may however be due to the implications of Coronavirus (i.e. lockdowns). Nevertheless, dog walking and walking, in particular, appear to show relatively little variation in numbers across the years, suggesting that the presence of the refuges has not resulted in these users being deterred over the three-year survey window.

5.9 The data for Cockwood, and to a lesser extent Dawlish Warren, show a marked seasonality with activity peaking in the summer and autumn. Aside from a slight decrease in observations during 2020/21 (again potentially due to the pandemic), the data does not show any apparent changes in activity

patterns at the Core Count locations on the western side of the estuary since the Dawlish refuge became active.

Key findings: number of recreation events

The Exmouth Core Count locations, incorporating areas in and outside of the Exmouth refuge, were much busier than those at Dawlish across the entire study period. Dog walking was the most commonly recorded activity at the Exmouth Duck Pond, with slightly smaller numbers recorded at Exmouth North. Dog walking was far less commonly observed at Dawlish. Watercraft dominated observations throughout at the two Dawlish Core Count locations. Exmouth Duck Pond was also a key location for recreational watersports, and bait digging was also frequently recorded.

Peak levels of recreation activity at the Exmouth Core Count locations were recorded during the summer, although many activities still occurred when the refuge was active during autumn and winter. Activity levels at the Cockwood Core Count location, and to a lesser extent Dawlish Warren, showed a marked seasonality, with activity peaking in the summer and autumn.

Changes in levels of use across the study area since the Exe Disturbance Study 2011 (Core Count data)

5.10 Table 4 provides a comparison between the number of activity events (expressed as counts per hour of survey) recorded from Core Counts in the Exe Disturbance Study 2011 and those detailed in the current study. The Core Count data does not differentiate between observations made inside and outside of the refuges, instead providing an indication of any changes which have occurred in the prevalence of particular recreation activities across the study area in the intervening period.

5.11 Data are only provided for Cockwood from the western side of the estuary, as the Dawlish Warren Core Count location was not surveyed during the 2009-2011 study. The table also depicts the percentage change in the observation rate of each activity in the intervening period, with these changes colour-coded to aid interpretation. Note that several of the activities were newly recorded during the current study, and it was not therefore possible to calculate a percentage change for them.

5.12 The data show that bait digging (including crab tiling and cockle raking), motor vehicles, and the number of people observed working on boats have declined at all three of the Core Count locations in the period between the two studies. It also shows that observations of birdwatchers, canoes on the water, and large motorboats at Cockwood have shown large increases. The large increase in birdwatcher observations at Cockwood is likely to have been caused by the loss of public access to the Dawlish Warren bird hide. This follows the total loss of the publicly-accessible bird hide path to storm damage in December 2020 (with storm damage-related access issues already apparent since November 2018) leading to a larger number of birdwatchers viewing the estuary from Cockwood.

5.13 The number of dogwalkers and RIBS observed at Cockwood have also increased to a slightly lesser extent. It is noteworthy however that the rate of observation of all other watercraft-related activities at the locality has declined since the 2011 study.

5.14 At both the Duck Pond and Exmouth North the rate of observation of dog walkers has nearly halved (-44% and -46%), and the numbers of walkers (-44% and -68%) and RIBs (-18% and -70%) at both localities have also declined. Nevertheless, the rate of observation of canoes on the water at the Duck Pond has increased by 69%, the number of jet-skis by a half, and windsurfing has also increased slightly (3%). Contrastingly, the rate of observation of both kitesurfers (-56%) and people accessing a boat or water (largely comprising watersports enthusiasts at this location) has decreased by a half.

5.15 At Exmouth North the rate of observation of RIBs (-70%) and windsurfers (-65%) has declined sharply, but the observation rate of small sailing boats at that location has increased by 40%. As at Cockwood, the rate of observation of birdwatchers has however increased by a large degree (180%), and the Exmouth North is the only one of the three locations detailed where the rate of observation of dogs off lead has increased (20%).

Table 4: Relative (%) changes in the observation rate (counts per hour) of recreational activities between the 2011 Exe Disturbance study and the current study at three of the four Core Count locations. Colour-scaling is provided to assist interpretation (dark blue = large % decrease; red = large % increase). Note that the data does not take account of refuge activity status or location of the observations with respect to the relevant refuge boundaries.

Activity	Cockwood[4]			Exmouth Duck Pond			Exmouth North		
	2009-11 count/hr	2018-21 count/hr	% change	2009-11 count/hr	2018-21 count/hr	% change	2009-11 count/hr	2018-21 count/hr	% change
Airborne	0	0.04	N/A	0.03	0.04	33%	0.1	0.16	60%
Bait digger etc[5]	1.28	0.28	-78%	1.07	0.32	-70%	0.24	0.07	-71%
Birdwatcher	0.07	0.35	400%	0.03	0.02	-33%	0.05	0.14	180%
Canoe on water	0.07	0.14	100%	0.32	0.54	69%	0	0.12	N/A
Cycling	0	0	N/A	0.16	0.04	-75%	6.77	3.37	-50%
Dog off lead	0	0	N/A	0.16	0.05	-69%	0.05	0.06	20%
Dog walker	0.13	0.17	31%	6.51	3.5	-46%	4.15	2.34	-44%
Fishing from shore	0.13	0.14	8%	0	0.04	N/A	0	0.16	N/A
Horse Riding	0	0	N/A	0.08	0	-100%	0.05	0	-100%
Jet Ski on water	0.13	0	-100%	0.06	0.09	50%	0	0	N/A
Jogger	0	0	N/A	0.03	0.07	133%	1	1.03	3%
Kids playing	0	0	N/A	0.11	0	-100%	0.05	0	-100%
Kite Flying	0	0	N/A	0.06	0	-100%	0	0	N/A
Kitesurfer on water	0.13	0.02	-85%	2.38	1.05	-56%	0	0.09	N/A
Large boat on outboard motor	0.55	1.16	111%	0	0	N/A	0	0.02	N/A
Moderate – large sailing boat	0.13	0.04	-69%	0	0	N/A	0	0	N/A
Motor vehicle	0.07	0.02	-71%	0.78	0.1	-87%	0.39	0.02	-95%
Other	0	0.04	N/A	0.14	0.09	-36%	0.05	0.06	20%
Person accessing boat / water	0.13	0.1	-23%	0.08	0.04	-50%	0	0.02	N/A
Person working on boat	0.25	0.17	-32%	0.03	0	-100%	0.05	0.04	-20%
Picnic/people sitting	0	0	N/A	0.14	0	-100%	0.05	0	-100%
Rib or similar fast small boat	0.85	1.18	39%	0.11	0.09	-18%	0.2	0.06	-70%
Rowing Boat	0.19	0.05	-74%	0.11	0	-100%	0	0.02	N/A
Small sailing boat	0.13	0.1	-23%	0	0.07	N/A	0.05	0.07	40%
Walking	0.67	0.77	15%	3.39	1.1	-68%	8.15	4.59	-44%
Windsurfer on water	0	0.02	N/A	0.86	0.89	3%	0.2	0.07	-65%

[4] The 2018-21 Dawlish Warren Core Count location was not subject to survey in 2009-2011.
[5] Includes crab tiling and cockle raking, as the latter two activities were not recorded separately in the 2009-2011 dataset.

Key findings: changes in levels of use since the Exe Disturbance Study 2011 (Core Count data)

Core Count data suggest that bait digging, motor vehicles, and the number of people observed working on boats have all declined across the entire study area in the period between the 2011 and current studies.

The data also suggests that birdwatchers, canoeists, and large motorboats at Cockwood have shown large increases in the same period, alongside smaller increases in the number of dog walkers and RIBs. All other watercraft-related activities at Cockwood have however declined.

At both the Duck Pond and Exmouth North the data suggest a decline in the numbers of dog walkers, walkers, and RIBs. The rate of observation of canoeists, jet-skis, and windsurfers at the Duck Pond have however increased, whilst both kitesurfers and people accessing a boat or the water have halved. At Exmouth North the rate of observation of RIBs and windsurfers has declined sharply, but the figure for small sailing boats at that location has increased by 40%. The rate of observation of birdwatchers at Exmouth North has also has increased by a large amount, and it is the only location where the number of dogs off lead has increased.

Changes in level of use inside the refuge areas since the Exe Disturbance Study 2011 (Vantage Point Count data)

5.16 The results of the Core Count analyses detailed in Table 4 are complemented by the comparison of Vantage Point Count data for the Exmouth Duck Pond depicted in Table 5. These data allow us to assess changes in recreational activity levels both in and outside the Exmouth refuge in the vicinity of the Duck Pond between the two study periods. Neither the Dawlish Warren nor Lympstone 2019-2021 Vantage Point locations were surveyed during the previous study, making a comparison with these sites impossible.

5.17 The table provides a comparison between the number of activity events at the Duck Pond Vantage Point location during the 2009-2011 study (pre-activation of the Exmouth refuge) and during the active and inactive refuge periods across the current study. The rate of observation of each activity type is expressed as the mean count across Vantage Point Count surveys, and the percentage change from the 2009-2011 is also provided in parentheses. These changes are colour-coded to aid interpretation, with

those activities which have shown an increase highlighted in red, and those that have shown a decrease highlighted in green.

5.18 Any comparison needs to be treated with some caution due to differences in survey effort and timing. Nonetheless, the data suggests that the rate of observation of bait digging, kitesurfing, large motorboats, both large and small sailing boats, and motor vehicles have either decreased or stayed the same both in and outside the refuge boundary during both its' active and inactive periods. Of particular note is the finding that the rate of observation of dog walkers inside the refuge decreased by 50% during the refuge's active period and by 22% during the inactive period. The allied 86% increase in dog walking outside the refuge during its' inactive period is potentially indicative of increasing year-round compliance, avoiding the refuge area by this user group. Walkers show a marked decrease in their rate of observation both in and outside the refuge during its' active period (-90% overall), but an increase both in and outside when it's inactive (14% overall), again indicative of avoidance.

5.19 RIBs, canoes on the water, and "other" are the only previously recorded activities which have increased their rates of observation within the refuge during the refuge's active period, with increases observed for the latter two activities across all categories. The increase in the rate of observation of RIBs inside the refuge during the active period has however occurred alongside an observed decrease in the rate outside of the refuge at the same time.

5.20 Of those activities not recorded during the 2011 study, cycling, jogging, people working on boats, and rowing boats were only observed outside the refuge, whereas paddleboarding was only recorded inside the refuge when it was inactive (although this may simply be a result of the seasonality of this activity within the study area). Windsurfing was recorded inside the refuge during both the active and inactive periods, but at a higher rate during the former. With respect to recreational watersports, the data suggests that a significant minority of canoeists, RIBs, and windsurfers do not avoid the refuge when it is active.

Table 5: Comparison between recreational activity (expressed as mean count per survey) from the 2011 study Vantage Point data from the Exmouth Duck Pond (prior to the refuges coming into operation) and the same data from the current study, split between the Exmouth refuge's active and inactive periods. The percentage change for each activity in the active/inactive period is provided in parentheses (with changes of > +/-1% in bold), with those activities which have increased highlighted in red, and those that have decreased highlighted in green. Activities which were not identified in the 2011 Duck Pond Vantage Point dataset are in bold and italicised.

Activity	Pre-operation (2011 study data: N = 22)			Post-operation when refuge inactive (N = 44)			Post-operation when refuge active (N = 44)		
	Outside refuge (count/VP)	Inside refuge (count/VP)	Total (count/VP)	Outside refuge (count/VP and % change)	Inside refuge (count/VP and % change)	Total (count/VP and % change)	Outside refuge (count/VP and % change)	Inside refuge (count/VP and % change)	Total (count/VP and % change)
Airborne	0	0	0	0 (N/A)	0 (N/A)	0 (N/A)	0.03 (N/A)	0 (N/A)	0.03 (N/A)
Bait digger	0.64	0.14	0.78	**0.21 (-68%)**	**0.07 (-50%)**	**0.28 (-65%)**	**0.16 (-75%)**	**0.1 (-29%)**	**0.25 (-68%)**
Canoe on water	0.05	0	0.05	**0.1 (100%)**	0.05 (N/A)	**0.14 (180%)**	**0.12 (140%)**	0.05 (N/A)	**0.16 (220%)**
Cycling	0	0	0	0.05 (N/A)	0 (N/A)	0.05 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
Dog walker	0.64	0.64	1.28	**1.19 (86%)**	**0.5 (-22%)**	**1.69 (33%)**	**0.57 (-11%)**	**0.32 (-50%)**	**0.89 (-31%)**
Fishing from shore	0.1	0	0.1	**0 (-100%)**	0.03 (N/A)	**0.03 (-70%)**	**0 (-100%)**	0 (N/A)	**0 (-100%)**
Jogger	0	0	0	0.07 (N/A)	0 (N/A)	0.07 (N/A)	0.03 (N/A)	0 (N/A)	0.03 (N/A)
Kids playing	0.14	0.05	0.19	**0.1 (-29%)**	0.05 (0%)	**0.14 (-27%)**	**0.03 (-79%)**	**0 (-100%)**	**0.03 (-85%)**
Kitesurfer on water	0.78	0.14	0.91	**0.25 (-68%)**	**0.12 (-15%)**	**0.37 (-60%)**	**0.6 (-24%)**	**0.05 (-65%)**	**0.64 (-30%)**
Large motorboat	0.1	0	0.1	**0.05 (-50%)**	0 (N/A)	**0.05 (-50%)**	**0.03 (-70%)**	0 (N/A)	**0.03 (-70%)**
Metal detectorist	0	0	0	0 (N/A)	0.03 (N/A)	0.03 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
Moderate to large sailing boat	0.19	0	0.19	**0 (-100%)**	0 (N/A)	**0 (-100%)**	**0 (-100%)**	0 (N/A)	**0 (-100%)**
Motor vehicle	0.19	0	0.19	**0.12 (-37%)**	0 (N/A)	**0.12 (-37%)**	**0.03 (-85%)**	0 (N/A)	**0.03 (-85%)**

Activity	Pre-operation (2011 study data: N = 22)			Post-operation when refuge inactive (N = 44)			Post-operation when refuge active (N = 44)		
	Outside refuge (count/VP)	Inside refuge (count/VP)	Total (count/VP)	Outside refuge (count/VP and % change)	Inside refuge (count/VP and % change)	Total (count/VP and % change)	Outside refuge (count/VP and % change)	Inside refuge (count/VP and % change)	Total (count/VP and % change)
Other	0	0	0	0.16 (N/A)	0.12 (N/A)	0.28 (N/A)	0.14 (N/A)	0.16 (N/A)	0.3 (N/A)
Paddleboarder	0	0	0	0.53 (N/A)	0.71 (N/A)	1.23 (N/A)	0.1 (N/A)	0 (N/A)	0.1 (N/A)
Person accessing boat or water	0.28	0	0.28	**0.03 (-90%)**	0.03 (N/A)	**0.05 (-83%)**	**0 (-100%)**	0 (N/A)	**0 (-100%)**
Person working on boat	0	0	0	0.03 (N/A)	0 (N/A)	0.03 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
Picnic	0	0	0	0.07 (N/A)	0.05 (N/A)	0.12 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
RIB or similar small fast boat	0.1	0	0.1	**0.14 (40%)**	0 (N/A)	**0.14 (40%)**	**0 (-100%)**	0.07 (N/A)	**0.07 (-30%)**
Rowing boat	0	0	0	0.03 (N/A)	0 (N/A)	0.03 (N/A)	0.05 (N/A)	0 (N/A)	0.05 (N/A)
Small sailing boat	0.28	0.19	0.46	**0.1 (-65%)**	**0 (-100%)**	**0.1 (-79%)**	**0.05 (-83%)**	**0 (-100%)**	**0.05 (-90%)**
Train	0	0	0	0.03 (N/A)	0 (N/A)	0.03 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
Walking	0.41	0.28	0.69	**0.48 (18%)**	**0.3 (8%)**	**0.78 (14%)**	**0.1 (-76%)**	**0.12 (-58%)**	**0.21 (-70%)**
Water-skiing	0	0	0	0.03 (N/A)	0 (N/A)	0.03 (N/A)	0 (N/A)	0 (N/A)	0 (N/A)
Windsurfer on water	0	0	0	0.28 (N/A)	0.21 (N/A)	0.48 (N/A)	0.6 (N/A)	0.07 (N/A)	0.66 (N/A)

Key findings: changes in level of use inside the refuge areas since the Exe Disturbance Study 2011 (Vantage Point Count data)

Vantage Point Count data allow us to compare changes in use of the Exmouth Duck Pond recording area between 2011 and the current study and to look specifically at change within the refuge. Excluding those activities not recorded in the 2011 study, during the Exmouth refuge's active periods the number of canoes on the water, windsurfers, and 'other' (i.e. non-categorised) activities was higher overall (both in and outside the refuge) during the current study than in 2011. Conversely, the number of bait diggers, dog walkers, kids playing, kitesurfers, small sailing boats, and walkers (without a dog) decreased overall (both in and outside the refuge) in the same period.

Incursions inside the refuges

5.21 It was possible to identify incursions into the refuge areas using both the Core Count and Vantage Point Count datasets. A total of 51 Vantage Point Counts were made at Exmouth Duck Pond, and 36 at Lympstone, when the Exmouth refuge was active, with a total of 69 made at Cockwood when the Dawlish refuge was active. Vantage Point data across the three years of the study identified 67 instances (of 12 readily identified activity types, plus an "other" category) of incursions into the refuge areas when the refuges were active. A table detailing each of the recorded incursions is provided in Appendix 2. We have included activities such as crab tiling, 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 activities within the refuge boundaries.

5.22 Dog walking comprised the most frequently recorded incursion activity combined across all sites during all three years of the study, with crab tiling (7 incursions in 2019/20 and a single incursion in 2018/19) and fishing from shore (5 incursions in 2018/19, and single incursions in both 2019/20 and 2020/21) also frequently recorded. Incursions by bait diggers (1 to 2), walkers (1 to 4), and windsurfers (single instances) were also recorded in each of the three years of the study. Incursions from birdwatchers, canoeists, kitesurfers, small motorboats, RIBs, picnickers, and "other" activities were noted less than annually.

Figure 9: A bait digger within the refuge area (note the yellow buoy in the foreground). An example of an activity which regularly comprised incursions into the refuges during their active periods.

5.23 It should again be noted that the majority of "other" activities recorded at the Duck Pond in 2019/20 comprised construction work being carried out on the coastal revetments rather than recreational activity. Surveyors noted that on a number of occasions this comprised workers outside of, or in the act of moving, screen fencing put up to minimise the visual impact of the works on birds within the refuge. Due to the extreme proximity of the works area to the refuge boundary however, it is considered possible that some of these "incursions" may be mapping artefact rather than true incursions.

5.24 In each year of the study a number of the incursions observed in the Vantage Point Count dataset comprised activities occurring >50m from the shore, and therefore clearly well inside the relevant refuge boundary. This comprised 9 such incursions in 2018/19, 12 in 2019/20, and 2 in 2020/21, with crab tiling (8 observations in total) and bait digging (4 observations in total) being the most frequently recorded incursions of this type. The majority of such

incursions (15 in total) occurred at low tide when expanses of estuarine mud were exposed.

5.25 Incursions within the refuges that were recorded during the Core Counts, across the entire three-year study period, are detailed in a second table in Appendix 2. In summary a total of 149 incursions were logged:

- Exmouth north: 21 counts (36.75 hours in total), 5 incursions on 5 dates;
- Exmouth Duck Pond: 21 counts (36.75 hours), 81 incursions on 15 dates;
- Dawlish Warren: 31 counts (54.25 hours), 31 incursions (of which 3 were crab tilers) on 15 dates; and,
- Cockwood: 32 counts (56 hours), 22 incursions (of which 6 were crab tilers) on 9 dates.

5.26 The majority of incursions recorded were at the Duck Pond, where 81 incursions occurred across 15 dates. A smaller number of incursions were recorded at Dawlish Warren and Cockwood (31 incursions over 15 dates and 22 incursions over 9 dates, respectively). The smallest number of incursions were recorded from Exmouth North (5 incursions over 5 dates).

5.27 The small number of incursions recorded at Exmouth North comprised 4 dog walkers and a single fisherman. 47% of the 81 incursions at the Duck Pond consisted of dog walkers, with kitesurfers and windsurfers each comprising 11% of the remaining observations. 7% of observations there comprised walkers, and 6% canoeists, with paddleboarders and RIBs each forming 4%.

5.28 At Dawlish Warren, 42% of the incursions consisted of walkers, with crab tilers and birdwatchers each comprising 10%. Swimmers, paddleboarders, RIBs, and people accessing boats or the water each comprised a further 6% of the total. Walkers also comprised 45% of the 22 incursions at Cockwood, with crab tilers forming 27% and dog walkers 14%.

Key findings: incursions into the refuges

The data show a reasonable level of compliance with the refuges when they were active, although incursions (when the refuge was active) were still logged in all years of the study. Over the three years of the study, 67 incursions were recorded into the refuges (when they were active) during the Core Counts and 139 were recorded during the Vantage Point Counts. The largest number of incursions were observed at the Duck Pond/within the Exmouth refuge, with the lowest number observed from Exmouth North.

Dog walking comprised the most frequently recorded incursion activity overall across the refuges, with crab tiling/bait digging, walking, and fishing from shore also frequently recorded (although note that crab tiling is not subject to the voluntary restrictions). Incursions by windsurfers and kitesurfers were also recorded, albeit less frequently, in each year, whilst incursions from birdwatchers, canoeists, small motorboats, RIBs, picnickers, and "other" activities were noted less than annually.

Most of the incursions recorded from the Vantage Point Counts were in close proximity to the refuge boundary (see para 5.24). A total of 23 incursions across the 3 years involved people more than 50m from the refuge boundary (i.e. well inside the refuge), and 8 of these were crab tilers (for whom the voluntary exclusion does not apply).

Changes in the number of incursions over the study period

5.29 The number of incursions recorded during the Vantage Point Counts in each of the three years of the study comprised 25 in 2018/19 (over 18 dates), 31 in 2019/20 (over 18 dates), and 11 in 2020/21 (over 7 dates). It is important to note that 6 of the 2019/20 incursions comprised work being carried out on the coastal revetments alongside the Duck Pond (classified as "other") and, if excluded from the total for that year, then the number of incursions relating to recreational activity have decreased in each year of the study. It is nevertheless unclear as to how much the Coronavirus pandemic impacted the overall activity levels (and the number of incursions) in the final year of the study.

5.30 The first year of the study showed incursions occurring within both the Exmouth and Dawlish refuges throughout the respective active refuge periods. The second year showed a spread of incursions throughout the year at Dawlish (in March, May, July, October, and February) and throughout September to November at Exmouth. Incursions in the final year were more prevalent in the spring and summer months at Dawlish (occurring in May, July, August, and October), but remained the same (in terms of monthly spread) at Exmouth.

5.31 The Vantage Point Count incursion data are summarised in Figure 10, which shows all the observations within the refuges. The figure shows that the number of incursions recorded at both the Duck Pond and Exmouth North decreased following the activation of the Exmouth refuge area in September 2018, although a lower level of incursions has been maintained throughout at the former locality. Nevertheless, incursions appeared to decrease at the Duck Pond during the Exmouth refuge's active period in each of the subsequent years and remained sporadic throughout at Lympstone.

5.32 In the final year of the study hardly any incursions occurred within the Exmouth Refuge during its' active period, although it is unclear as to how much of this can be explained by the lower levels of recreational activity observed due to the Coronavirus pandemic.

5.33 The situation at Dawlish Warren is less clear cut, although it is apparent that there has been a decrease in the small number of sporadic incursions occurring within the refuge since its' activation.

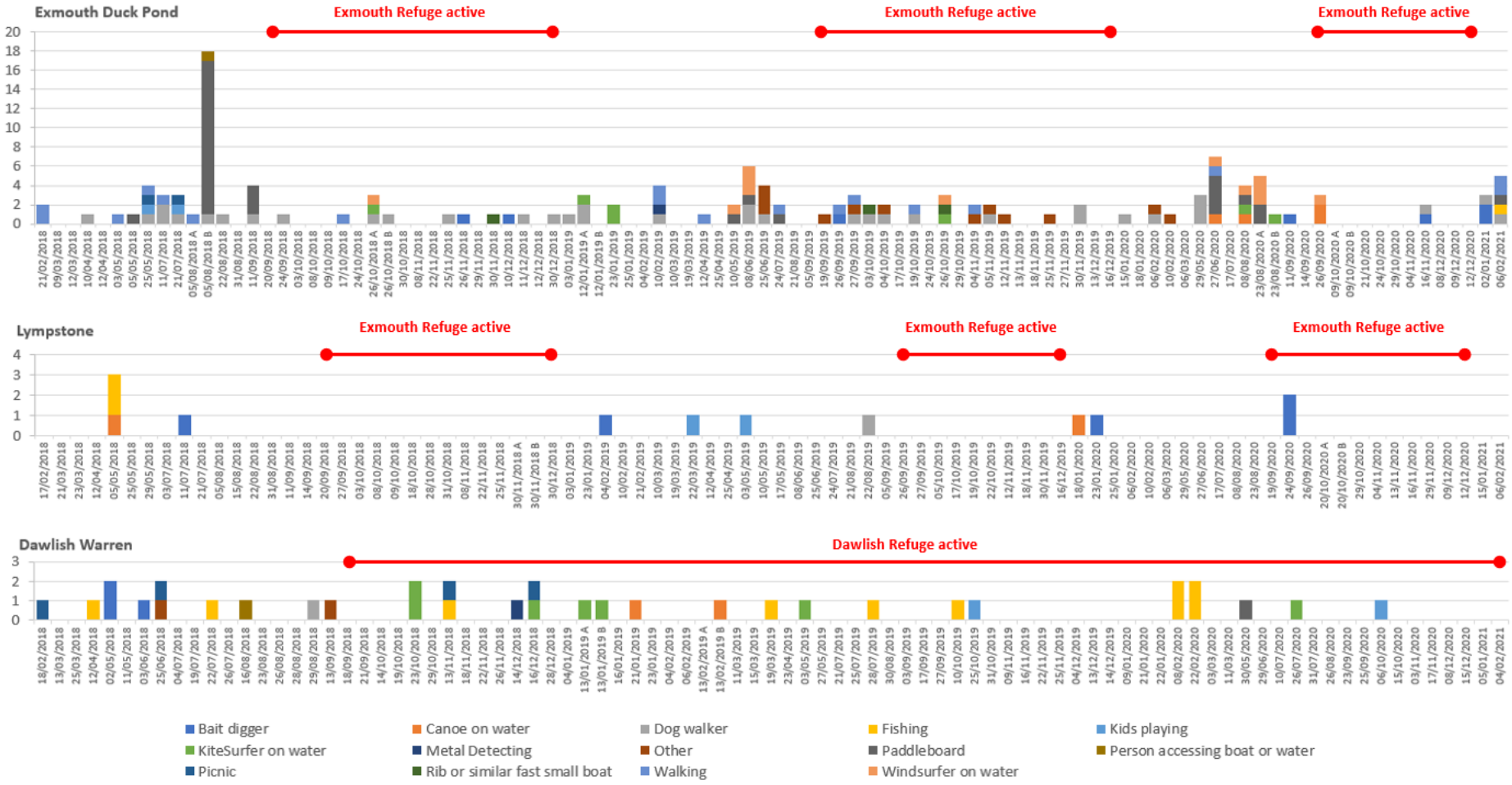


Figure 10: Vantage Point Count data showing all observations inside refuges, by activity. The three plots represent the three survey points, and the red lines indicate when the relevant refuge was operational/active. Note that the y axis scales differ between plots. Note also the dates differ between plots and dates with no bars indicate zero counts.

5.34 Figure 11 summarises the Core Count data for those activities identified as prevalent in the refuge incursion dataset. The bait digger category also includes crab tilers and cockle rakers, and watercraft comprises all water/boat-based activities (excluding swimmers and people working on stationary boats). The stacked bars describe the location of the activity (in or outside the refuge), with Exmouth refuge's inactive periods highlighted with a paler overall tone. Note that the figure combines data from Exmouth North and the Duck Pond in the Exmouth refuge plots, and from Cockwood and Dawlish Warren in the Dawlish refuge plots.

5.35 It can be seen that the overall numbers of dog walkers recorded from the Exmouth refuge Core Count locations during the refuge's active period, declined over the three years of the study, but remained relatively stable during its inactive periods. The figure also indicates that, during the second and third years of the study, a larger relative proportion of dog walkers were recorded within the Exmouth refuge during its active period than during its inactive periods. Conversely, the number of dog walkers at the Dawlish Warren Core Count locations increased across the study period, although there was no clear pattern in the number of incursions recorded across the three years.

5.36 The number of walkers recorded from the Exmouth refuge Core Count locations during the refuge's active period, also declined over the three years of the study, but varied across its inactive periods. There was however no clear interannual trend in the proportion of walkers recorded in or outside the refuge, although similar proportions were recorded inside the refuge during both its active and inactive periods during each of the three years. The number of walkers observed at the Dawlish Core Count locations varied from year to year, but the proportion recorded inside the Dawlish refuge decreased in each year of the study.

5.37 Smaller numbers of bait diggers, cockle rakers, and crab tilers were recorded from each respective refuges' Core Count locations. These activities were recorded relatively infrequently from within the Exmouth refuge, and there was no clear pattern in their temporal distribution. Bait diggers, cockle rakers, and crab tilers were recorded inside the Dawlish Refuge much more frequently, comprising approximately 50% of observations during the first two years of the study. The proportion observed inside the refuge during the final year of the study did decline, however, although a smaller number of observations were also made overall.

5.38 The number of water-based activities observed at the Exmouth refuge Core Count locations increased in each year of the study during the refuge's active period but varied across its inactive periods. The proportion of water-based activities observed inside the refuge during its active period remained relatively stable across the study period (between approximately 65% and 75%), but an interannual decline was apparent during its inactive periods. Furthermore, a larger relative proportion of observations were made inside the Exmouth refuge during its inactive period (compared to its active period) in the first and second years of the study. Nevertheless, in the final year of the study the relative proportion recorded inside the Exmouth refuge remained the same during both its active and inactive periods. A much larger number of water-based activities were recorded from the Dawlish Core Count locations, but these were almost exclusively observed outside the refuge boundary.

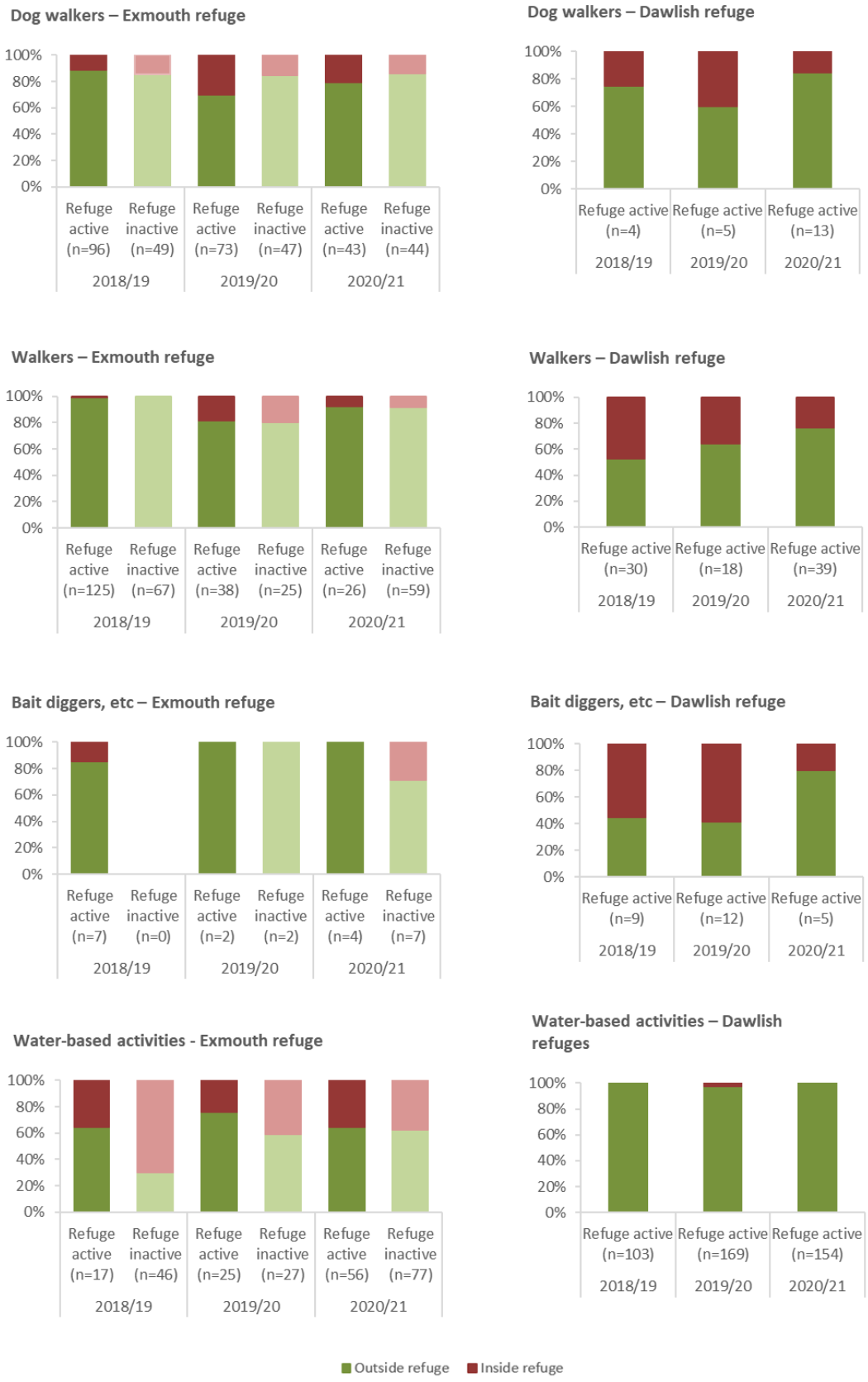


Figure 11: Relative percentages of frequently recorded activities (Core Count data) occurring inside and outside the two refuges across the three years of the study. The Exmouth plots depict the Exmouth refuge's active and inactive periods (combined Duck Pond and Exmouth North data) whilst the Dawlish plots depict data from the refuge's post-activation period only (combined Cockwood and Dawlish Warren data).

Key findings: changes in the number of incursions over the study period

In the final year of the study hardly any incursions occurred within the Exmouth Refuge during its' active period. There has also been a decrease in the small number of sporadic incursions occurring within the Dawlish refuge since its' activation.

The Vantage Point Count data showed a year on year decrease across the three years in the number of observations involving recreational activity inside the refuges when they were active (although no such pattern was evident from the Core Count data - see paras 5.35 to 5.38).

The relative proportion of walkers and bait diggers accessing the Dawlish refuge decreased over the study period, whilst the proportion of dog walkers accessing the refuge showed greater interannual variation (see Figure 11).

The proportion of dog walkers, walkers, bait diggers, and water-based activities accessing the Exmouth refuge varied across the three years of the study, although a larger relative proportion of water-based activities were observed inside the refuge during its inactive period, compared to when it was active, in the first and second years of the study (see Figure 11).

Sizes of groups entering refuges and duration of incursions

5.39 All of the incursions at Exmouth North recorded in the Core Count dataset consisted of single individuals, but group size varied markedly at the other three locations. At the Duck Pond, incursion group sizes generally ranged between 1 and 5 individuals, although a school group of 28 was observed on 10/12/2018. Group size ranged between 1 and 4 at Dawlish Warren and between 1 and 2 at Cockwood, with 3 observations of ranger intervention also recorded during the incursions observed at the Duck Pond.

5.40 The incursions at the Duck Pond were associated with by far the largest number of dogs (43 off lead and 4 on lead), with 5 dogs noted at Dawlish Warren (3 off lead), 4 at Exmouth North (all off lead), and 3 at Cockwood (1 off lead).

5.41 Analyses of the duration of individual incursion events within the Core Count dataset is not straightforward, as some activities will have commenced prior to the start of the diary recording period, whilst others will have continued after the recording period ended. Furthermore, it was often difficult for the

surveyors to monitor the fine-scale movements of particularly mobile activities, such as windsurfers, across individual diary recording periods.

5.42 Nevertheless, the data indicates that incursions resulting from certain activities tended to last longer than those resulting from others. Crab tilers and/or bait diggers were noted as present within the Dawlish refuge for more than 85 to 120 minutes on four survey dates, for example, and for 105 minutes (on a single occasion) within the Exmouth refuge. Incursions from other activities, including the majority of those observed from watersports enthusiasts, tended to be more fleeting, with several such incursions noted as resulting from launching within the refuge boundary (prior to accessing areas of water outside of it) or briefly navigating within the buoy marker line.

Key findings: sizes of groups entering refuges and duration of incursions

Incursion group sizes varied, but generally comprised 1 to 5 individuals. Larger group sizes were however noted on occasion.

Incursions within the Exmouth refuge, at the Duck Pond, incorporated the largest number of dogs (on and off lead).

Most incursions within the refuges were of relatively short duration, although incursions from some activities (e.g. bait digging) often lasted much longer.

Ranger visibility during incursions

5.43 The presence/absence of the ranger team during each Core Count and Vantage Point Count survey was noted, i.e. whether or not they were visible to the surveyor when the count was being undertaken. This information is incorporated separately for each of the two survey approaches within the two incursion tables in Appendix 2, with the combined data for both methodologies and refuge areas summarised in Figure 12.

5.44 It should be noted that the survey methodologies used were not explicitly designed to monitor the effect of ranger presence or to coincide with when the rangers might or might not be present. While we logged simple ranger presence/absence, we did not try to determine whether the rangers were visible from different parts of the refuge. Furthermore, the exact duration that the rangers were present for, or their location in relation to any observed incursion during the Core Count surveys, was not recorded (i.e. whether they were visible for the entire count period, or for a shorter period

of time within the survey window, or whether the incursion occurred in proximity to the rangers or at a distance further removed along the refuge boundary).

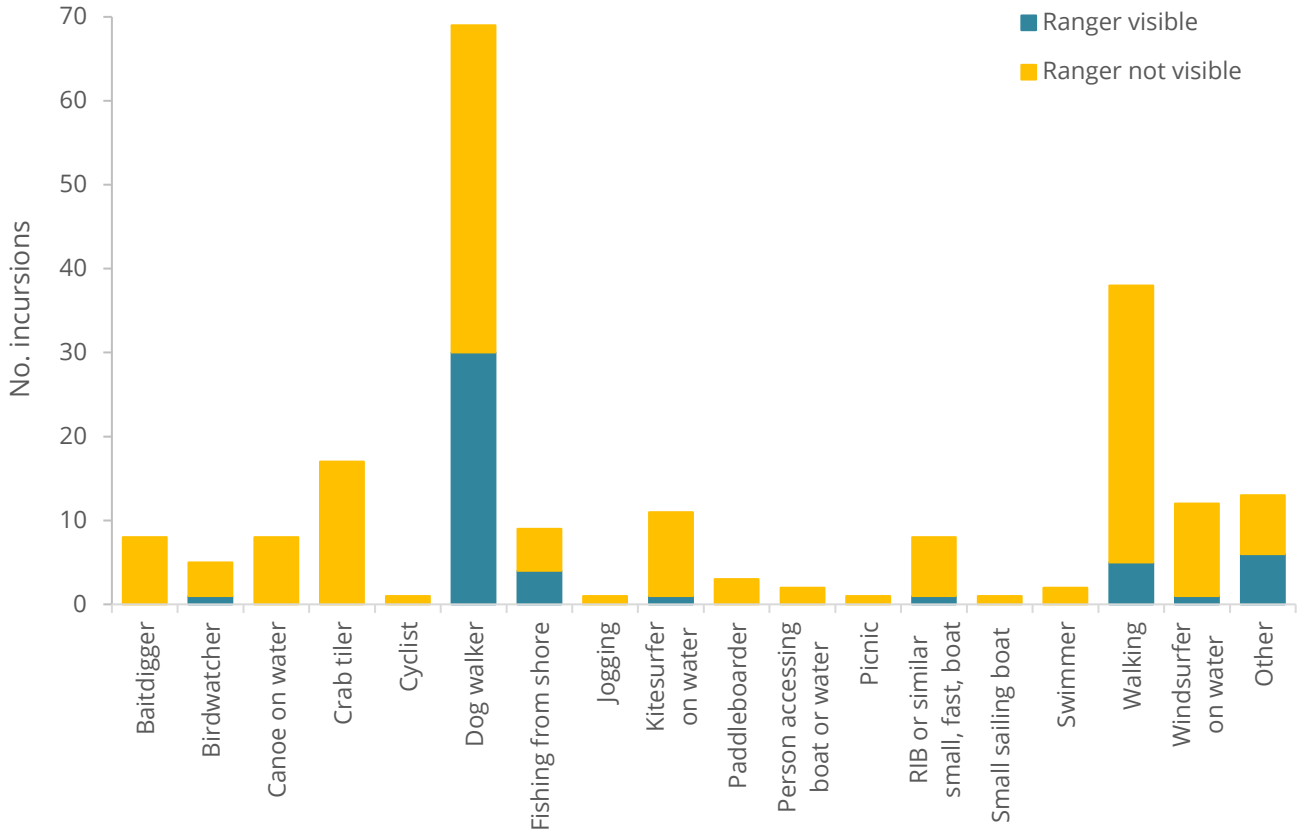


Figure 12: Combined observations of refuge incursions (Core Count and Vantage Point data) stratified by activity type and visibility of rangers to the surveyor at the time of the observation.

5.45 The combined data indicate that the majority of the incursions observed across most of the activity types depicted occurred when the rangers were not visible to the surveyor and were assumed to be absent from the site. Nevertheless, a relatively large proportion of the incursions by dog walkers (44%) and anglers (45%) occurred during survey periods when the rangers were noted as present (for at least part of the count), with 20% of incursions by birdwatchers, 14% by walkers, 13% by RIB activity, 10% by kitesurfers, and 9% by windsurfers also occurring in periods with ranger visibility.

5.46 It should however be noted that the data presented here does not take into account the level of recreational activity (i.e. "busyness") on any particular survey date, and any limitations placed on the number of potential interactions with members of the public within a given period for the small

ranger team. On busy days the ranger team may not be able to interact with every individual accessing the refuge in question, or the incursion may occur from access points far removed from the ranger team, further along the refuge area boundary from where they are stationed.

Key findings: ranger visibility during incursions

The majority of observed incursions occurred when the ranger team wasn't present.

Nevertheless, a relatively large proportion of the incursions by dog walkers (44%) and anglers (45%) occurred during survey periods when the rangers were noted as present (for at least part of the count). Smaller numbers of incursions by birdwatchers, walkers, RIBs, kitesurfers, and windsurfers also occurred during periods when the rangers were noted as present.

Distribution of recreational activity

5.47 The spatial data resulting from the mapping of the activities recorded during all of the Vantage Point Counts carried out across the three-year study period are shown in Maps 4 and 5. Map 4 shows all the data collected during the period prior to the refuges activation and during the subsequent inactive periods of the Exmouth refuge. Map 5 shows the data for the period subsequent to the Dawlish refuge's activation in mid-September 2018, and during all associated active periods of the Exmouth refuge.

5.48 The maps allow an appreciation of the overall density of observations across activity types at certain key locations (e.g. the Duck Pond area) across the two periods and highlight the wide range of activities recorded around the estuary during the study. They are also useful in identifying those particular activities which were more frequently recorded within the refuges during their respective active periods.

5.49 In terms of overall concentrations of activities during the refuges inactive periods, Map 4 shows areas of high use across the southern half of the Exmouth refuge and around the Duck Pond shoreline, with activity mainly running north along the estuary's eastern shore before again increasing in concentration around Lympstone. The western half of the estuary, in contrast, exhibits a relatively small number of dispersed observations (almost exclusively along the main channel north of the Dawlish refuge), with few observations made within proximity (or within) the Dawlish refuge itself.

5.50 The overall distribution of activities shown in Map 5 (during the refuges active periods) is very different, with a dense concentration of observations in the main channel immediately north of the Dawlish refuge boundary. Nevertheless, an approximately similar number of observations are shown within the Dawlish refuge both pre- and post-activation, with a concentration of observations in proximity to the Cockwood Vantage Point in both periods also.

5.51 In order to allow easier interpretation of the distribution of individual activities, or grouped activity types, additional maps are provided in Appendix 3. All of the observations depicted in Maps 4 and 5 have been split across Maps 6 to 11, with each map stratified by the relevant refuges active and inactive period. Map 6 shows the distribution of all boat-based activities, Map 7 that of recreational watersports, Map 8 dog walkers, Map 9 walkers, Map 10 bait diggers, cockle rakers, and crab tilers, and Map 11 all other activity types. The individual maps are summarised below.

5.52 The data show that observations of boat-based activities (Map 6, Appendix 3) were largely limited to areas outside of the two refuges, irrespective of refuge activity status, although the sole observation of a small motorboat within the Dawlish refuge was made prior to that refuge's activation. Motorboats and sailing craft were largely restricted to the main channel of the estuary, running north past Cockwood.

5.53 Recreational watersport activity (Map 7, Appendix 3) was concentrated within the south-eastern extent of the estuary, including in proximity to the Duck Pond and the Exmouth refuge. A large number of watersports observations were made from within the Exmouth refuge boundary during the refuge's inactive period, with paddleboarders and windsurfers recorded most commonly within the refuge. The number of such observations made within the Exmouth refuge boundary during the refuge's active period was however much lower, with only a small number of windsurfers, kitesurfers, and canoeists noted within the refuge.

5.54 Dog walking activity (Map 8, Appendix 3) was densely clustered along the Duck Pond shoreline of the Exmouth refuge during both its active and inactive periods, although the observations made of dog walkers well inside (i.e. >50m) the refuge boundary were mostly made during the refuge's inactive period. A smaller cluster of observations were also apparent in the vicinity of the Lympstone Vantage Point to the north, although more observations were made during the refuge's inactive period. No observations of dog walkers were made in proximity to the Dawlish refuge prior to its

activation, although a small concentration of observations was apparent around the Cockwood Vantage Point.

5.55 The distribution of walkers (Map 9, Appendix 3) was similar to that for dog walkers, with observations concentrated along the boundary of the refuges (and with an obvious cluster in proximity to the Exmouth refuge's Duck Pond shoreline). Observations of walkers around the Exmouth refuge were however much reduced during the refuge's active period, whilst a small number of observations were made around the periphery of the Dawlish refuge both pre- and post-activation.

5.56 The distribution of bait diggers, cockle rakers, and crab tilers across the estuary (Map 10, Appendix 3) did not vary particularly between the pre- and post-activation periods of the two refuges. Concentrations of bait diggers and crab tilers were noted in the northern half of the Dawlish refuge (including in areas south of the "no crab tiling" line), with bait diggers also present within the southern half of the Exmouth refuge, during the refuge's active periods.

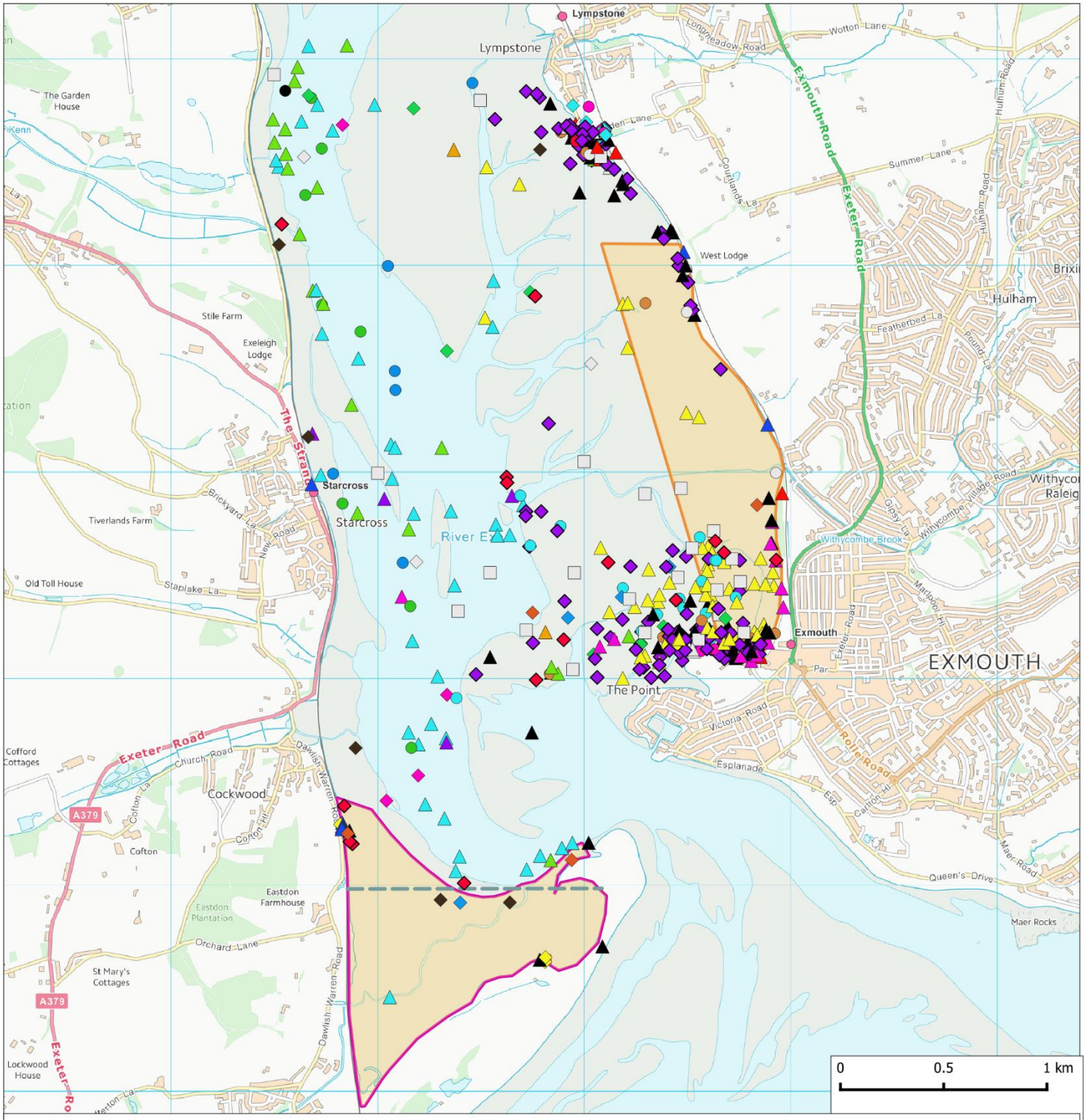
5.57 The majority of the other recorded activities (Map 11, Appendix 3) were generally discretely clustered, with observations of children playing largely limited to the Duck Pond area (during the refuge inactive period) and in the vicinity of Lympstone (during the refuge's active period). Similarly, anglers favoured the area immediately north of the Dawlish refuge boundary post-activation (with some observations made inside the refuge), whereas the Duck Pond area and the eastern estuary shoreline north of Exmouth were favoured during the inactive period. It should again be noted that the cluster of 'other' activities noted along the south-eastern perimeter of the Exmouth refuge during the refuge's active period largely corresponded to work being carried out on the coastal defences there.

Key findings: distribution of recreational activity

The southern half of the Exmouth refuge and the Duck Pond shoreline supported a large volume of recreational activity during the refuges' inactive period, whilst the smaller numbers of observations in proximity to the Dawlish refuge were mostly spread along the main channel running north of the Dawlish refuge.

During the refuges active periods the majority of observations were made outside of the refuge boundaries, with a dense concentration of observations in the main channel immediately north of the Dawlish refuge boundary and on the perimeter of the Exmouth refuge at the Duck Pond. A small number of observations were nevertheless made inside both of the refuges during their respective active periods.

Map 4: Vantage Point data: all activities during inactive refuge periods

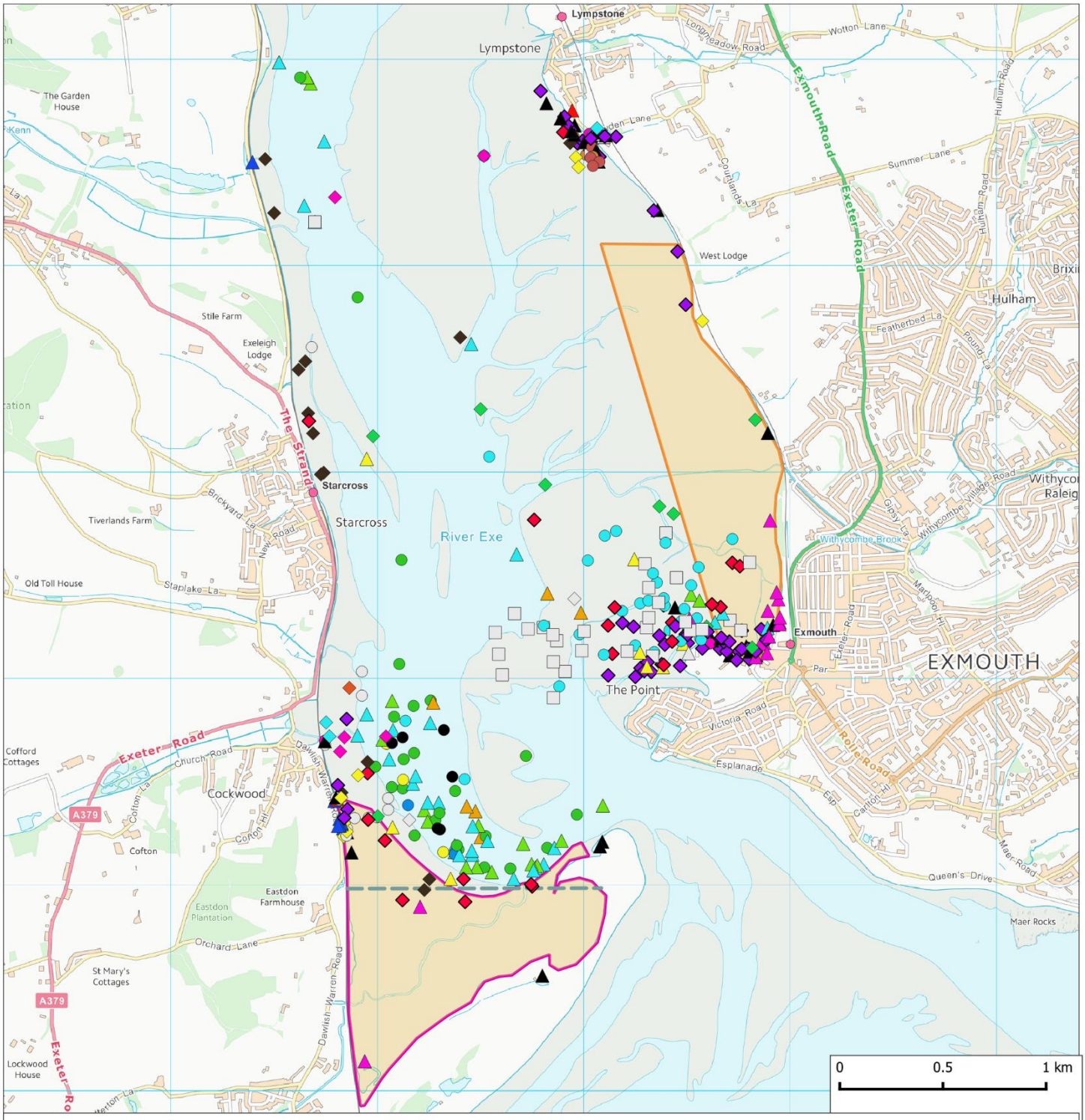


Legend

Activities [522]

- Airborne [3]
- Person working on a boat [4]
- Bait digger [16]
- Birdwatcher [3]
- Person accessing boat or water [4]
- Cyclist [22]
- Canoe on water [10]
- Cockle raker [4]
- Crab tiler [6]
- Dog walker [116]
- Fisherman [4]
- Jogger [8]
- Jogger with dogs [1]
- Kids playing [10]
- Kitesurfer [16]
- Large motor boat [8]
- Moderate to large sailing boat [6]
- Motorboat with inboard engine <10m [1]
- Metal detector [1]
- Motor vehicle [18]
- Other [12]
- Picnic [11]
- Paddleboarder [60]
- Rowing boat [2]
- Small motorboat [38]
- Small sailing boat [21]
- Train [11]
- Walker [77]
- Water Skier [4]
- Windsurfer [25]
- Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)
- Dawlish Warren refuge area
- Exmouth refuge area

Map 5: Vantage Point data: all activities during active refuge periods



Legend

Activities [395]

- Airborne [2]
- Person working on a boat [5]
- Bait digger [21]
- Birdwatcher [9]
- Person accessing boat or water [1]
- Cyclist [12]
- Canoe on water [10]
- Crab tiler [14]
- Dog walker [61]
- Fisherman [15]
- Horse rider [4]
- Jogger [3]
- Jet Ski on water [3]
- Kids playing [4]
- Kitesurfer [30]
- Large motor boat [24]
- Moderate to large sailing boat [4]
- Motorboat with inboard engine <10m [6]
- Motor vehicle [8]
- Other [15]
- Picnic [2]
- Paddleboarder [8]
- Rowing boat [6]
- Small motorboat [29]
- Small sailing boat [19]
- Train [14]
- Walker [35]
- Windsurfer [31]
- Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)
- Dawlish Warren refuge area
- Exmouth refuge area

6. Bird responses to disturbance

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

Effect of disturbance on the number of birds present

6.2 Figure 13 shows the number birds present at the end of each Core Count, at each of the four survey locations, in relation to the number of activity events recorded during the previous diary session (with the individual datapoints coloured by survey year). All of the plots depict a negative relationship between increasing number of events and number of birds present. The Spearman's correlation coefficient for each plot indicates that the relationship is strongest at Exmouth North (r_s = -0.47, p = 0.01) and the Exmouth Duck Pond (r_s = -0.34, p = 0.05), with non-significant negative correlations observed at both Cockwood (rs = -0.10, p = 0.55) and Dawlish Warren (rs = -0.15, p = 0.39).

6.3 There is also a clear indication of a temporal effect at Exmouth North, with fewer activities and more birds recorded in the final year of the study and more events and fewer birds recorded in the first year. Any temporal effect at the other three locations is less clear.

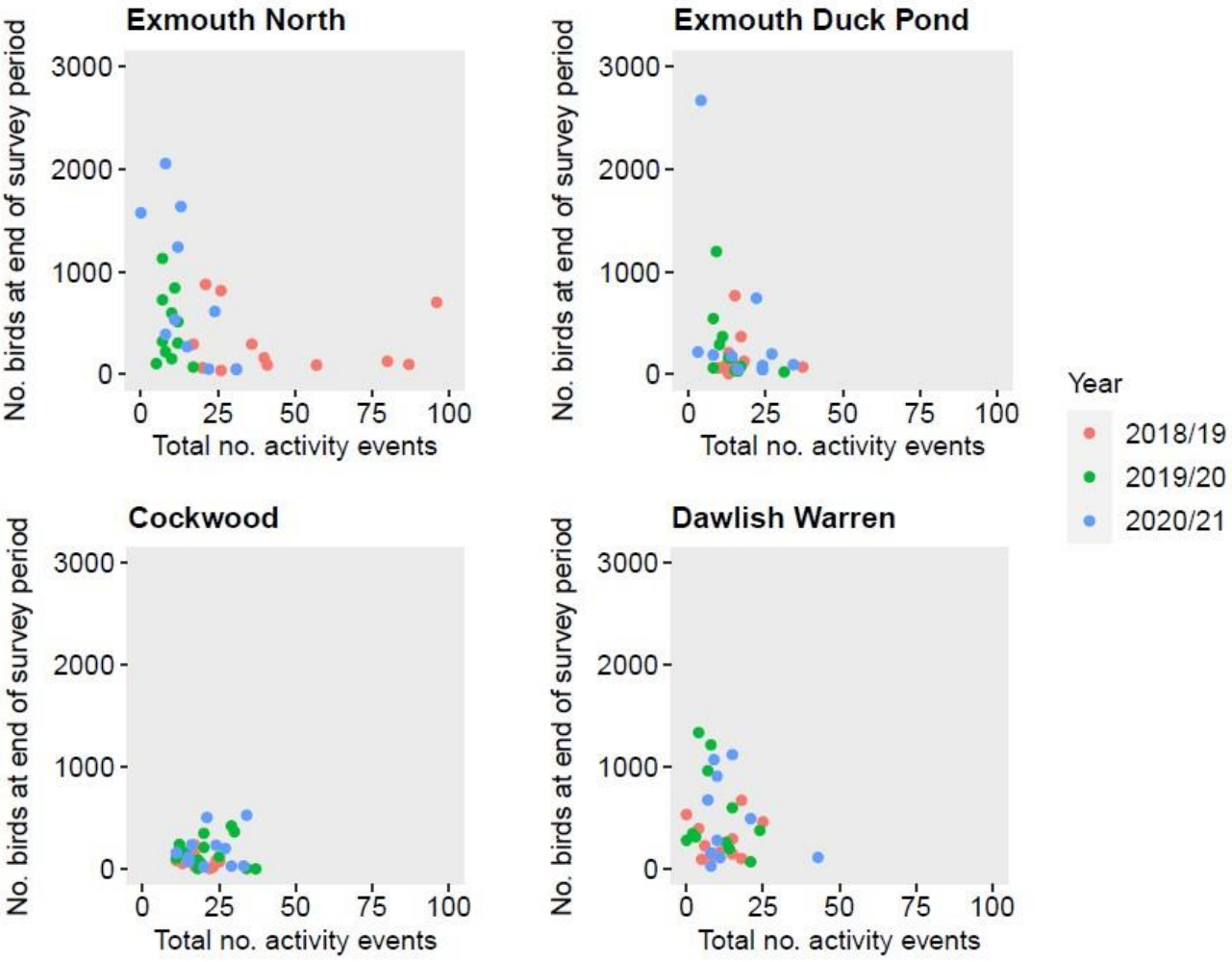


Figure 13: Number of birds left at the end of each Core Count, at each of the four survey locations, in relation to the number of activity events recorded in the same period stratified by year of study.

Key findings: effect of disturbance on the number of birds present

The number of birds present at the end of each Core Count generally showed a negative relationship with the number of potential disturbance events recorded during the count (i.e. the preceding 105 minutes). In other words, when there had been higher levels of human activity there were fewer birds present in and around the refuges.

A temporal effect was also noted at Exmouth North, with fewer activities and more birds recorded in the final year of the study and more events and fewer birds recorded in the first year.

Responses to different activity types

6.4 Responses to each of the different activity events recorded across the entire three-year period are summarised in Figure 14, which uses the data from all observations (i.e. those in and outside of the refuge boundaries within the 500m survey areas) and all time periods (i.e. when the Exmouth refuge was both active and inactive). Sample sizes were very small for most of the activities recorded during the study however, making interpretation difficult.

6.5 Of the more frequently observed activities at Dawlish Warren, crab tiling led to the birds present making a short flight approximately 20% of the time, with the same frequency observed for birds walking or swimming away. Walkers caused birds to fly a long distance on <25% of occasions, with a further 10% of observations leading to a short flight. Passing trains were observed on many more occasions than any other activity type and led to a short or major flight on >35% of occasions. The majority of observations (90%+) of the more frequently recorded watercraft (comprising large and small motorboats and RIBs) led to no response from the birds present. Small sailing boats and canoes were both observed less frequently but led to a higher proportion of flushing events. Although only 2 dog walking events were observed at Dawlish Warren, they both led to birds being flushed.

6.6 At Exmouth, dog walking was the most frequently observed activity and led to a behavioural response in the birds present in >70% of cases (with c.45% of these comprising short or major flight response). Of the other more frequently recorded activities, walkers caused a behavioural response in >55% of cases, with c.37% comprising a flight response. Both kitesurfing and windsurfing also led to a high proportion of behavioural responses (nearly 70% of the former and 100% of the latter). Furthermore, kitesurfers caused an extreme response (major flight) in c.55% of observations and windsurfers in 60%. Of the less frequently recorded activities at Exmouth, canoeists, fisherman, paddleboarders, and small watercraft all led to a disproportionately high frequency of behavioural responses from the birds present.

6.7 The different responses observed to the same activities on either side of the estuary are notable, although it is difficult to provide a detailed explanation for this. It may be partially explained by relative differences in species composition, with the larger numbers of wildfowl recorded within the Exmouth refuge potentially responding differently to wader species more abundantly found in proximity to the Dawlish refuge. Furthermore, differing

use of the two localities across the tidal cycle may also lead to differences in response, with waders roosting on the railway embankment at Cockwood over high tide potentially more susceptible to disturbance at specific points in the day from terrestrial activities, for example.

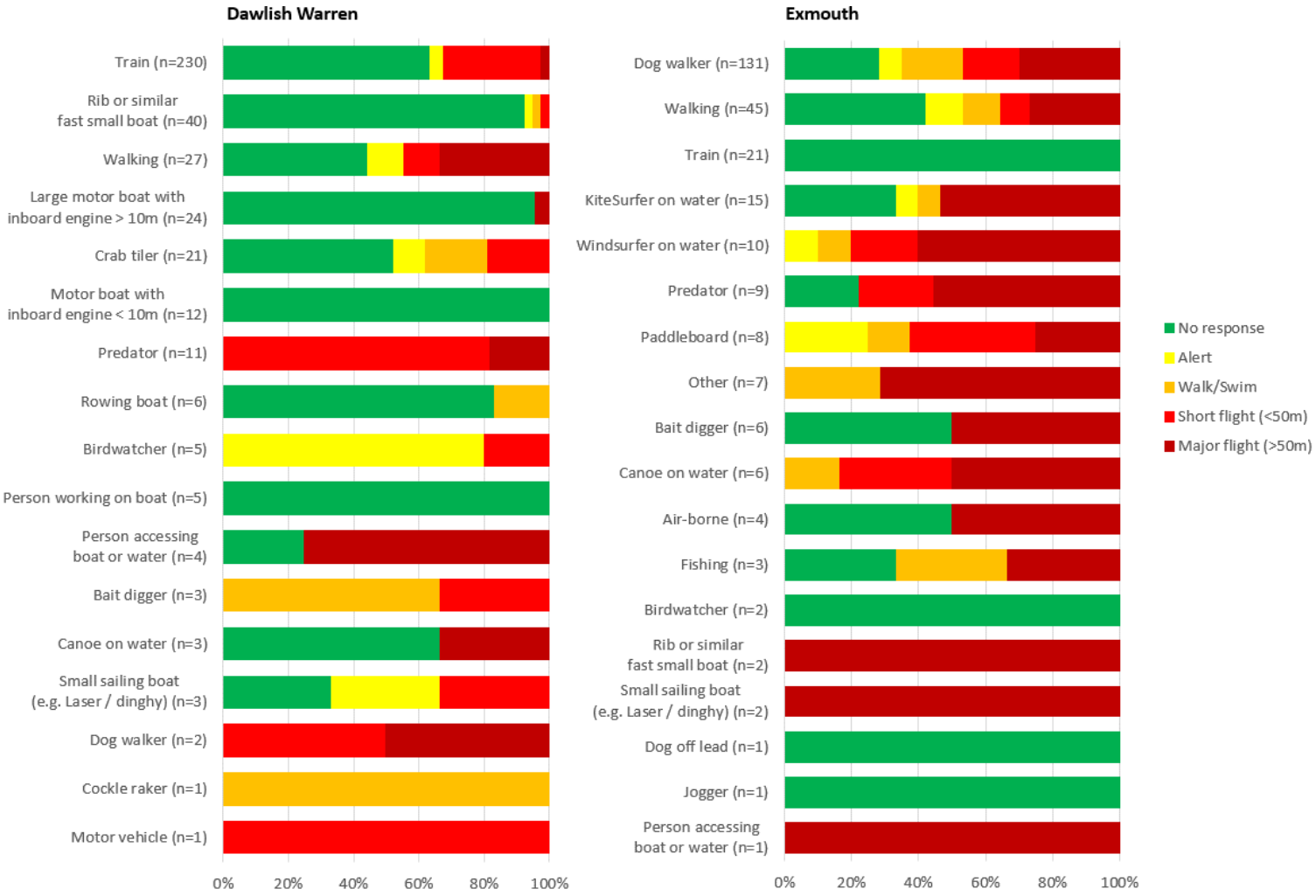


Figure 14: Bird responses to different activities at Core Count locations incorporating the Dawlish Warren and Exmouth refuges (irrespective of refuge activity status), across the entire three-year study period. Dawlish Warren corresponds to the Cockwood and Dawlish Warren Core Count locations, and Exmouth to those at the Duck Pond and Exmouth North. The activities are arranged in decreasing order of prevalence within the dataset for each of the refuge areas.

Key findings: responses to different activity types

At Dawlish Warren crab tiling and walking were two of the more frequently recorded activities and led to a behavioral response (i.e. birds walking away or flushed) in >40% of cases. Passing trains were observed on many more occasions than any other activity type there, and led to a short or major flight on >35% of occasions. The majority of watercraft observations caused no response from the birds present.

At Exmouth, dog walking was the most frequently observed activity and led to a behavioural response in the birds present in >70% of cases (with c.45% of these comprising short or major flight response). Of the other more frequently recorded activities (i.e. 10 or more observations), walkers, kitesurfers, and windsurfers led to a high proportion of behavioural responses, with the former causing a major flight (such that birds were displaced >50m) in c.55% of observations and windsurfers doing so in 60%.

Of the less frequently recorded activities at Exmouth, canoeists, fisherman, paddleboarders, and small watercraft all led to a disproportionately high frequency of behavioural responses from the birds present.

Events that flushed birds

6.8 Events that result in birds taking flight are likely to be those that have the most impact in terms of the energetic costs for the birds. Figure 15 provides an overview across all the data of the proportion of waders and wildfowl flushed (i.e. caused to undertake a short or major flight) by the different activities recorded across all Core Count survey locations across the entire study. Any analysis is again restricted by the small sample sizes for most of the activities, with the exception of trains, dog walkers, and walkers. Nevertheless, the data suggest that most instances of flushing events resulted in approximately 10% to 90% of any birds present taking flight (based upon the mean values).

6.9 The graph indicates that (based upon mean values) people accessing boats or the water and windsurfers caused a larger proportion of birds to take flight (approx. 80%) than the other human activities depicted. Windsurfing, in particular, appeared to flush a disproportionately high percentage of birds across all recorded events. Nevertheless, several other activities (i.e. overflying aircraft, canoeists, dog walkers, kitesurfers, paddleboarders, and small sailing boats) each led to at least 40% to 60% of the birds present being flushed, on average. The spread of data around the mean value, and the

prevalence of the particular activity within the dataset, also suggest that dog walking cumulatively leads to more frequent flushing events than any other activity.

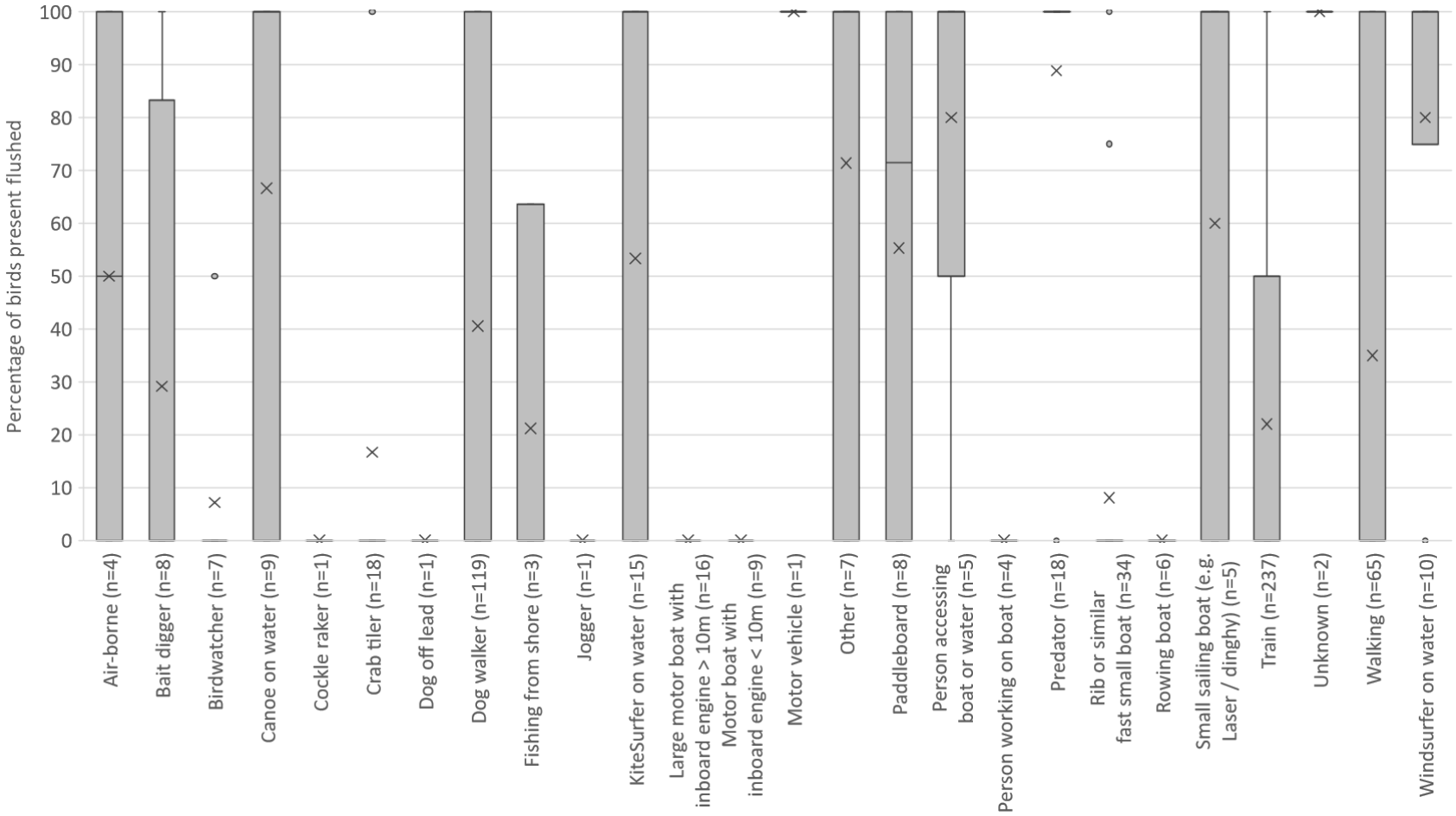


Figure 15: Percentage of waders and wildfowl present within 200m of each recreation event flushed (caused to fly) during Core Counts across entire three-year study period. Numbers in parentheses correspond to the total number of each event recorded, crosses identify the mean value, bars the median, and circles are outlier values.

6.10 Although there was a large degree of variation across species groups, the largest relative proportion of birds recorded flushed across the entire study period (based upon mean values) were small wader species and wildfowl (see Figure 16a), with these groups also comprising those with the largest numbers of individual birds caused to take flight (see Figure 16b).

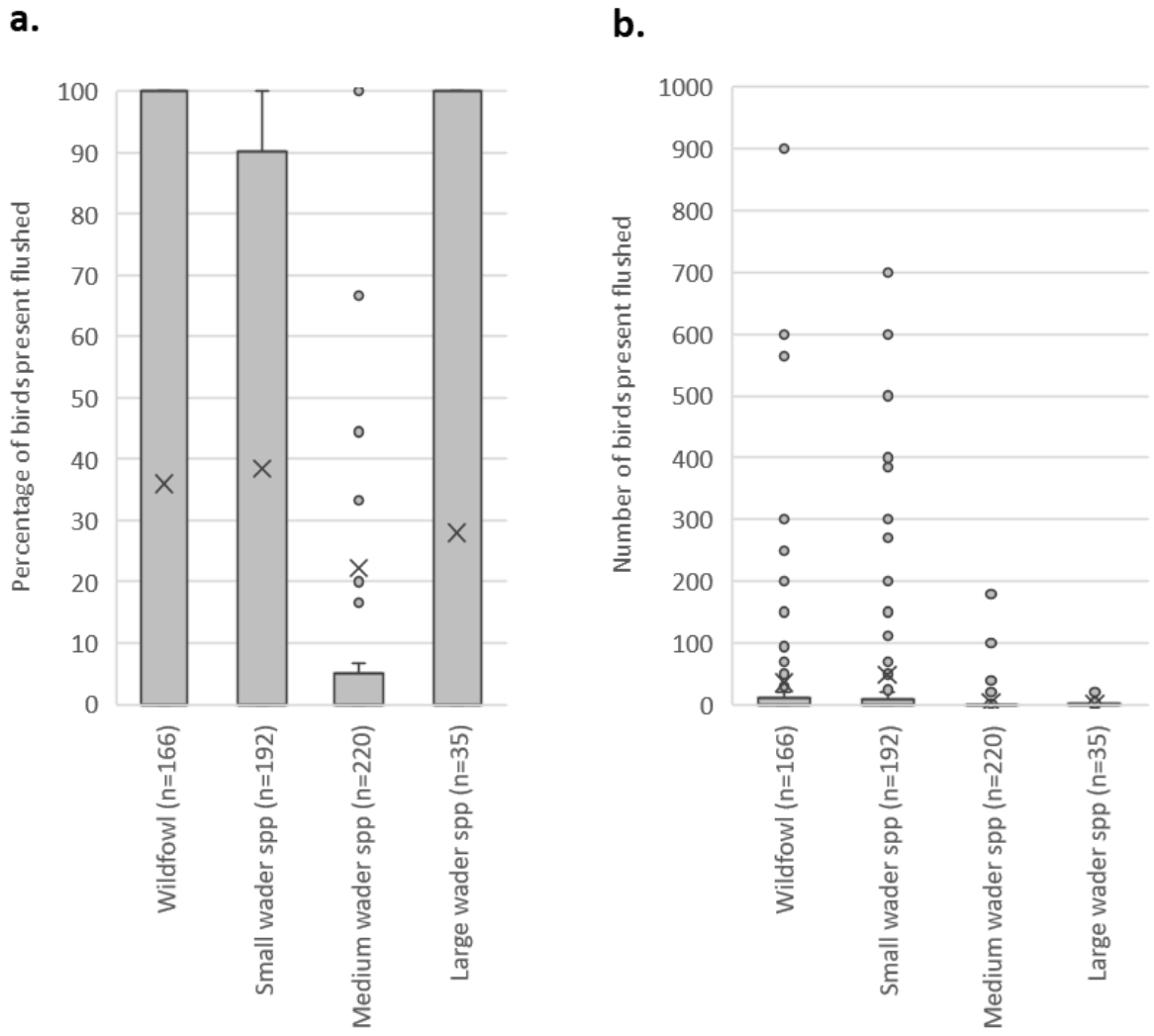


Figure 16: Percentage (a) and number (b) of birds present within 200m of each recreation event flushed (caused to fly) during Core Counts across entire three-year study period, split by species group. Large waders comprise Curlew and godwits, medium waders the shanks, Oystercatcher, *Pluvialis* plovers, and Lapwing, and small waders include Turnstone, Sanderling, Ringed Plover, and Dunlin. Numbers in parentheses correspond to the number of flight response observations within each grouping recorded across all survey visits. Crosses identify the mean value, bars the median, and circles outlier values.

6.11 The number of birds flushed per event is summarised by activity type in Figure 17. Typically, canoeists, dog walkers, RIBs, trains, and windsurfing activity resulted in more birds being flushed, with dog walkers causing

several hundred birds to fly on several occasions. The data suggest that a canoeists and windsurfers are likely to flush more birds per event than any other human activity, aside from “other” (again largely comprising temporally restricted construction work alongside the Duck Pond in 2019/20). The remaining activities generally resulted in a smaller number of birds being flushed, although note the small sample sizes recorded for the majority of the activity types. The large sample size for dog walkers does however suggest that this activity will cause the most birds to be flushed overall.

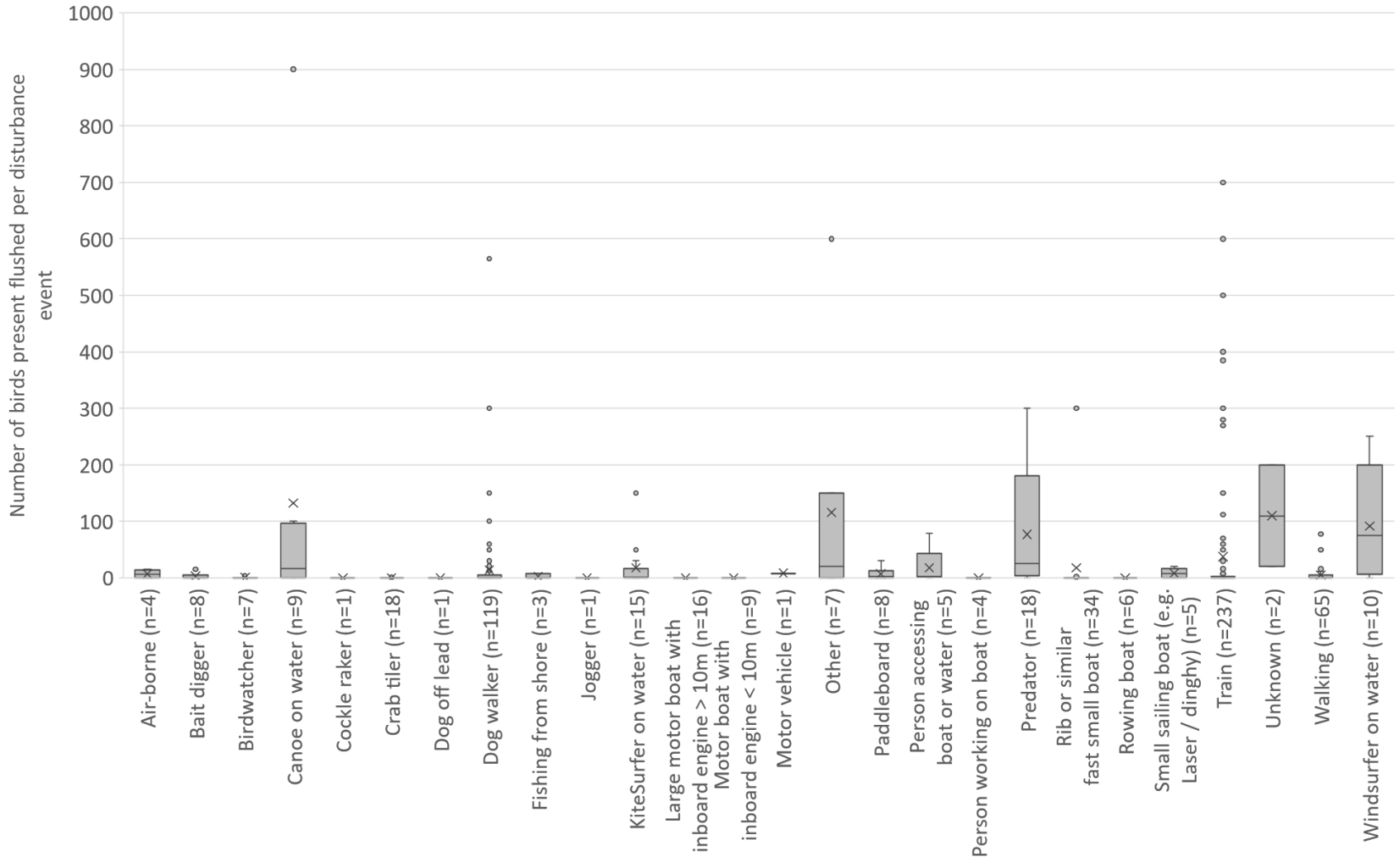


Figure 17: Total number of birds present within 200m of each disturbance event flushed (caused to fly) during Core Counts across entire three-year study period, stratified by activity type. Numbers in parentheses correspond to number of each event per activity recorded during the survey period. Crosses identify the mean value, bars the median, and circles outlier values.

6.12 Figure 18 displays the distance in metres that birds were displaced by individual disturbance events, stratified by activity type. Again, aside from trains, the figure depicts data with only small sample sizes so any interpretation should be made cautiously. Nevertheless, it would appear that water-based activities (including canoeing, RIBs, and windsurfing, in particular) displaced birds a greater distance than other types of activity (based upon mean values and upper quartiles). Nevertheless, dog walking, walking, and fishing from the shore also frequently displaced birds 100m to 200m (based upon mean values). The graph also again highlights the impact of construction work carried out alongside the Exmouth refuge (accounting for the majority of observations in the “other” category).

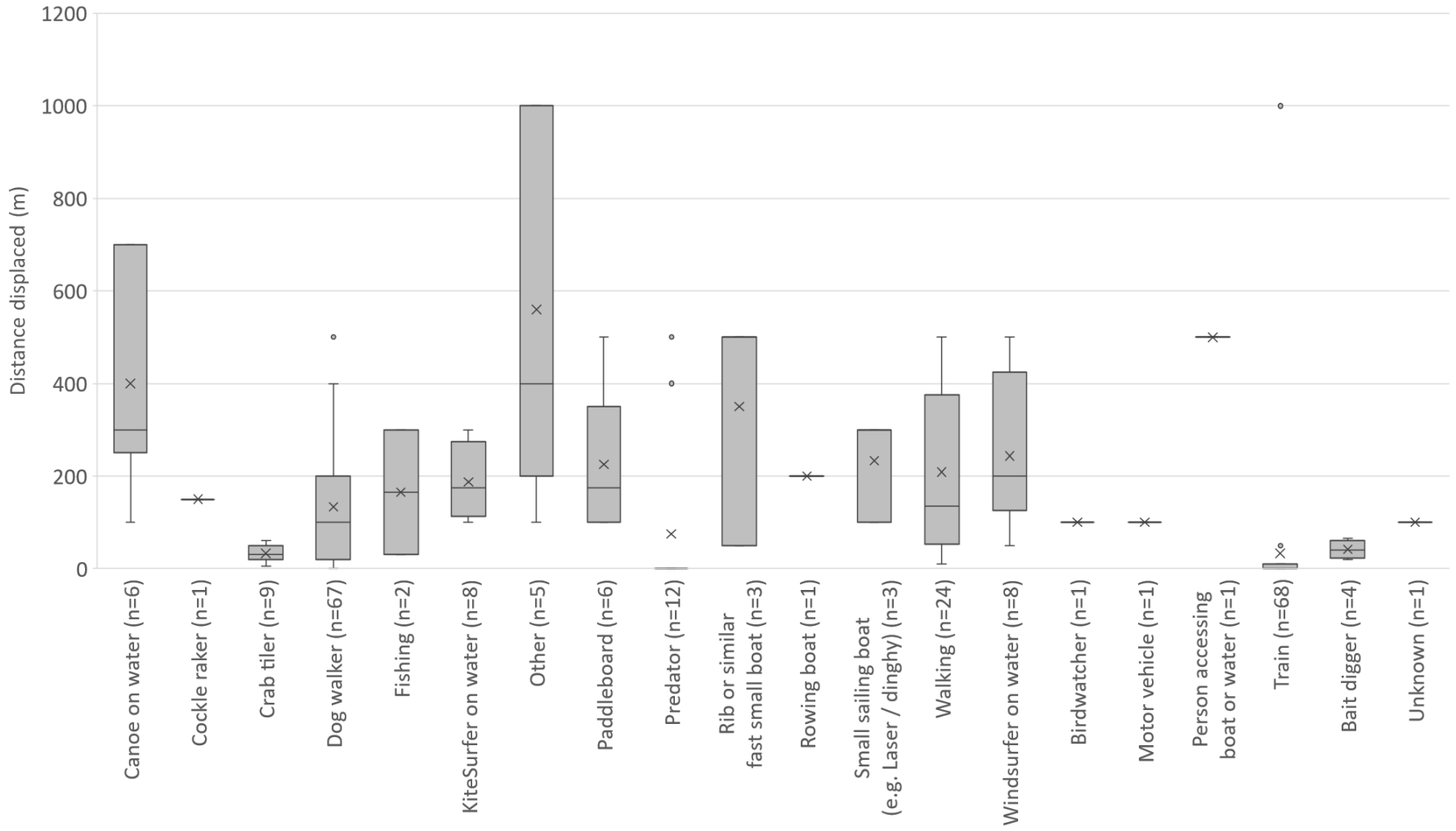


Figure 18: Distance that waders and wildfowl were displaced by individual disturbance events recorded during Core Counts across entire three-year study period, stratified by activity type. Numbers in parentheses correspond to the number of each event recorded during the survey period for which it was possible to identify a displacement distance. Crosses identify the mean value, bars the median, and circles outlier values.

6.13 Figure 19a depicts the displacement distances associated with the observed disturbance events across the entire study period, stratified by species group, whilst Figure 19b shows the time taken for disturbed birds to resume their previous behaviour. Figure 19a shows that wildfowl were generally displaced a much greater distance than waders, and that displacement amongst waders appeared to be stratified by body size (with larger species flying further).

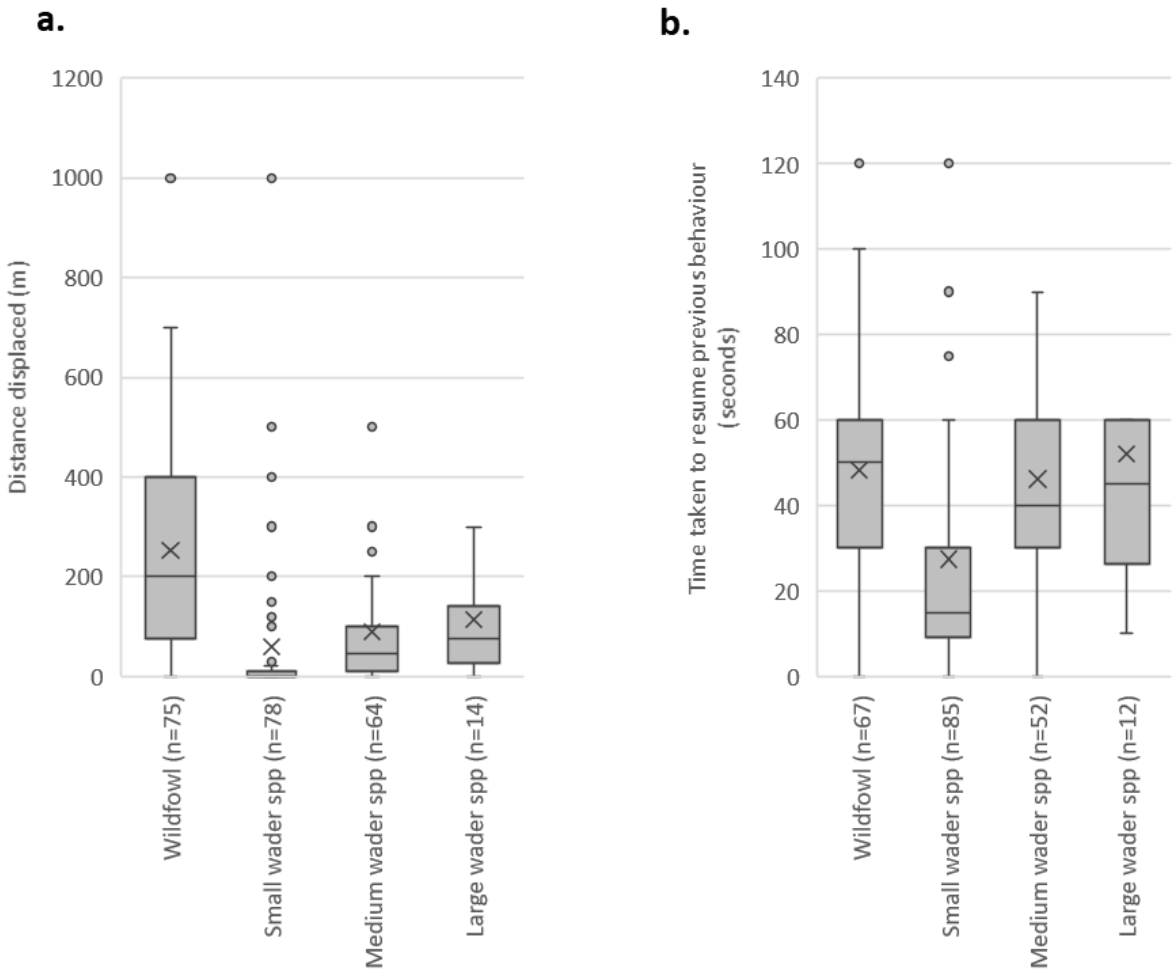


Figure 19: Distance birds were displaced (a) and the time taken to resume their original behaviour (b) after each disturbance event during Core Counts across entire three-year study period, split by species group. Large waders comprise Curlew and godwits, medium waders the shanks, Oystercatcher, *Pluvialis* plovers, and Lapwing, and small waders comprise Turnstone, Sanderling, Ringed Plover, and Dunlin. Numbers in parentheses correspond to the number of events recorded for each group during the survey period for which it was possible to identify a displacement distance or resumption time, respectively. Crosses identify the mean value, bars the median, and circles outlier values. Note that a single extreme outlier value of 1500 seconds (for wildfowl, caused by a paddleboarder) has been removed from Figure 19b to assist interpretation.

6.14 Figure 19b shows that most birds subjected to disturbance take less than 1 minute to return to their previous behaviour (based upon mean values). Furthermore, small wader species tended to resume their previous more quickly after a disturbance event than the other species groups, although a single extreme outlier of 1,500 seconds for wildfowl has been removed from the plot.

Key findings: events that flushed birds

In general, across all the Core Counts (i.e. regardless of whether the refuge was active or not), small wader species and wildfowl were proportionately the most commonly flushed bird groups and also those with the largest numbers of individual birds caused to take flight. Most instances of flushing resulted in approximately 10% to 90% of any birds present taking flight. Wildfowl generally flew a much greater distance than waders when flushed, and larger waders flew farther than smaller wader species. Most species soon resumed their previous behaviours after individual disturbance events, however.

People accessing boats or the water, and windsurfers, caused a larger proportion of the birds present to take flight. Windsurfers, in particular, appeared to flush a disproportionately high percentage of birds, although several other activities each led to at least 40% to 60% of the birds present being flushed.

Canoeists, dog walkers, RIBs, trains, and windsurfing activity resulted in some large flocks being flushed, with dog walkers causing several hundred birds to fly on several occasions. Canoeists and windsurfers, in particular, flushed larger numbers of birds more frequently, but dog walkers caused birds to flush more frequently overall (when adjusted for the prevalence of that activity in the dataset).

Disturbance events within the refuges

6.15 All potential disturbance events that occurred during the Core Counts and within the refuges whilst they were active (i.e. 'incursions'), across the entire three-year study period, are listed in Appendix 4, with Table 6 summarising those activities which actually resulted in birds flushed.

6.16 As the refuges extend beyond the recording areas for Core Counts it is possible that individual events disturbed more birds than recorded. Furthermore, some events were present in the area for a prolonged period, extending before and/or after the count period – in such cases additional behavioural responses may have been triggered and not recorded.

Nevertheless, it can be seen that a total of 1,617 wildfowl and 123 waders were seen to be flushed more than 50m (major flight) by events that were incursions into the refuge across the entire study period. The number of actual events (29) is however quite low.

Table 6: The number of potential disturbance events (from core count data) recorded within the refuges, while they were active, across the entire three-year study period that resulted in birds being flushed (major or minor flights). The table also identifies the total number of birds (waders and wildfowl only) that flew more than 50m (major flights).

Activity type	Number of observations where birds flushed					Total number of wildfowl major flights	Total number of wader major flights
	Cockwood	Dawlish Warren	Exmouth Duck Pond	Exmouth North	Total		
Bait digger	1		1		2		5
Canoe on water		1	1		2	1,002	
Dog walker			10	3	13	31	81
Kitesurfer on water			1		1		16
Other			1		1	150	
Rib or similar fast small boat			1		1	150	
Walking	2		3		5	54	21
Windsurfer on water			4		4	230	
Total	**3**	**1**	**22**	**3**	**29**	**1,617**	**123**

6.17 Response data are summarised in Figure 20, which provide responses by Core Count location. The response data corresponds to the entirety of the 500m recording area around each Core Count survey location, and as such includes those responses observed in and outside of the refuge areas (see Map 2). The six plots are stratified by survey year (rows) and by relevant refuge activity period (inactive period on the left and active period on the right). Note that the Dawlish refuge (incorporating the Dawlish Warren and Cockwood Core Count locations) remained constantly active in the second and third year of the study.

6.18 The plot shows that a high proportion of events result in disturbance and particularly birds taking flight (i.e. red and dark red) when the refuges are active and there is some indication that this has increased over the three years (i.e. longer red bars in the more recent years). This is the pattern that might be expected if bird use becomes more concentrated in the refuges.

6.19 The ratio of disturbance events seen at Exmouth North in the inactive and active periods has remained relatively stable through the three years of the study. However, a proportionately much larger number of behavioural responses were noted during both the active and inactive periods in the study's second year. No behavioural responses were recorded during the inactive period in the final year of the study, but responses (and major flight responses in particular) remained high during the refuge's active period.

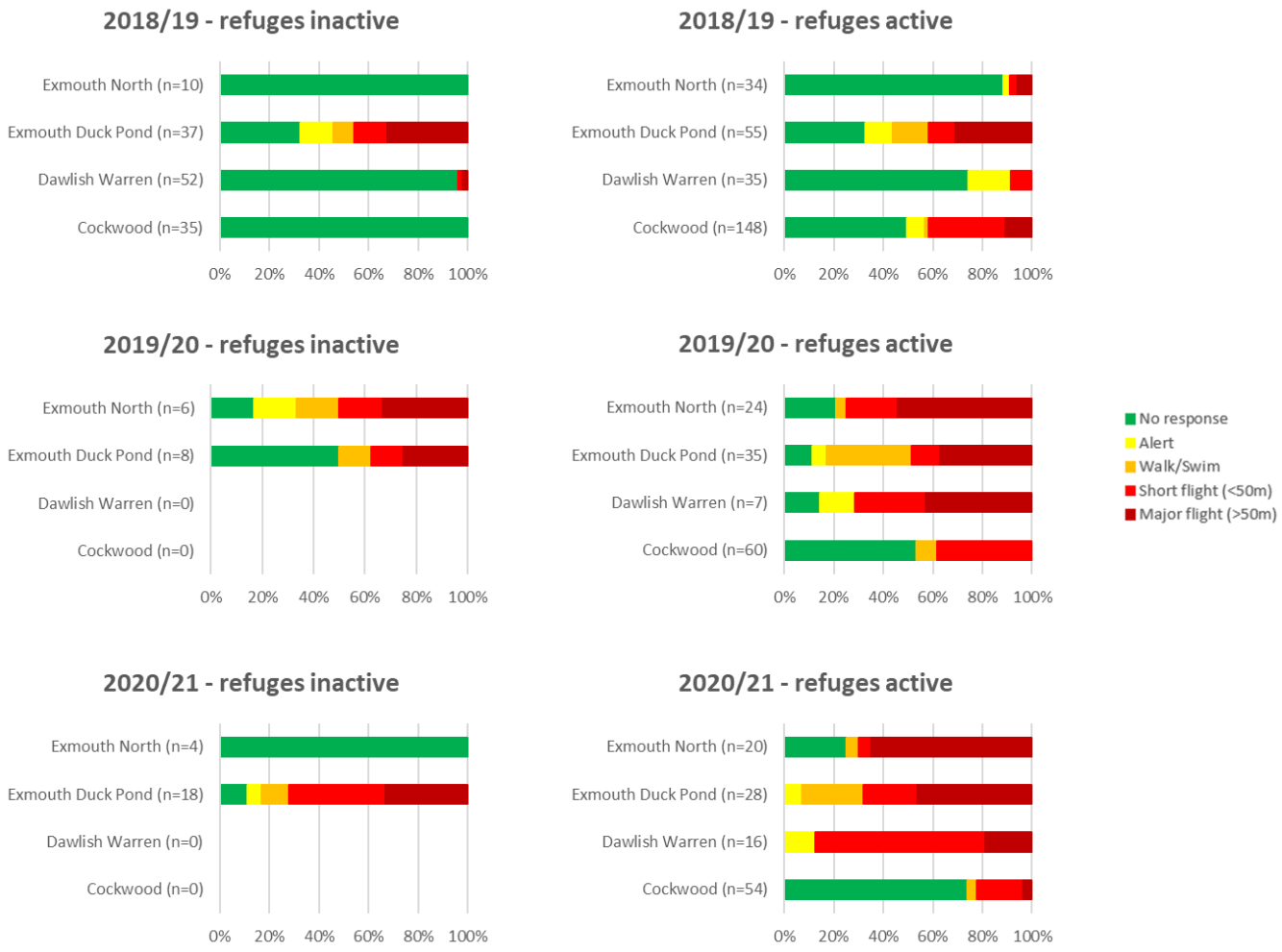


Figure 20: Responses to potential disturbance events by Core Count location within each year of the three-year study, stratified by relevant refuge activity status. The data depicted represents the most extreme response recorded per event (i.e. a single response code), with the number of observations from each location provided in parentheses.

6.20 Aside from a slight dip in the second year of the study, the ratio of disturbance events seen at the Duck Pond in the refuge's inactive and active

periods has remained relatively stable throughout. The number of behavioural responses observed in each period have also remained relatively stable, although a small proportional increase in both the inactive and active refuge periods was noted in the final year.

6.21 The number of events recorded at Dawlish Warren has varied considerably between years, and an overall decline in events was noted between the first and final years of the study. Nevertheless, the proportion of events causing birds to flush (combined minor and major flights) at the locality has increased in each year of the study.

6.22 The number of events recorded at Cockwood has also varied, although again an apparent decrease in events was noted between the first and final years of the study. Furthermore, the number of behavioural responses recorded there has decreased each year since the Dawlish refuge's activation

6.23 Table 7 depicts summary data from the Core Counts for the three years of the study, comprising the combined dataset from the four Core Count locations. The table shows that the number of potential disturbance events recorded per hour halved in the year following activation of the two refuges, and that the number of birds flushed per hour decreased by approximately 75% in the same period. The latter figure rose in the final year of the study, but still comprised <50% of the first-year figure. In contrast, the mean number of flight responses per hour has remained similar throughout each year of the study and the rate of incursions into the refuges has increased ever so slightly.

Table 7: Variation in the total number of potential disturbance events, flight responses, number of birds flushed, and number of incursions within the refuges within each year of the study during the refuges active period only. The metrics are expressed per hour of (Core Count) survey.

Year of study	Core Count hours	No. of potential disturbance events per hour of survey	No.of flight responses per hour of survey	No. birds flushed per hour of survey	No. of refuge incursions per hour of survey
2018/19	87.5	3.2	1.1	114.5	0.5
2019/20	80.5	1.6	0.8	28.3	0.8
2020/21	75.5	1.7	0.9	54.6	0.7

Key findings: disturbance events within the refuge

1,617 wildfowl and 123 waders were seen to be flushed more than 50m (a major flight) by refuge incursion events across the study period.

The data suggest that the number of potential disturbance events recorded per hour halved in the year following activation of the two refuges, with the number of birds flushed per hour decreasing by approximately 75%, although the latter figure rose slightly in the final year of the study. The mean number of flight responses per hour remained similar throughout each year of the study and the rate of incursions into the refuges increased ever so slightly. Furthermore, while the total number of potential disturbance events decreased when the refuges were active the number of behavioral responses seen at most of the Core Count locations increased.

These results indicate that the relatively small number of incursions which are still taking place when the refuges are active can nevertheless result in a marked behavioural response from the birds present (i.e. causing them to flush/take flight).

7. Discussion

7.1 This study presents three years of monitoring data relating to the voluntary refuges. We have recorded bird use in and around the refuges, levels of recreational use, and the interactions between birds and people.

7.2 The results broadly show that the refuges are well used by the birds, with some high counts recorded which (for some species) comprise a high proportion of the entire SPA population.

7.3 Recreational use in and around the refuges includes a wide range of activities, but in general relatively few incursions were recorded when the refuges were active.

7.4 Nevertheless, a proportion of those incursions comprised activities well within the refuge (i.e. not just skirting the edge). Activities such as bait digging, windsurfing, kitesurfing, small motorboats, dog walking, walking, and fishing were recorded well within the refuges on occasion and these, when present, had a marked effect on the birds present, with a high proportion of such events resulting in birds being flushed (and potentially leaving the refuge).

General adherence to the refuges

7.5 There has been an 11.9% increase in the number of residential properties within 10km of the Exe Estuary SPA in the last 10 years (with postcode data indicating around 99,093 residential delivery points in 2011 compared to 110,872 in 2021). This will mean more people living in the vicinity of the estuary and growing pressure on the Estuary for recreation. This potentially explains the increase seen in the prevalence of several recreational activities across the Exe Estuary, and the recording of several new ones, between the current study and that carried out in 2009-2011.

7.6 The data show that Core Count and Vantage Point Count locations situated within/alongside the Exmouth refuge are much busier than those located within/alongside the Dawlish refuge, and that the distribution and relative proportion of different activities vary between them (see para 5.2 to 5.9). Dog walking is by far the most prevalent recreational activity carried out in the vicinity of the Duck Pond and is also one of the most frequently observed activities further up the estuary at Exmouth North. The Duck Pond area is also a key locality for a range of watersports and bait digging. Watercraft

comprise the most frequently observed activities from the Dawlish survey points, although crab tiling and birdwatching are also frequently observed.

7.7 Our data (see Maps 4 to 11) show that since they came on-line, the majority of site users avoid entering the refuges during their respective active periods. There is also evidence of avoidance by the majority of both dog walkers and walkers at the Duck Pond. Nevertheless, the data for recreational watersports suggests that a minority of canoeists, RIBs, and windsurfers do not necessarily always avoid the refuges when they are active, whilst paddle boarders appear to be complying with the refuges.

7.8 Although there appears to have been a decline in the total number of dog walkers and walkers in the relevant areas (when compared to 2011: see Table 4 and Table 5), the relative proportion of both accessing the refuges during their active period has remained relatively similar throughout this three year study. This suggests that a small cohort of site users within specific user groups continue to access the refuges during their active periods.

7.9 The results therefore indicate that the refuges are generally being well adhered to despite a small number of participants within certain user groups (mainly dog walkers, crab tilers, bait diggers, windsurfers, and walkers) remaining an issue. Furthermore, the number of incursions within each of the refuges is likely to be influenced by a range of factors, including the size of nearby source populations, parking, and access points, and the shape and extent of the refuge boundary.

The role of the refuges as part of the mitigation package

7.10 The refuges have been shown to support large numbers of many of the Exe Estuary SPA's qualifying species and members of its qualifying bird assemblage (see para 4.5 to para 4.11). There were frequent counts of 1,000 to 2,000+ birds within the refuges made during study period. This shows that the refuges incorporate suitable habitat for the SPA bird interest and have the potential to play a key role in reducing disturbance. To some extent this is to be expected, as while the refuges account for only around 7% of the total area of the SPA, they were carefully selected to represent some of the key areas for birds.

7.11 The Exmouth refuge is particularly important for Wigeon, Mallard, Pintail, and Dark-bellied Brent Geese, and also regularly holds high numbers of Oystercatcher and Curlew. The importance of the refuge for wildfowl is

presumably due to the presence of the eelgrass beds. The Dawlish refuge has been shown to be particularly important for wader species (especially Oystercatcher, Dunlin, Curlew, and Redshank) and contains the main high tide roost within the estuary. The Dawlish Warren refuge area is also important for several species of wildfowl (namely Wigeon, Dark-bellied Brent Goose, and Shelduck). The two refuges are therefore clearly different and complement each other in the habitat and role they provide.

7.12 A much larger number of wildfowl are found within the refuges when they are active than when they are not (see Figure 4) and the survey data indicates that the total number of wildfowl using the Exmouth refuge when it is active has increased over the study period (see Figure 2). The data also indicates that total wildfowl, and possibly wader, numbers have increased within the Dawlish refuge since its activation (see Figure 3). These results imply (albeit based only on 3 years data) that the refuges are becoming more important for birds over time.

7.13 The data also suggest that when the Exmouth refuge was active a higher relative number of waders were present inside the refuge than when it was inactive – suggesting that use by waders is relatively more concentrated within the refuge when it is active (see Table 3). This would imply that, for waders at least, the refuge is working and bird distributions are shifting to make use of the refuge space when it is active (potentially as a result of being flushed from other parts of the estuary).

7.14 Our data show that the number of potential disturbance events recorded from the Exmouth Core Count locations, and from Cockwood, during the relevant refuge's active period have declined in each year of the study, but varied between years at Dawlish Warren (see Figure 20). This translated to an approximate halving in the number of potential disturbance events recorded per hour across the entire study area, during the refuges' active periods, between the first and second years of the study (see Table 7). This figure then remained relatively static in the second and final year. This shows that the number of events with the potential to disturb birds has decreased following the implementation of the refuges.

7.15 The number of flight responses per hour of survey across the study area, when the refuges were active, remained relatively stable across all three years of the study, although the number of birds flushed declined sharply after the first year (see Table 7). The number of incursions (based on Vantage Point and Core Count data) when the refuges were active appeared to

decline each year, although this represented no relative change when survey effort was taken into account. Therefore, the number of disturbance events across the study area have generally decreased year on year, although the observed behavioural responses to the remaining intrusions are often extreme (i.e. causing major flights), with the number of flight responses overall remaining the same.

7.16 The majority of incursions into the refuges observed over the study period occurred when the ranger team was not visible to the surveyor (see para 5.45). This suggests that the presence of the ranger team is having a positive impact upon the level of voluntary adherence in avoiding the refuge areas. This is to be expected and the effectiveness of the refuges is likely to depend on associated measures such as wardening, signage, awareness raising, etc. Nevertheless, incursions by a relatively large proportion of certain activity types (e.g. dog walkers) occurred when the rangers were visible. This is potentially indicative of certain individuals within the relevant activity categories being resistant to the ranger's message, or the large numbers of individuals carrying out a particular activity, such as dog walking, limiting the overall number of possible interactions with the ranger team, or that that those entering the refuges are able to avoid the wardens (e.g. by accessing the shoreline at a different location). These incursions have a disproportionate impact on the birds present.

7.17 The results provide evidence that the refuges are playing a role in providing foraging and roosting habitat for the SPA bird interest and ensure that a range of disturbance-reduced areas are always available for birds to use. It is clear that the refuges on their own are not a panacea to completely address recreation impacts on the SPA, but rather they fit within a package of measures. It is the combination of the refuge provision, alongside wardening, awareness raising, codes of conduct, provision of alternative sites, and other mitigation that is likely to ensure the resilience of the estuary and provide the confidence that effective mitigation is in place to address the pressure from new housing growth and increasing recreation. No measure is likely to be entirely effective on its own, and the effectiveness of the refuges will depend on how they are communicated, marked out, and wardened.

7.18 The importance of the refuges is likely to change with time, particularly if the number of incursions continues to reduce with time. The use by birds will likely be affected by changing conditions around the estuary and also be dependent on the levels of disturbance in other parts of the site. The

pandemic has highlighted how access levels and types of use can change in unexpected ways and it is not clear how access levels might further change in the future, in the post-pandemic period. It is also important to highlight that the number of birds using the refuge areas and wider SPA, and their distribution within them, is not solely driven by recreational activity. Interannual variation in bird numbers may be affected by adult survival or juvenile recruitment between years, as well as food availability, water quality, and climatic impacts, for example.

Recommendations

7.19 We recommend that:

- Monitoring should continue, potentially undertaken solely by the ranger team; and,
- Monitoring results should help to target warden presence and other measures to ensure the effectiveness of the refuges.

Monitoring

7.20 The data presented in this report span three years, but it is important to recognise that the pandemic will have influenced recreation use during this time and, as restrictions are lifted, access patterns are likely to continue to change. Recreational use of the Exe Estuary is also likely to change over time as new and different activities become popular and as conditions change around the site. As an example, paddleboarding is a relatively new activity that was not recorded at all in the 2011 disturbance study, yet paddleboarding is now a common sight.

7.21 A clear recommendation is therefore that monitoring should be continued. Continued collection of data over a longer period will allow more robust conclusions to be made, and also allow for any potential impacts of the pandemic in the final year of the study on activity levels to be contextualised. The collection of a larger dataset over an increased number of years will allow ever more robust conclusions to be drawn concerning use of the refuge areas by the SPA's bird populations and their avoidance by site users during the active period.

7.22 It is recognised that any future monitoring will require both surveyor time and funding, and as such it is important to choose a methodology which will provide abundant data for minimal time use/cost. The geographic and temporal scale of any monitoring should also be carefully considered.

Targeting of areas of the SPA removed from/in addition to those detailed in this report (i.e. within proximity to the refuge areas) may also increase the probability of detecting any displacement of birds and/or recreational activities elsewhere with the estuary/SPA. The location and timing of any future monitoring locations should also be informed by the results of other work carried out by the SEDHRP to assess impacts within south-east Devon's protected area network (e.g. visitor surveys).

7.23 The Vantage Point Count methodology provides a suitable long-term monitoring approach that can be done quickly and the data used to show patterns over multiple tide states, times of day, seasons and weather conditions. This monitoring can easily be undertaken by the ranger team as part of their work on site, as the method is both fast and effective. Any future monitoring will still also need to monitor and adapt to the changing conditions on site and within the wider populace (e.g. Coronavirus).

7.24 There may also be potential to use movement data of birds from colour-ringing and GPS tagging, as various SPA qualifying species have been trapped and tracked in this way on the site in recent years[6].

7.25 It should be remembered that the estuary is a dynamic system, and the changing natures of the refuges, and the roles that they play for the birds which use them, should be factored into future decision making. The well-documented decline of the Exe Estuary SPA's Oystercatcher population, following a collapse in shellfish stocks, is indicative of how the role of the refuges may alter. Potential hydrological and geophysical changes to the estuary may also occur in the future, dependent upon how much longer coastal defence works are maintained on the seaward side of Dawlish Warren.

Use of future monitoring data

7.26 Monitoring data should therefore be used to regularly review the refuges and could influence whether they should change shape, whether changes in duration of when they are active should be applied, and whether further work is necessary to reduce incursions. Such actions could involve greater

[6] See https://www.dcwrg.org.uk/

wardening presence, changes to signage, engagement work with particular user groups, or consideration of the need for enforcement.

7.27 The targeted use of rangers at the right time of year should also be continued, with a focus upon the Exmouth refuge in September to December. In order for this to be effective it is essential that all site users are fully aware of the accurate location of the refuge boundaries. During the second year of the study it was highlighted that the yellow buoys marking the boundary of the Exmouth refuge at high tide had moved, and these had still not been moved back to their correct position by the study's end. Their movement back to their original, correct, locations is therefore identified as a high priority.

7.28 Any ranger interventions should focus upon the key user groups, comprising those carrying out the majority of intrusions during the refuges' active periods. Dog walking, crab tiling and bait digging, and watersports (comprising windsurfing and canoeing in particular) are the activities which have been identified as continuing to cause disturbance to birds within the refuges and comprise most of the intrusions within them. Dog-walkers remain a particular issue at the Duck Pond (with many dogs observed off lead within the refuge), alongside kitesurfing and windsurfing, canoeing, paddleboarding, and RIBS to a lesser extent. Crab tiling, birdwatching, and dog-walkers are the main issues for the Dawlish refuge.

7.29 Dog walking, kitesurfing and windsurfing, canoeing, paddleboarding, and crab tiling have, on average, been shown to lead to a higher proportion of any birds present (irrespective of flock size) exhibiting an extreme behavioural response (i.e. caused to fly >50m). Windsurfers, RIBs, canoeists, and dog walkers flush larger absolute numbers of birds and also tend to displace them a greater distance than other types of activity. Any focussed intervention work in the future should therefore focus upon these user groups in order to minimise the impact of those within them who choose not to recognise the status of the refuges.

7.30 The increase in birdwatcher-related disturbance is believed to have been caused by the loss of access to the bird hide at Dawlish Warren. Any new viewing facilities (or changes to where birds roost) could influence the risks of disturbance from this group, and monitoring data will therefore also be important to ensure any issues are identified early on and addressed.

7.31 Finally, it is important to highlight the importance of the Duck Pond area of the Exmouth refuge for wintering wildfowl in particular and the high level of

recreational activity that goes on alongside it. This should be borne in mind when considering the risk of any adverse cumulative impacts arising from other activities organised at the Duck Pond (e.g. public engagement events, concerts, etc). The importance of the Duck Pond for wildfowl compounds any such issue, as the study has shown that wildfowl are generally displaced much further than waders by disturbance events.

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Appendix 1: Temporal spread of counts

This appendix summarises the number different counts by month and location, over the entire three-year study period. Ticks indicate whether the refuge was operational during the relevant month. The dashed lines separate the different years of the study.

Month	Year	Core Counts Exmouth	Core Counts Dawlish	Total Core Counts	Vantage Point Counts (Footprint Ecology)	Vantage Point Counts (SE Devon Habitats Regulations Partnership)	Total Vantage Point Counts	Exmouth refuge active	Dawlish refuge active
Feb	2018	2	2	4	3	0	3		
Mar	2018	2	2	4	3	3	6		
Apr	2018	0	0	0	3	1	4		
May	2018	0	0	0	0	8	8		
Jun	2018	0	0	0	0	2	2		
Jul	2018	0	0	0	0	9	9		
Aug	2018	0	2	2	3	10	13		
Sep	2018	4	2	6	6	4	10	✓	✓
Oct	2018	4	4	8	6	12	18	✓	✓
Nov	2018	6	4	10	9	6	15	✓	✓
Dec	2018	4	2	6	6	2	8	✓	✓
Jan	2019	2	2	4	6	7	13		✓
Feb	2019	2	4	6	6	3	9		✓
Mar	2019	0	2	2	6	2	8		✓
Apr	2019	0	2	2	3	2	5		✓
May	2019	0	2	2	3	3	6		✓
Jun	2019	0	0	0	2	2	4		✓
Jul	2019	0	0	0	4	1	5		✓
Aug	2019	2	0	2	3	1	4		✓
Sep	2019	4	4	8	6	4	10	✓	✓
Oct	2019	4	2	6	6	8	14	✓	✓
Nov	2019	4	2	6	6	9	15	✓	✓
Dec	2019	4	4	8	5	1	6	✓	✓
Jan	2020	2	4	6	6	2	8		✓
Feb	2020	2	2	4	6	0	6		✓
Mar	2020	0	2	2	3	1	4		✓
May	2020	2	0	2	3	0	3		✓
Jun	2020	0	0	0	3	0	3		✓
Jul	2020	0	0	0	3	2	5		✓
Aug	2020	1	2	3	4	2	6		✓
Sep	2020	4	2	6	5	3	8	✓	✓
Oct	2020	4	3	7	6	4	10	✓	✓
Nov	2020	4	4	8	6	2	8	✓	✓
Dec	2020	2	2	4	6	1	7	✓	✓
Jan	2021	2	4	6	3	0	3		✓
Feb	2021	2	2	4	3	0	3		✓
	Total	69	69	138	152	117	269		

Appendix 2: Incursions into active refuges

The table below lists all observations of incursions into the refuges when active, arranged in chronological order, from Vantage Point Count data (dashed lines separate the years of the study). Grey shading highlights those observations at least 50m from the shore – i.e. those that were well within the boundary of the refuge. Note that group size for watercraft (indicated with asterisks) refers to the number of boats/ships within the party, not the number of individuals upon them.

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

Date	Refuge	Ranger visible? (Y/N)	Activity	Group size (no. of people)	Number dogs off lead	Number dogs on lead	Tide	Approx. distance from shore (m)
03/05/2019	Dawlish	Y	Fishing from shore	1	0	0	High	65
28/07/2019	Dawlish	N	Crab tiler	1	0	0	Low	400
19/09/2019	Exmouth	Y	Other	3	0	0	Falling	20
26/09/2019	Exmouth	N	Bait digger	1	0	0	Low	180
26/09/2019	Exmouth	N	Walker	2	0	0	Low	20
27/09/2019	Exmouth	Y	Other	1	0	0	Falling	20
27/09/2019	Exmouth	Y	Dog walker	1	1	0	Falling	20
27/09/2019	Exmouth	Y	Walker	1	0	0	Falling	10
03/10/2019	Exmouth	Y	Dog walker	1	1	0	High	30
03/10/2019	Exmouth	Y	Small motorboat	1*	0	0	High	140
04/10/2019	Exmouth	Y	Dog walker	1	1	0	Falling	30
04/10/2019	Exmouth	Y	Other	1	0	0	Falling	30
10/10/2019	Dawlish	N	Crab tiler	1	0	0	Low	260
19/10/2019	Exmouth	Y	Walker	1	0	0	Falling	10
19/10/2019	Exmouth	Y	Dog walker	1	0	1	Falling	15
25/10/2019	Dawlish	Y	Dog walker	1	0	1	Rising	40
26/10/2019	Exmouth	N	Small motorboat	6*	0	0	High	100
26/10/2019	Exmouth	N	Windsurfer on water	4	0	0	High	100
26/10/2019	Exmouth	N	Kitesurfer on water	1	0	0	High	380
04/11/2019	Exmouth	N	Other	3	0	0	Falling	10
04/11/2019	Exmouth	N	Walker	2	0	0	Falling	15
05/11/2019	Exmouth	Y	Other	8	0	0	Falling	50
05/11/2019	Exmouth	Y	Dog walker	1	1	0	Falling	30
25/11/2019	Exmouth	N	Other	1	0	0	Low	10
30/11/2019	Exmouth	Y	Dog walker	1	0	1	High	27
30/11/2019	Exmouth	Y	Dog walker	1	0	1	High	20
08/02/2020	Dawlish	N	Crab tiler	1	0	0	Low	120
08/02/2020	Dawlish	N	Crab tiler	1	0	0	Low	195
22/02/2020	Dawlish	N	Crab tiler	1	0	0	Low	125
22/02/2020	Dawlish	N	Crab tiler	1	0	0	Low	120
30/05/2020	Dawlish	N	Picnic	2	0	0	High	3
26/07/2020	Dawlish	N	Fishing from shore	1	0	0	High	9
26/08/2020	Dawlish	N	Walker	4	0	0	Falling	28
24/09/2020	Exmouth	Y	Dog walker	1	0	1	High	17
24/09/2020	Exmouth	Y	Dog walker	1	1	0	High	28
26/09/2020	Exmouth	N	Windsurfer on water	1	0	0	High	140
26/09/2020	Exmouth	N	Canoe on water	1	0	0	High	39
26/09/2020	Exmouth	N	Canoe on water	1	0	0	High	42
06/10/2020	Dawlish	N	Dog walker	2	1	0	Falling	14

Date	Refuge	Ranger visible? (Y/N)	Activity	Group size (no. of people)	Number dogs off lead	Number dogs on lead	Tide	Approx. distance from shore (m)
16/11/2020	Exmouth	N	Bait digger	1	0	0	Low	182
16/11/2020	Exmouth	N	Dog walker	1	1	0	Low	26

The following table lists all incursions into the active refuges identified during the Core Counts. Again note that group size for watercraft (indicated with asterisks) refers to the number of boats/ships within the party, not the number of individuals upon them.

Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
Exmouth North: a total of 5 incursions on 5 dates (out of 21); 36.75 hours observation.							
30/11/2018	3	N	Dog walker	1		1	On foreshore 5m from wall.
24/10/2019	4	N	Dog walker	1		1	On thin area above water below sea wall.
04/11/2019	10	N	Dog walker	1		1	Threw sticks into water for dog.
07/12/2019	47	N	Fishing from shore	1			Angler within refuge but no birds within 200m.
16/12/2019	10	N	Dog walker	1		1	All birds on shore flew south. Throwing sticks for dog into water.
Exmouth Duck Pond: a total of 81 incursions across 15 dates (out of 21); 36.75 hours observation							
28/10/2018	15	N	Windsurfer on water				Launched on shore within refuge.
28/10/2018	5	N	Rib or similar fast small boat				Fast speed boat/RIB.
28/10/2018	19	N	Windsurfer on water				Same windsurfer left area and returned 4x
16/11/2018	3	N	Dog walker	1		1	
16/11/2018	21	N	Dog walker	1		1	Beachcombing/collecting on high tide line.
16/11/2018	3	N	Dog walker	2		1	
16/11/2018	10	N	Dog walker	1		1	
26/11/2018	105	N	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	N	Walking	28			Pre-school group with 5 adults walked onto shore.
10/12/2018	2	N	Dog walker	1		1	
10/12/2018	3	N	Dog walker	1		1	B returned. No birds near.

Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
10/12/2018	32	N	Dog walker	1		1	Collecting from tideline.
30/12/2018	10	N	Dog walker	2		1	Dog entered water.
30/12/2018	4	N	Dog walker	2		1	
30/12/2018	8	N	Dog walker	5		1	
30/12/2018	4	N	Cycling	3			Boys on bikes along bottom of sea wall.
26/09/2019	13	N	Dog walker	2	1	1	One dog, off lead then put on lead.
26/09/2019	15	N	Kitesurfer on water	1			Landed on sea wall well inside refuge.
26/09/2019	30	N	Kitesurfer on water	1			Landed on beach inside refuge.
26/10/2019	3	N	Dog walker	1		1	
26/10/2019	2	N	Walker	2			On shore.
26/10/2019	20	N	RIB or similar fast small boat	1*			Speedboat. Around buoys and out again.
26/10/2019	20	N	RIB or similar fast small boat	1*			Speedboat. Around buoys and out.
26/10/2019	30	N	Windsurfer on water	1			Around buoys, and briefly into refuge.
26/10/2019	25	N	Windsurfer on water	1			Well into refuge in proximity to 8 Dark-bellied Brent Geese.
07/11/2019	4	Y	Dog walker	1		2	On far shore north of boatyard.
07/11/2019	4	Y	Dog walker	1		1	
07/11/2019	20 & 30	Y	Other	5			Worker from seawall works, outside screen.
07/11/2019	4	Y	Walker	1			
07/11/2019	20	Y	Dog walker	2		1	
25/11/2019	4	N	Dog walker	1		1	On beach.
25/11/2019	50	N	Other	1			Worker from seawall works, outside screen.
25/11/2019	17	N	Other	1			Worker from seawall works, outside screen.
25/11/2019	6	N	Walker	2			Got out of vehicle.
07/12/2019	6	Y	Dog walker	1		2	
07/12/2019	16	Y	Dog walker	1		1	
07/12/2019	10	Y	Walker	1			
07/12/2019	4	Y	Dog walker	1		2	Ranger intervention.
07/12/2019	3	Y	Dog walker	2		1	Ranger intervention.
07/12/2019	3	Y	Dog walker	2		1	Ranger intervention.
07/12/2019	4	Y	Dog walker	2	1		

Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
07/12/2019	3	Y	Dog walker	1		1	
07/12/2019	2	Y	Dog walker	1		1	
07/12/2019	3	Y	Dog walker	1		1	
13/12/2019	10	N	Dog walker	1		1	In northern end of refuge.
13/12/2019	18	N	Dog walker	1		1	Very briefly in refuge, just past buoys.
13/12/2019	21	N	Dog walker	1		5	
13/12/2019	3	N	Dog walker	1	1		One dog, off lead then put on lead.
26/09/2020	2	N	Walker	2			
26/09/2020	1	N	Dog walker	1		1	Dog chased gulls.
26/09/2020	60	N	Windsurfer on water	4			4 launched between buoys.
26/09/2020	60	N	Windsurfer on water	1			One went into refuge 14:05 (1 min).
26/09/2020	50	N	Windsurfer on water	2			Launched within refuge between rows of buoys.
26/09/2020	2	N	Canoe on water	1			Launched in refuge.
26/09/2020	6	N	Canoe on water	1			Relaunched in refuge and collected child.
26/09/2020	15	N	Canoe on water	1			
26/09/2020	10	N	Canoe on water	1			Launched in refuge. Inflatable canoe.
26/09/2020	6	N	Canoe on water	1			Northern end of refuge.
26/09/2020	6	N	Walker	2			Near roost.
09/10/2020	40	N	Other	1			Motorised board. Between two rows of buoys.
09/10/2020	35	N	Paddleboard	1			
09/10/2020	6	N	Dog walker	1		1	On beach/seawall. Dog in water.
09/10/2020	6	N	Other	1			Model speed boat. Very fast and noisy.
09/10/2020	6	N	Paddleboard	1			To launch and leave water. Between two rows of buoys.
09/10/2020	12	N	Paddleboard	1			Between two rows of buoys.
04/11/2020	60	N	Dog walker	2		1	Walking between the buoys, in refuge briefly but outside of inner buoys.
04/11/2020	32	N	Dog walker	2		3	Walking between the buoys, in refuge but outside of inner buoys.

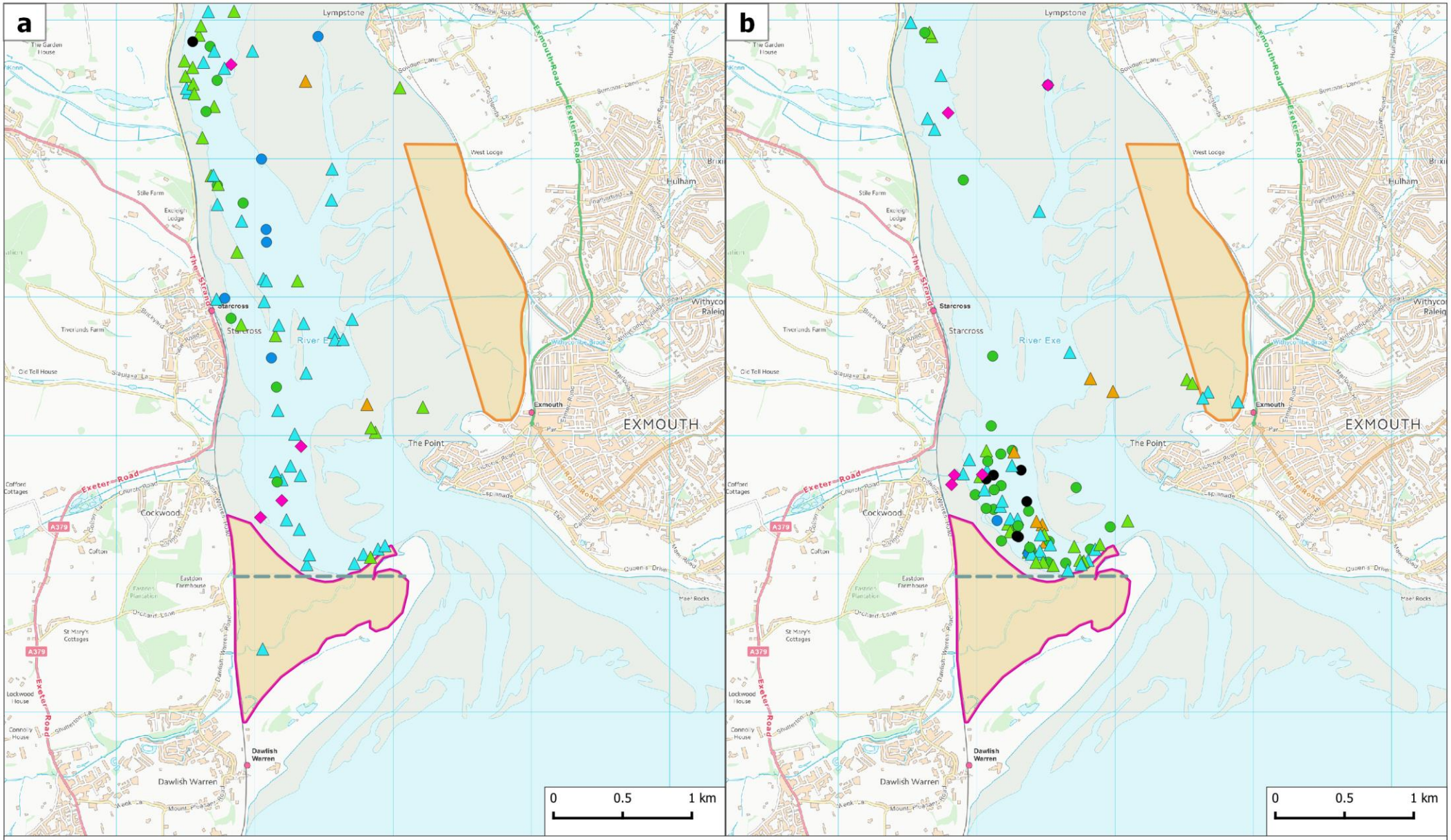
Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
04/11/2020	15	N	Dog walker	1		1	Walking between the buoys, in refuge briefly but outside of inner buoys.
04/11/2020	14	N	Dog walker	1	1		Walking between the buoys, in refuge briefly but outside of inner buoys.
04/11/2020	20	N	Dog walker	1		1	Walking between the buoys, in refuge but outside of inner buoys.
12/12/2020	33	N	Kitesurfer on water	1			Birds disturbed before count.
12/12/2020	12	N	Dog walker	1		1	
12/12/2020	8	N	Dog walker	1			
12/12/2020	32	N	Kitesurfer on water	1			Before the two rows of buoys.
12/12/2020	232	N	Kitesurfer on water	1			Before the two rows of buoys.
12/12/2020	45	N	Windsurfer on water	1			Before the two rows of buoys.
12/12/2020	33	N	Kitesurfer on water	1			(4 inside refuge) east of buoys.
12/12/2020	40	N	Kitesurfer on water	1			Before the two rows of buoys.
12/12/2020	30	N	Kitesurfer on water	1			Before the two rows of buoys.
12/12/2020	27	N	Kitesurfer on water	1			Briefly in refuge, east of all buoys.
12/12/2020	35	N	Windsurfer on water	1			Briefly in refuge.
Dawlish Warren: 31 incursions, including 3 crab tilers. Incursions recorded on 15 dates (out of 31): 54.25 hours observation.							
26/11/2018	6	N	Walker	1			
26/11/2018	35	N	Walker	2			Sat down - moved into dunes
26/11/2018	35	N	Crab tiling				Turning over seaweed
17/03/2019	2	N	Jogger	2			Rounded point into bight
17/03/2019	3	N	Walker	1			Kept above high tide line
17/03/2019	5	N	Walker	2			Walking across bight
17/03/2019	14	N	Person accessing boat or water	1			Salvage operation. Man walked into refuge to sort anchor, then returned to boat.
17/03/2019	10	N	Person accessing boat or water	1			Salvage operation. Man returned to anchor on intertidal
17/03/2019	8	N	Walker	2			On far side, below Cockwood and railway

Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
03/09/2019	3	N	RIB or similar fast small boat	1*			Entered channel from Eastdon; reduced speed until in channel.
03/09/2019	3	N	RIB or similar fast small boat	1*			Into refuge, lost to view after 3 mins. Returning small boat to Eastdon dock.
10/10/2019	9	N	Canoe on water	1			Kayak - into refuge.
09/11/2019	10	N	Small sailing boat	1*			Briefly entered refuge.
14/12/2019	12	N	Birdwatcher	2			On high tide line, walked around point.
14/12/2019	9	N	Walker	4			On high tide line, walked around point.
14/12/2019	8	N	Birdwatcher	2			On high tide line, walked around point.
09/01/2020	10	N	Bait digger	1			Left area in small boat.
09/01/2020	6	N	Walker	2			In bay.
09/01/2020	3	N	Walker	2			Around point into bay, turned around and walked back.
11/03/2020	45	N	Crab tiler	1			Crab tiler from small boat. Landed north of hide, outside buoys. No interaction with birds apart from attracting c.12 Herring Gulls to follow him around.
26/08/2020	6	N	Walker	2			From point into bay.
26/08/2020	12	N	Walker	2			Returned to point.
26/08/2020	5	N	Walker	2			As above but no birds now.
26/08/2020	4	N	Swimmer	1			Swam out of sight.
26/08/2020	4	N	Swimmer	1			
25/09/2020	2	N	Dog walker	2		1	Dog suddenly ran onto intertidal area. Curlew flew, dog returned to owner in 30 seconds in refuge.
15/10/2020	10	N	Walker	2			But above high tide line.
03/11/2020	10	N	Dog walker	3	2	2	Two dogs, off lead at first, then, above high tide line, put dogs on leads after reading sign.
17/11/2020	6	N	Walker	2			On Finger Point.
15/12/2020	38	N	Birdwatcher	2			Bird photographers on point.
27/01/2021	38	N	Crab tiler	1			checking tiles on tide line.

Date	Duration (mins)	Ranger visible ? (Y/N)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
Cockwood: total of 22 incursions, including 6 crab tilers. Incursions recorded on 9 dates (out of 32); 56.00 hours observation.							
21/09/2018	50	N	Walker	1			
21/09/2018	55	N	Walker	1			Fed c.20 Herring Gulls.
21/09/2018	40	N	Crab tiling				
21/09/2018	14	N	Walker	2			Moved slightly onto shore – intertidal.
21/09/2018	20	N	Dog walker	2		1	
20/12/2018	120+	N	Crab tiling	1			
13/02/2019	10	N	Walker	2			
11/03/2019	86+	N	Crab tiling	1			
27/05/2019	8	N	Walker	2			Walked across bight.
27/05/2019	90	N	Fishing from shore	1			Fishing south of Cockwood steps.
27/09/2019	45	N	Crab tiler	1			Present on arrival.
10/10/2019	120	N	Bait digger	1			
10/10/2019	6	N	Dog walker	1	1		
10/10/2019	5	N	Dog walker	1	1		
10/10/2019	10	N	Bait digger	1			Landed from small boat, turning over seaweed.
10/10/2019	11	N	Walker	1			Kept tight to seawall. 50m into refuge.
16/12/2019	105	N	Crab tiler	1			
16/12/2019	-	N	Crab tiler	1			Duration not recorded.
16/10/2020	-	N	Walker	2			Walked from refuge to car.
16/10/2020	21	N	Walker	2			Walked south into refuge.
16/10/2020	33	N	Walker	2			Just inside - sat on seawall.
16/10/2020	23	N	Walker	2			Then towards Cockwood harbour.

Appendix 3: Maps depicting the distribution of individual activities, or grouped activity types, recorded during the Vantage Point surveys, stratified by the relevant refuge's active and inactive period

Map 6: Vantage Point data of boat-based activities during:(a) inactive refuge periods and (b) active refuge periods

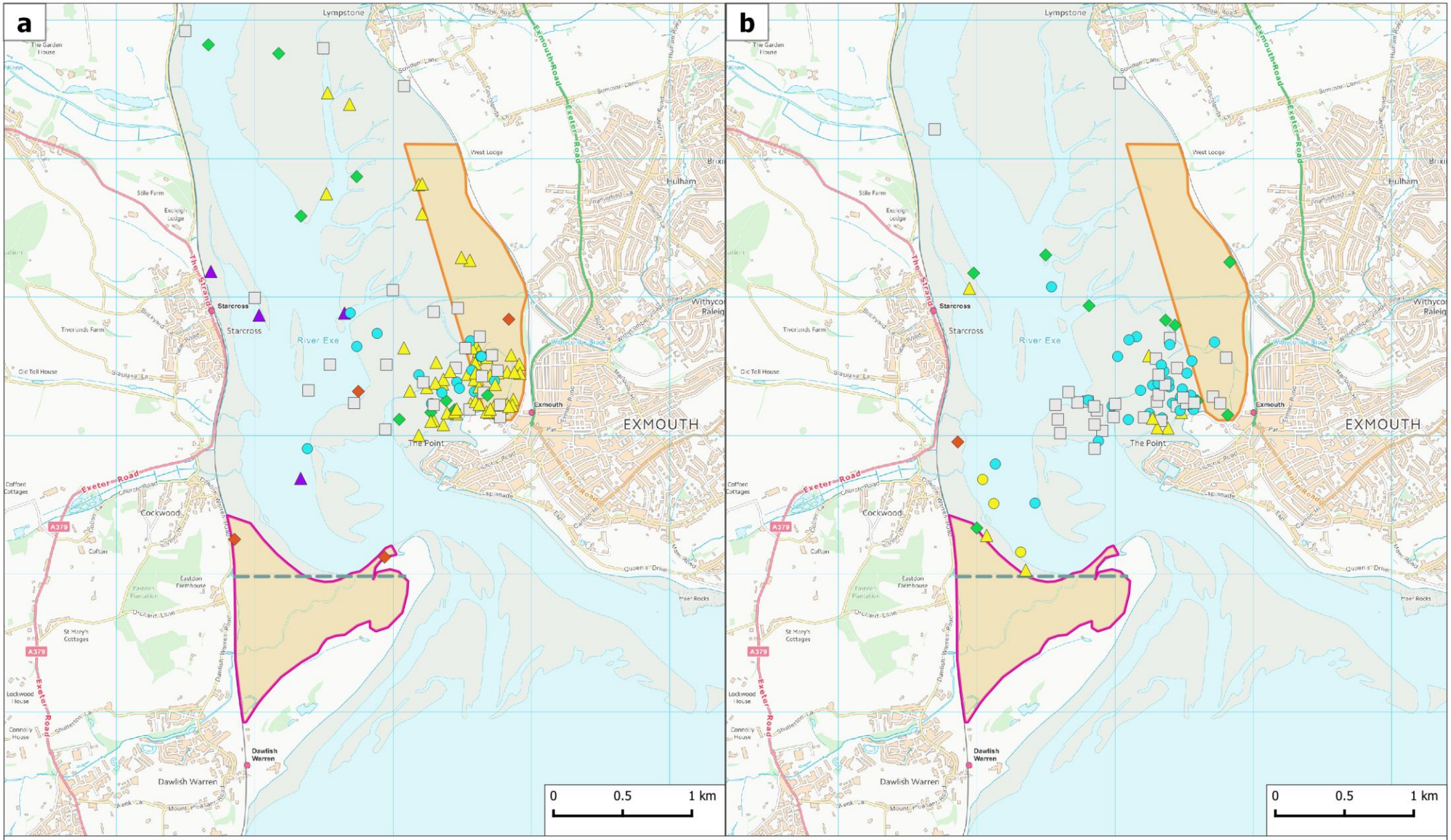


Legend

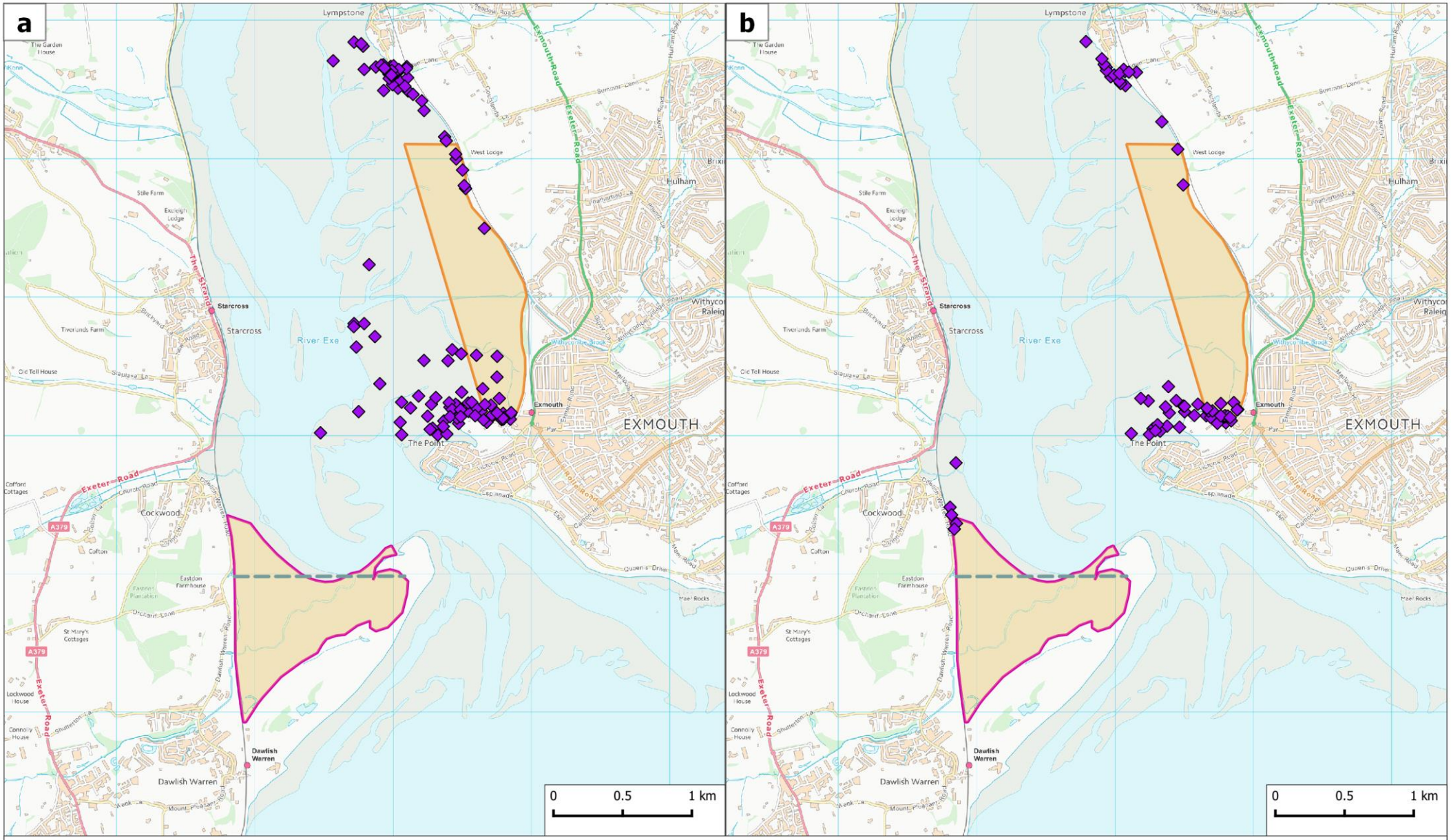
Activities

- Person working on a boat
- Large motor boat
- Moderate to large sailing boat
- Motorboat with inboard engine <10m
- Rowing boat
- Small motorboat
- Small sailing boat
- Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)
- Dawlish Warren refuge area
- Exmouth refuge area

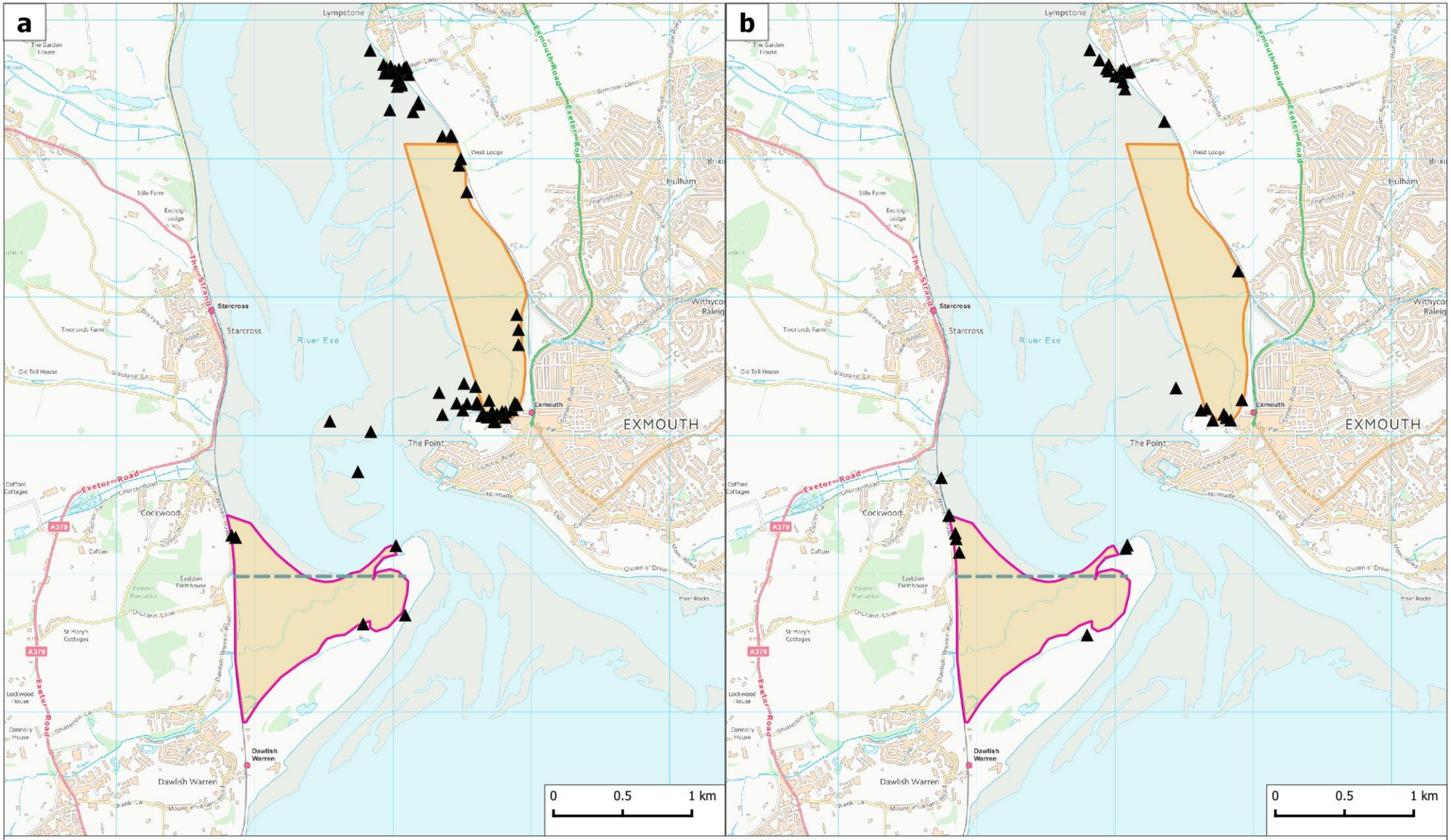
Map 7: Vantage Point data of recreational watersports during:(a) inactive refuge periods and (b) active refuge periods



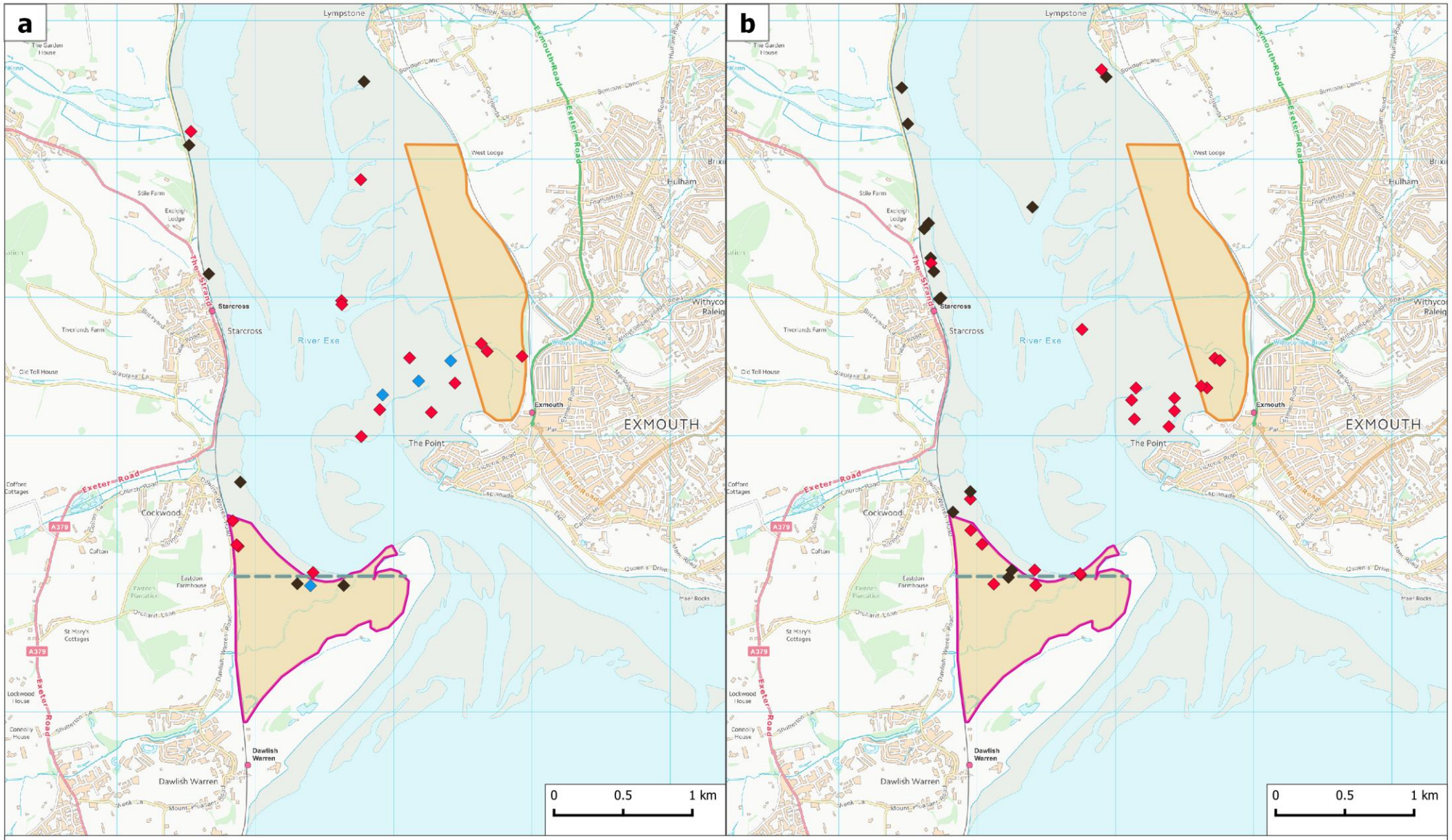
Map 8: Vantage Point data of dog walkers during:(a) inactive refuge periods and (b) active refuge periods



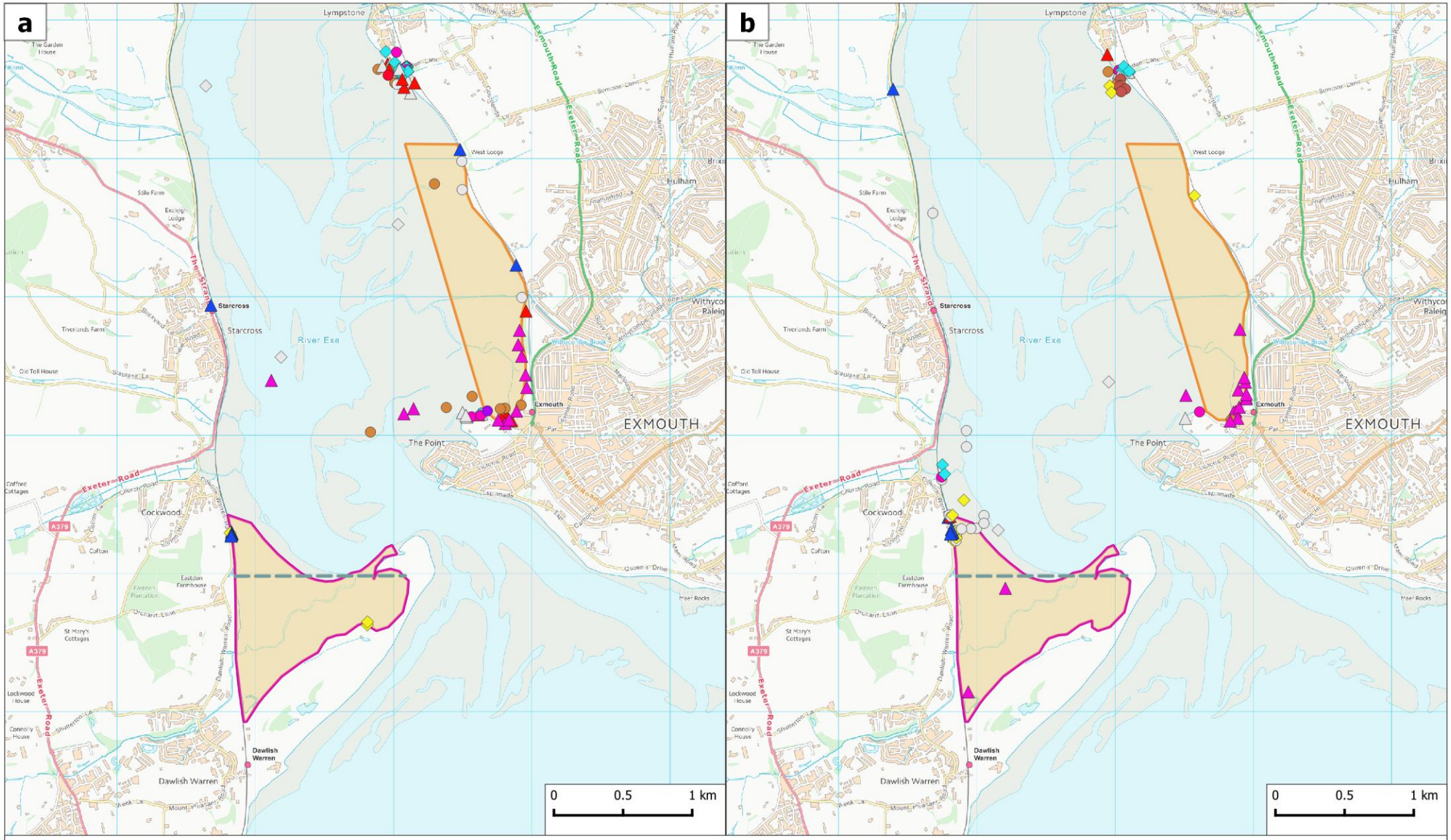
Map 9: Vantage Point data of walkers during:(a) inactive refuge periods and (b) active refuge periods



Map 10: Vantage Point data of bait diggers, cockle rakers, and crab tilers during:(a) inactive refuge periods and (b) active refuge periods



Map 11: Vantage Point data of all other activities not shown on Maps 6 to 10 during:(a) inactive refuge periods and (b) active refuge periods



Legend

Activities

- Airborne
- Birdwatcher
- Cyclist
- Fisherman
- Horse rider
- Jogger
- Jogger with dogs
- Kids playing
- Metal detector
- Motor vehicle
- Other
- Picnic
- Train
- Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)
- Dawlish Warren refuge area
- Exmouth refuge area

Appendix 4: All potential disturbance events within the refuges, while they were active, from the Core Count data

The table lists all potential disturbance events recorded within the refuges, while they were active, across the entire three-year study period. The table also identifies the number of birds (waders and wildfowl only) in each category of response, with dashed lines separating each year of the study.

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							
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	Dawlish Warren	26/11/18	1	2								
Dog walker	Exmouth North	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							

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	30/12/18			3							
Walking	Cockwood	13/02/19				6						
Bait digger	Cockwood	11/03/19	11	1	1							
Person accessing boat or water	Dawlish Warren	17/03/19	6									
Annual total			**68**	**3**	**36**	**16**	**50**	**163**	**185**		**308**	**388**
Walker	Dawlish Warren	27/05/2019	17									
Bait digger	Cockwood	10/10/2019			3							
Bait digger	Cockwood	10/10/2019				3						
Canoe on water	Dawlish Warren	10/10/2019										8
Dog walker	Exmouth Duck Pond	26/10/2019	6							120		
Dog walker	Exmouth North	04/11/2019				5	8					23
Dog walker	Exmouth Duck Pond	07/11/2019					9					
Walker	Exmouth Duck Pond	07/11/2019						60				
Walker	Exmouth Duck Pond	07/11/2019							14			
Dog walker	Exmouth Duck Pond	07/11/2019							45	5		
Dog walker	Exmouth Duck Pond	25/11/2019						6				
Walker	Exmouth Duck Pond	25/11/2019					6					4
Dog walker	Exmouth Duck Pond	07/12/2019				6						
Dog walker	Exmouth Duck Pond	07/12/2019				2				25		
Dog walker	Exmouth Duck Pond	07/12/2019								8	8	
Dog walker	Exmouth Duck Pond	07/12/2019					13					
Dog walker	Exmouth Duck Pond	13/12/2019			2							
Dog walker	Exmouth North	16/12/2019					14					

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
Crab tiler	Cockwood	16/12/2019	2	2	2							
Crab tiler	Cockwood	16/12/2019		2	2							
Annual total			**25**	**4**	**9**	**16**	**50**	**66**	**59**	**158**	**8**	**35**
Canoe on water	Exmouth Duck Pond	26/09/2020										994
Walking	Exmouth Duck Pond	26/09/2020										50
Dog walker	Exmouth North	26/09/2020					3					
Other	Exmouth Duck Pond	09/10/2020							10	20		150
Other	Exmouth Duck Pond	09/10/2020								40		
Paddleboard	Exmouth Duck Pond	09/10/2020							6	8		
Dog walker	Exmouth Duck Pond	04/11/2020				2						
Dog walker	Exmouth Duck Pond	12/12/2020			4		4					
Kitesurfer on water	Exmouth Duck Pond	12/12/2020					16					
Annual total					**4**	**2**	**23**		**16**	**68**		**1,194**
Total across three-year study			**93**	**7**	**49**	**34**	**123**	**229**	**260**	**226**	**316**	**1,617**