Report

footprint ECOLOGY

# Exe Disturbance Study

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## Summary

This report considers human disturbance to wintering waterfowl on the Exe Estuary in Devon. We have used a novel and fresh approach to gain an estuary-wide perspective on recreational use and disturbance. Our approach has combined direct observation on birds with data from users themselves, including GPS track data for a range of different water sport activities.

A wide range of different activities occur around the Exe and overlap in time and space. Water based activities involve a wide range of craft, and include both commercial and recreational use. A range of shore-based activities also take place and people were regularly recorded on the intertidal, below the mean high water mark. Taking an overview of access, the estuary is clearly very busy and it is only a small proportion of the perimeter of the estuary where access is limited or difficult. The highest levels of access occur around the lower stretches of the estuary, at Exmouth and also at the very top of the estuary, around Topsham.

The Exe Estuary in internationally important for wintering birds, and qualifies as an SPA for avocet and slavonian grebe, and also as it regularly supports an assemblage of at least 20,000 waterfowl. Dunlin, oystercatcher, lapwing, wigeon and dark-bellied brent goose are the most abundant species within this assemblage. Wintering bird numbers start building from August, peaking in December.

At nine survey locations within the estuary where detailed repeat counts were undertaken (relating to pre-defined areas of mudflat and intertidal habitat):

- Shore based activities accounted for 55% of observed recreation events, mostly involving walkers without a dog (32%) and dog-walkers (9%).
- Activities on the intertidal accounted for 36% of observed recreation events and included dog-walkers (17%), bait diggers/crab tilers etc (7%) and walkers without dogs (7%).
- Water-based activities accounted 8% of observed recreation events and included a wide variety of different types of activity such as RIBs/small motor boats (3%); kitesurfers (1%) and windsurfers (1%).

There is evidence that bird distributions are related to access. In general terms the numbers of birds appear low at the Duck Pond and at Topsham in relation to adjacent count sectors. The parts of the estuary with the lowest levels of access (such as Shutterton Creek) are also the parts of the estuary with the highest bird counts. At the Duck Pond, Lympstone, Starcross South and Powderham there is evidence that the number of birds varied in response to the levels of access over the previous 45 minutes: i.e. when more people had been present, fewer birds were recorded.

Around 14% of groups/recreational events observed across the survey locations flushed birds and caused a major flight event (birds flying more than 50m). Just under two-thirds (62%) of events evoked no response at all from the birds.

After controlling for distance, tide and location, birds were more likely to take flight when the activity took place on the intertidal or on the water compared to the shore. The probability of major flight events was lower at Topsham and Powderham compared to other sites. The probability of a major flight event occurring was also lower at low tide. Bait digging on the intertidal, dog walking

with dogs off leads on the intertidal, walking on the shore and intertidal and kitesurfing are the activities which account for the majority of major flight events. It is dog walkers with their dogs off leads on the intertidal that caused the highest percentage of major flights from all the observed potential disturbance events.

We use the actual route data from visitor work (GPS tracks and face to face interviews) and the analysis of flight response to calculate comparative 'areas' of intertidal habitat lost as a result of different activity types. These calculations suggest that, at intermediate tide stages, the average area lost to a windsurfer or kitesurfer would be around 8ha, while a dog walker on the mudflats at the duck pond results in an area lost of around 3ha (note that this figure is likely to underestimate the impact of dogs as we only have route data for the owners rather than the pet). By contrast the disturbance caused by someone walking along the shore path at Goat Walk at low tide equates to an equivalent impact of the loss of 0.1ha of intertidal habitat to the birds.

## Contents

## Acknowledgements

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# 1. Introduction

### Overview

This study addresses the effects of recreational disturbance to waterbirds on the Exe Estuary, in Devon. The study focuses on water based activities, and has been commissioned by the Exe Estuary Management Partnership. Our approach has been to collect data on recreational use through interviews, direct observation and route mapping using GPS devices. These data are combined with detailed ornithological fieldwork and existing bird count data to explore the extent to which disturbance is an issue for birds on the Exe. In this section of the report we summarise the background to the work and the need for the study.

## Disturbance to birds

1.1 Disturbance can be defined as any human activity that influences a bird's behaviour or survival. There are a wide variety of studies which review disturbance effects (Hockin *et al.* 1992; Hill *et al.* 1997; Carney & Sydeman 1999; Nisbet 2000; Saunders *et al.* 2000; Woodfield & Langston 2004; Lowen *et al.* 2008). The range of studies is potentially bewildering, demonstrating a range of different impacts, in different circumstances, to different species. There is still contention about the applicability of the methods of study and the impacts on bird populations (Gill 2007).

1.2 Most studies of disturbance demonstrate behavioural effects, such as birds changing their feeding behaviour (Burger 1991; Fitzpatrick & Bouchez 1998; Verhulst, Oosterbeek, & Ens 2001; Thomas, Kvitek, & Bretz 2003), taking flight (e.g. Stalmaster & Kaiser 1997; Burger 1998; Fernandez-Juricic, Jimenez, & Lucas 2001; Blumstein 2003; Blumstein et al. 2003; Fernandez-Juricic et al. 2005; Webb & Blumstein 2005) or being more vigilant (Fernandez-Juricic & Schroeder 2003; Randler 2006). Other studies have focused on physiological impacts, such as demonstrating changes in the levels of stress hormones (Remage-Healey & Romero 2000; Tempel & Gutierrez 2003; Walker et al. 2007) or monitoring changes in heart rate (Nimon, Schroter, & Oxenham 1996; Weimerskirch et al. 2002). While behavioural and physiological studies show an impact of disturbance, it is usually difficult to understand whether the disturbance does actually have an impact on the population size of the species in question. For example, the fact that a bird takes flight when a person approaches is to be expected and a short flight is unlikely to have a major impact on the individual in question, let alone the population as a whole.

1.3 Certain impacts of disturbance are perhaps more likely to have consequences at a population scale. Direct mortality resulting from disturbance has been shown in a few circumstances (Liley 1999; Yasué & Dearden 2006) and many (but not all) studies have shown a reduction in breeding success where disturbance is greater (e.g. Murison 2002; Bolduc & Guillemette 2003; Ruhlen et al. 2003; Arroyo & Razin 2006). There are also many examples of otherwise suitable habitat being unused as a result of disturbance

(Gill 1996; Kaiser *et al.* 2006; Liley *et al.* 2006b; Liley & Sutherland 2007). Very few studies have actually placed disturbance impacts in a population context, showing the actual impact of disturbance on population size (West *et al.* 2002; Liley & Sutherland 2007; Mallord *et al.* 2007; Stillman *et al.* 2007a).

1.4 Studies have shown disturbance effects for a wide range of activities besides simply people, for example aircraft (see Drewitt 1999), traffic (see Reijnen, Foppen, & Veenbaas 1997 for a review), dogs (Lord et al. 2001; Banks & Bryant 2007) and chainsaws (Delaney et al. 1999; Tempel & Gutierrez 2003). There is still relatively little work on the effects of different types of water based craft and the impacts from jet skis, kitesurfers, windsurfers etc (see Kirby et al. 2004 for a review). Some types of disturbance are clearly likely to invoke different responses. In very general terms, both distance from the source of disturbance and the scale of the disturbance (noise level, group size) will both influence the response (Delaney et al. 1999; Beale & Monaghan 2004).

1.5 Many authors define a definitive distance beyond which disturbance is assumed to have no effect and this is then used to determine set-back distances or similar (Rodgers & Smith 1995, 1997; Stalmaster & Kaiser 1997; Fernandez-Juricic et al. 2001, 2004). It is inappropriate to set such distances as responses to disturbance vary between species (Blumstein et al. 2005) and between individuals of the same species (Beale & Monaghan 2004). Particular circumstances, such as habitat, flock size, cold weather or variations in food availability will also influence birds' abilities to respond to disturbance and hence the scale of the impact (Stillman et al. 2001; Rees, Bruce, & White 2005). Birds can also modify their behaviour to compensate for disturbance, for example by feeding for longer time periods (Urfi, Goss-Custard, & Lev. Dit Durell 1996). Birds can become habituated (Nisbet 2000; Walker, Dee Boersma, & Wingfield 2006; Baudains & Lloyd 2007) to particular disturbance events or types of disturbance, and this habituation can develop over short time periods (Rees et al. 2005). The frequency of the disturbance event will determine the extent to which birds can become habituated, and therefore the distance at which they respond.

1.6 Population impacts are not necessarily relative to the scale of disturbance (Liley & Sutherland 2007; Mallord *et al.* 2007), i.e. small changes in disturbance can result in disproportionately large impacts and vice versa. As described previously, behavioural responses may not necessarily describe the impact of disturbance at a population scale, with behavioural responses not necessarily reflecting the true impact of disturbance. Therefore, while the use of a single set-back distance is an appealing and simple approach to limiting the effects of particular works, the approach is flawed and will not necessarily ensure disturbance effects are avoided.

1.7 Rather than rely on set distances, it is instead necessary to consider the species' ecology, use of an area and other factors that may influence the scale of the disturbance. This information can then be used to identify what kinds of disturbance, at which locations, are likely to have an impact.

## The Exe Estuary: Description, Designations and Conservation Importance

1.8 The Exe Estuary lies between Teignbridge District to the West, East Devon District to the East and Exeter City to the north. It is designated as a Special Protection Area (SPA), Ramsar site and SSSI.

1.9 The SPA (Map 1) includes the estuary waters, foreshore, saltmarsh and the sand dunes of Dawlish Warren with the double spit across the estuary mouth and extends to Exeter at the top (northern part) of the estuary. The estuary includes a range of intertidal habitats, including eelgrass *zostera sp.* beds, saltmarsh, mussel (*Mytilus edulis*) beds and saltmarsh. A number of roost sites at the top end of the estuary are freshwater grazing marsh and lagoons at Bowling Green Marsh, Matford Marshes and Exminster Marshes lie within the SPA and are RSPB reserves. Key locations referred to within the text of this report are labelled on Map 1.

1.10 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 East Anglia or the south coast. The Exe Estuary is one of only three SPAs classified for non-breeding avocets, with the majority being on the East Anglian coast.

- 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. The Exe Estuary is therefore a critical overwintering ground for this species in the UK.

1.11 The Exe Estuary qualifies under Article 4.2 of the Birds Directive for regularly supporting 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*.

1.12 The area also qualifies under Article 4.2 of the Directive as it regularly supports an assemblage of at least 20,000 waterfowl, including: Black-tailed Godwit *Limosa limosa islandica*, Dunlin *Calidris alpina alpina*, Lapwing *Vanellus vanellus*, Grey Plover *Pluvialis squatarola*, Oystercatcher *Haematopus ostralegus*, Red-breasted Merganser *Mergus serrator*, Wigeon *Anas penelope*, Dark-bellied Brent Goose *Branta bernicla bernicla*, Cormorant *Phalacrocorax carbo*, Avocet *Recurvirostra avosetta*, Slavonian Grebe *Podiceps auritus* and Whimbrel *Numenius phaeopus.* This list is taken from the site citation where a range of assemblage species is normally quoted, but not the entire assemblage species list. Other species therefore also form part of the assemblage.

1.13 It should be noted that the Article 4.2 migratory species are not listed as qualifying features in the SPA Review of 2001 (i.e. the Review cites wintering Slavonian Grebe, wintering Avocet and the assemblage of at least 20,000 waterfowl). That review is still

being progressed, and the Natura 2000 data form is therefore referred to for a current list of qualifying features, which includes the Article 4.2 migratory species.

1.14 The Exe Estuary is also listed as a Ramsar site, due to its estuarine habitats and its overwintering and on passage waterbirds. The SSSI designation reflects not only the wintering bird interest, but also the flora and invertebrates of the surrounding marshes, the saltmarsh, the invertebrate communities within the estuary, the eelgrass beds (*Zostera* spp.) and the geological interest.

## Trends in Bird Numbers on the Exe

1.15 Standard counts of wintering waterfowl are undertaken around the UK in the form of WeBS counts. Analysis of these data by the BTO is used to identify 'alerts' where declines have occurred at individual SPA sites. On the Exe, there are currently[1] WeBs alerts for four species: oystercatcher, grey plover, red-breasted merganser, lapwing. For grey plover, red-breasted merganser and lapwing the declines would appear to be in line with other sites and would therefore suggest that the issues are not specific to the Exe. In the case of oystercatcher however, the decline has occurred far more rapidly than that on other sites. This would suggest that the decline is driven by site-specific pressures (see BTO website and Thaxter *et al.* 2010 for details).

1.16 The alert analysis did not include slavonian grebes, the numbers of which were not assessed as it occurs in numbers too low, and is recorded by routine WeBS counts too infrequently, to support trend fitting and analysis.

## Disturbance and wintering waterfowl

1.17 During the non-breeding season, the main impacts of human disturbance on birds is interruption to foraging and, to a lesser extent, roosting (Woodfield & Langston 2004). The extent to which disturbance affects the actual distribution of birds within a site will vary according to the species involved, the availability of other resources and the birds' own state. If birds are under stress, for example during cold winter weather when food resources are scarce, they may be less easily disturbed than at other times (Stillman & Goss-Custard 2002; Burton 2007), they may simply not be able to afford to stop feeding. There may also be seasonal variation within a species' responsiveness to disturbance, as individuals alter their threshold in response to shifts in the basic trade-off between increased perceived predation risk (tolerating disturbance) and the increased starvation risk of not feeding, i.e. avoiding disturbance (Stillman & Goss-Custard 2002).

1.18 Shorebirds are often considered highly susceptible to disturbance because of their very obvious flight responses to humans and because they use areas that are generally subject to high levels of human recreational use, such as coastlines. Many species may appear to avoid human presence (e.g. Ravenscroft et al. 2008) but this avoidance may

[1] Analysis to the winter 2007/8, see http://www.bto.org/sites/default/files/u18/downloads/alerts/uk9010081.pdf
[2] http://www.exe-estuary.org/index/news/exepress.htm

not reduce the number of animals supported in an area. Assessing the influence of disturbance on the relationship between animal distribution and resource distribution can provide a means of assessing whether numbers are constrained by disturbance (Gill, Norris, & Sutherland 2001), but is potentially difficult as it involves determining prey distribution etc. A variety of studies have examined the impacts of disturbance on the behaviour of estuary waders in particular and some studies have sought to extrapolate findings to make inferences about population effects (Sutherland 2006; Stillman *et al.* 2007aundefinedb; Stillman & Goss-Custard 2010). There is good evidence that shorebird survival on non-breeding grounds is a factor in population limitation (Sutherland 1996; Yalden & Pearce-Higgins 1997; Newton 2004; Gunnarsson *et al.* 2005).

1.19 Disturbance from people walking along estuary footpaths / sea walls appears to have an adverse impact on the distribution of estuary birds. For example numbers of four species (brent goose *Branta bernicla*, shelduck *Tadorna tadorna*, dunlin *Calidris alpina* and redshank *Tringa totanus*) decreased with increased proximity to a footpath access point on weekends, when use was likely to have been greatest (Burton et al. 2002). Similarly, recreational use (particularly dogs running off the lead) of shorebird foraging areas reduced foraging time of sanderlings *Calidris alba*, according to a study in the United States (Thomas, Hay, & Newton 2003). Walkers were the most common potential disturbance event recorded in a study on two Suffolk estuaries (Ravenscroft et al. 2008).

1.20 In contrast, another study on the Suffolk estuaries, that looked at the effects of disturbance on wintering black-tailed godwits *Limosa limosa,* found that the presence of footpaths had no effect on the numbers of birds supported by adjacent intertidal areas once bivalve food supply had been taken into account (Gill, Norris, & Sutherland 2001a). However, caution was suggested in extrapolating these findings to other species or other life-cycle stages, particularly because fieldwork was only conducted on weekdays, when recreational disturbance can be assumed to have been lower (Woodfield & Langston 2004).

1.21 The Exe has been the subject of intensive research on the impacts of disturbance to birds, mainly focused on the mussel beds and oystercatchers. Goss-Custard and Verboven (1993) review disturbance and feeding shorebirds, focusing particularly on oystercatchers feeding on mussel-beds. While now dated, they identified that disturbance levels had increased over the previous 10-15 years, yet while there may have been some redistribution of the birds, there was no detectable change in bird populations, with oystercatcher numbers over the same period increasing in line with the national population.

1.22 A sequence of individual-based models predicts the consequences of environmental change for shorebird and wildfowl populations. The first two shorebird models (Goss-Custard et al. 1995a; Goss-Custard et al. 1995b) described in increasing detail the oystercatcher–shellfish system. The third shorebird model was also primarily developed for oystercatchers on the Exe estuary (Stillman *et al.* 2000, 2001; West et al. 2002), but

was subsequently parameterized for Oystercatchers and other shorebirds and applied to a range of other sites. These models provide useful context for this contract, yet were clearly developed at a time when access levels were likely to be very different to the current use. The modelling by West *et al.* in 2002 predicts the impact of human disturbance on oystercatchers on using the Exe Estuary in winter. The modelling showed that disturbance had the potential to be more damaging than actual habitat loss, but that at the levels of access then occurring on the Exe, disturbance was not predicted to result in increased mortality. The work also suggested that preventing disturbance during late winter, when feeding conditions were harder, would practically eliminate any predicted population consequences.

1.23 The national cycle trail around the Exe was subject to a detailed appropriate assessment (Goss-Custard 2007) which summarises disturbance data for the Exe, including flight distances. Based on the author's considerable data set and experience, the work suggests distances at which activities on the shoreline are considered to have no impact on birds present on the Exe. These distances are 200m for sections of shoreline where the people are not on the skyline and people are simply cycling/walking along a path. For sections on the skyline and for activities that are more irregular a distance of 400m is suggested.

1.24 A further piece of relevant research is visitor survey work on the estuary, undertaken jointly by Footprint Ecology and Teignbridge District Council (Liley & Cruickshanks 2010). This work involved interviews with visitors to the Exe Estuary during the late winter period. The work highlights the high numbers of visitors to the Exe, even in the winter. It describes visitor access patterns, the routes undertaken during their visit and also shows where people travel from (their home postcodes) when visiting the Exe.

### This study and the need for further work on disturbance

1.25 Levels of recreation within the countryside are increasing (TNS Research International Travel & Tourism 2010). There are now a wide range of leisure activities that take place in coastal environments that are relatively novel and have become popular within the UK in a short space of time (Davenport & Davenport 2006), for example personal watercraft (Whitfield & Roche 2007), coasteering (Rogers 2010, 2011) and kitesurfing (Smith 2004). Many activities take place during the winter, when the estuaries and coastal habitats often support high numbers of birds.

1.26 The Exe Estuary is a relatively small estuary, and it lies close to a number of towns and the city of Exeter. The estuary is scenic and it draws people from a wide area. Visitor numbers are therefore potentially high and a wide range of recreational activities occur. There is evidence of declines in the numbers of some key species wintering on the estuary.

1.27 This study was therefore commissioned by the Exe Estuary Management Partnership to inform future management of the estuary for recreation. The study was commissioned in 2009, with a focus on water-based activities. The study and level of fieldwork was extended in 2010. We summarise the aims of this work as:

- To determine the extent and nature of disturbance from water-based recreation on the internationally important populations of wintering waterbirds on the Exe Estuary.
- To identify the water-based recreation activities and their characteristics that cause significant and the greatest behavioural response in waterbirds.
- To consider the consequences of cumulative responses to disturbance on waterbird fitness and condition.

# 2. Our Approach

### Overview

There is already data on the impacts of disturbance to birds on the Exe Estuary and a large body of literature on disturbance, however this is dated. In order to inform future management, the most important information concerns access patterns – how visitors behave and why. Our approach has been to develop this by working closely with local user groups and to collate various different data sources, some of which involved direct counts and observation of recreation and birds, but much of which has been to collate existing knowledge, understanding and expertise. We have used GIS to co-ordinate and link various data sets together, allowing us to integrate the data and create a holistic, practical and intuitive way of understanding the issues. Data and information gathering methods for the study of recreational access are summarised below:

- GPS units – used to collect route information from different watersports users
- Information and routes collected as part of the Exe Estuary Visitor Survey for Teignbridge District Council (TDC)
- Total counts – all users on the water and shore are mapped and categorised according to activity
- Unstructured / informal interviews – to gain detailed information from local stakeholders about levels of use, issues and options for management
- Expert opinion – WeBS counters, wardens, Natural England staff, RSPB staff, EA staff and any other local experts have scored the estuary to show where activities take place and how this has changed over time.

We have structured our approach so as to collect information relating to:

- Water based recreation
- Land based recreation
- Distribution of birds and identification of key areas
- Distribution of habitat
- Effect of disturbance

### Water based Recreation

2.1 We used different data to determine the current extent and potential for future management of water based recreation activities. These different elements are discussed in further detail below.

#### Counts and maps of recreational use from direct observation

2.2 In order to determine visitor numbers for the entire estuary, a series of direct counts were required. We conducted 28 counts of people and activities on the estuary between 28/12/2009 and 02/04/2011. The counts were carried out using two methods: a boat transect on the Stuart Line Cruises river cruise (4 completed) and also shore counts using binoculars from the duck pond, the seafront and the Maer (24 completed). The boat transect and the shore counts provided a full survey of the estuary up to Powderham Sand (the area shown in Map 2) and these allowed us to count the number

of craft out on the water (in use rather than just moored) or being accessed and the number of people visible (e.g. water craft/boats, people on intertidal, people on embankments, dogs and family picnics etc). The boat transect allowed counts further up the estuary when tides permitted but these data points have been excluded from the maps generated as only a small sample of counts included the whole estuary. We had hoped to conduct many more boat transect surveys but timings and tides rarely coincided to complete the surveys all the way to Topsham.

2.3 The counts are simple snapshots and cover a range of dates across the year, a range of tide heights, weather conditions and times of day. The dates on which the shore and cruise surveys were conducted are shown in Table 1. Eleven of the surveys were conducted on a weekend day, 17 were on a week day and five fell within the school holidays. Where more than one shore count was conducted in a single day, they were spaced by at least four hours.

**Table 1: Total count and boat transect survey dates (* indicates school holidays).**

| Date | Day | Boat transect | Shore total count |
|---|---|---|---|
| 31/10/2009* | Saturday | 1 | |
| 28/12/2009* | Monday | 1 | |
| 20/01/2010 | Wednesday | | 1 |
| 24/01/2010 | Sunday | | 1 |
| 12/02/2010 | Friday | | 1 |
| 14/02/2010* | Sunday | | 1 |
| 21/03/2010 | Sunday | | 1 |
| 23/03/2010 | Tuesday | | 1 |
| 16/04/2010* | Friday | 1 | |
| 04/07/2010 | Sunday | 1 | |
| 23/09/2010 | Thursday | | 1 |
| 10/10/2010 | Sunday | | 1 |
| 29/10/2010* | Friday | | 1 |
| 20/11/2010 | Saturday | | 1 |
| 09/02/2011 | Wednesday | | 2 |
| 10/03/2011 | Thursday | | 2 |
| 12/03/2011 | Saturday | | 2 |
| 14/03/2011 | Monday | | 2 |
| 31/03/2011 | Thursday | | 2 |
| 01/04/2011 | Friday | | 2 |
| 02/04/2011 | Saturday | | 2 |
| Total | | 4 | 24 |

2.4 During the counts, all activities and people visible were mapped, using a series of standard codes and plotting all events as points on a detailed aerial photograph. These were later transferred to GIS, again as point data coded to standard activity types.

### Distribution of launch points and zones

2.5 We have created a single GIS layer of all locations where craft can be launched using published maps from the Exe Estuary Management Partnership website. We have also combined information on existing management measures such as dedicated zones in order to allow us to show existing management for water craft.

### GPS units

2.6 GPS units were circulated amongst watersports users to collect route information for a variety of activities on the Exe. Four Garmin Fortrex 201 units were used initially. This small wrist watch sized unit is designed for those undertaking extreme sports, and is widely used by kayakers and windsurfers. The units are simple to use and the technology is familiar to many of the people. A number of other GPS units (igotU GT-120 Tracker) became available for use later in the study. Initially the units were circulated amongst staff and customers at Edge Watersports and also by post to individuals who volunteered to take a unit out over the course of the study at the Exe Forum in January 2010. Some units were also sent to AS Watersports in Exeter, Exe Sailing Club, Devon Paddle Club, Exmouth Rowing Club, Haven Banks Centre and Tad water sports shop in Exmouth.

2.7 Due to the extremely cold conditions combined with a lack of wind over the winter and into the spring, many volunteers were not out on the water as much as they expected. Therefore, Footprint Ecology staff spent a number of days on the Exe distributing the units to watersports users. The timing of these visits was planned carefully to optimise wind conditions for kite and windsurfers. This method was more efficient compared to relying on volunteers to take the units out, use them correctly and return them. Furthermore this gave us the opportunity to speak to watersports users, explain the study and discuss their suggestions for options to manage the estuary.

2.8 The units are relatively cost effective and have a battery life of 10-15 hours. The units record the routes while undertaking activities by recording a point location every 3 seconds. Each time the units were used we asked the user to fill a very short trip report, detailing the weather conditions, launching point and their postcode.

2.9 While we recognise that the volunteers may not behave in a typical fashion while wearing the units, they give a useful indication of trip length, use of different sites and speed of travel. Crucially their inclusion means we were able to directly involve local groups and individual users in the data collection. We gave each volunteer a commitment not to publish their name alongside the route data and a guarantee that the data would not be used to police existing zones. As an incentive we provided maps and summary reports of each route if the volunteer requested including top speed, average speed, area covered and length of route.

2.10 The route data collected from the GPS units has been used to look at how different activities are undertaken on the estuary in different weather (wind) conditions. The routes provide information about time spent out on the water, area and distance covered and an estimate of the average speed. The area covered by each route is calculated from the convex hull area in a GIS (a polygon containing the entire route within the smallest area). These variables have been used in conjunction with the bird data and standard watches to explore the impacts of disturbance by different activities.

### Expert opinion

2.11 We have divided the Exe into a series of different sections or zones which are, as far as possible, aligned with WeBS sections. Experts, including WeBS counters and EEMP

members, were asked to score each section with which they are familiar for the level of use for different activities ranging from 0 (no access) through to 5 (very busy). Sixteen different scores were requested for each section. There were 32 sections and therefore scores were collected using a matrix of 32 columns (sections) and 16 rows (activities). The categories for activities are listed below:

- Overall Score for overall "busy-ness"
- Dogs off lead on intertidal
- Dog walking along shore
- Walking along shore
- Motor vehicles on seawalls /intertidal
- Bait Digging
- Crab tiling
- Shell fishing
- Kitesurfing
- Windsurfing
- Kayaking/Canoeing
- Ribs/small powerboats / jet skis
- Other boats (sail boats, ferries, etc)
- Birdwatchers
- Rowing boats
- Planes/helicopters/paragliders etc

2.12 Scoring matrices were circulated by email. Responses were received from 12 'experts'. Only three 'experts' felt able to score all 32 sections, and most scored sections of the estuary they knew well, for example one side of the estuary. The scores were combined by taking the average score for each cell in the matrix. This allowed maps to be generated showing comparative scores for different sections of the estuary for different activities. The incorporation of this approach into our methods allows us to generate maps showing use across the estuary as a whole and allows water based activities to be seen in context with other recreational use.

**Focal Groups**

2.13 Focal groups were held at two EEMP forums (winter 2010 and 2011). At the first event attendees were invited to choose a workshop facilitated by a member of Footprint Ecology Staff and the Exe Estuary Officer. The topics covered were:

- Commercial fishing / angling / crab-tiling / bait digging / shell fishing
- Boating / water-based activities
- Changes over time / current use
- Options for managing access on the estuary

2.14 At this event attendees were asked to volunteer if they were willing to contribute to the study. This allowed us to identify the key people to talk to and also provided us with contact details of people willing to take the GPS units out on the water

2.15 At the winter 2011 forum we presented preliminary results of the disturbance study and invited people to attend workshops on the results, issues raised, their implications and ways in which any issues could be managed. Five workshops were run covering

different areas within the estuary: Middle estuary, Starcross to Dawlish Warren, Exmouth LNR, Upper estuary and Exmouth seafront.

2.16 Key local stakeholders have been informally interviewed to gather their opinions on the Exe, its management, issues relating to user conflicts, disturbance to birds and means and ways in which the community can feed into the management process.

2.17 Articles have been provided for five editions of the EEMP newsletter 'Exe Press' since the beginning of the study[2]. The articles have promoted the disturbance study, updated readers on progress and encouraged estuary users to provide information about their activities through diaries, the two forum events and distribution of the GPS units.

#### Diaries

2.18 Online diaries were promoted to watercraft users via the EEMP website. The diaries provided users with the opportunity to describe routes taken on the estuary, launch points, weather conditions etc. In total eleven (valid rather than spam) responses were received and these data have not been incorporated into the report due to the low number of returns.

#### Visitor survey routes and information

2.19 Hand drawn routes and data from the visitor survey (Liley & Cruickshanks 2010) were available for use as part of this study. The data includes information on why, when and how often people visit the Exe, where they live, what activities they undertake and which other sites they visit for similar purposes.

### Land-based Recreation

2.20 Although much less of a focus for this contract than the water based recreation, understanding the distribution of people on the shore is crucial to understanding the pressures on the estuary. We have digitised all key components of shoreline access, including footpaths along the river wall, shoreline paths and car-parks using information presented on the Exe Estuary Management Partnership website and site visits. As for water based recreation, data collected as part of the face to face visitor survey was made available for this study and included data on visitors and their visit behaviour and routes for different activities including land based recreation such as walking and dog walking.

2.21 Experts scored 32 sections of the estuary for the level of use for different activities (see above) ranging from 1 (no access) through to 5 (very busy). The scoring categories for shore based activities are listed below:

- Dogs off lead on intertidal
- Dog walking along shore
- Walking along shore

[2] http://www.exe-estuary.org/index/news/exepress.htm

- Motor vehicles on seawalls / intertidal
- Bait digging
- Crab tiling
- Shell fishing
- Birdwatchers

### Distribution of birds and identification of key areas

2.22 Comprehensive bird count data were made available from the WeBS counts and from the bird distribution survey undertaken by local counters. The distribution survey was undertaken during 2006-2008 with the aim to obtain updated information on the distribution of different species on the Exe, and their pattern of movement around the estuary throughout the tide cycle. The data is therefore purely independent of the disturbance work and we are fortunate that such data exists for the estuary. The survey work for the distribution survey obtained one hour "snapshot" counts and distribution patterns at each of the different stages of the tide cycle (high tide, falling tide, low tide and rising tide). The tide cycle was considered to be 12 hours and the stages allocated such that high tide counts were 2 hours either side of high tide, falling tide counts were 2-4 hours after high tide, low tide counts were 2 hours either side of low tide and rising tide 2-4 hours before high tide. WeBS counts are normally carried out about an hour before high tide, so it was not considered necessary to undertake a separate survey for this period of the tide cycle, and suitable WeBS count data was utilised to provide this information. For the remaining periods, surveys were carried out on the basis of two back to back hours covering the tide cycle. Apart from the standard WeBS counts (high tide data) separate counts were made of birds roosting and feeding.

2.23 For this report the distribution of birds was summarised by plotting the data on similar maps to the recreation data, facilitating visual comparison of the different data.

### Effect of Disturbance on foraging birds

2.24 Nine locations (Map 3) were selected for detailed observations of foraging birds. These locations were selected partly based on recommendations from the steering group and also to ensure a reasonable spatial coverage of the estuary.

2.25 A total of 220 hours of detailed observations were undertaken at these nine locations, and spread over a number of months (between September 2009 and March 2010, and then from August 2010 through to March 2011). The survey effort coincides with the period of the year when wintering waterfowl are present on the estuary. The aim of the fieldwork at these locations was to record the behavioural responses of birds and gather data on the distances at which birds responded to disturbance, lost feeding time, distance displaced etc. Detailed counts within a set recording area also allowed us to relate bird numbers to the level of disturbance.

2.26 At each survey location a focal area for the bird fieldwork was defined, these focal areas are shown in Map 3. This area stretched up to 500m from the surveyor and included all visible areas of intertidal habitat, below MHWM (mean high water mark), within this 500m radius. The 500m radius was selected as this was the maximum distance at which surveyors felt confident counting birds at the same time as recording levels of human activity, and within which it was possible to reliably estimate distances between disturbance events and the birds.

2.27 On straight sections of shore this area was typically defined simply as an arc (radius 500m) drawn from the survey location. Where jetties, creeks, headlands etc meant that there were no clear sight-lines, then the boundaries of the focal area became more complex. The focal area encompassed a different total area at each survey point.

2.28 At the start of the project, counts of birds were made at the beginning of the survey visit but not at the end. The method was adapted as we became more confident with the methods and it became clear that it would be useful to relate the number of birds at the end of the count to the number of potential disturbance events that took place during the count. A total of 175 surveys therefore had counts made at the beginning and the end, while a total of 45 counts had counts only at the beginning. Only waders, wildfowl, herons, divers and grebes were counted.

### Diary of Recreational Activity

2.29 During the 45 minute count, all events that involved recreational access or other events that might cause disturbance were then recorded, in chronological order. Each event was given a unique letter code (A, B, C etc), enabling diary events to be crossed referenced to other data. All activities/people were recorded by the surveyors, regardless of whether they entered the focal area used for the bird counts. For each event the following were recorded:

- Start and end time (i.e. when first in view to when lost from sight)
- Whether the event came within 200m of birds within the focal area
- Habitat (simply coded as shore, intertidal or water)
- Group size (number of people), this was not always possible to record, e.g. with boats
- Number of dogs
- Activity types (categorised according to activity types see Appendix 1)
- Any other information / notes

2.30 The diary data therefore provides a description of the total amount of activity and types of activity taking place at each location. The coding allowed multiple pieces of information to be recorded for each event, and surveyors often used combinations of

codes to indicate where a group or individual was undertaking different activities simultaneously (for example jogging with a dog).

2.31 The diary data were reviewed prior to analysis, and all activities simplified into few groups to facilitate analysis. In particular, where multiple codes had been used for individual events these were simplified to reduce the number of categories and types of activity included in the analysis. There were three instances of cyclists with dogs off leads, these were simplified as dog walkers with dogs off lead. There were two cases of cyclists pushing bikes and not seen to ride them, these were categorised as walkers. There were two cases where a dog was seen but no owner was in sight. These were still categorised as dog walkers with dog off lead. There were six instances where owners had multiple dogs with them, and some dogs were off-lead and some were on-lead. These cases were all treated as dog walkers with dogs off leads. Where a jogger was recorded with a dog off lead we categorised the event as a dog walker with dog off lead rather than a jogger. Similarly where a motor vehicle was recorded with a dog running along outside, this was categorised as dog walking. Finally there were two cases of children rock-pooling which were categorised as 'kids playing'

**Response of the Birds**

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

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

- Species
- Count (number present within 200m)
- Behaviour of the birds (prior to the disturbance event), simply categorised as F (feeding) or R (roosting/preening/loafing)
- Response of the birds (see Table 2) ultimately observed
- Distance: if "No response" this distance was the minimum distance from the potential disturbance event to the nearest individual bird of a given species; if disturbance occurred then this distance was the maximum distance from one individual to the disturbance event.
- Distance displaced, i.e. the distance that the disturbed bird(s) walked/swam/flew if disturbed
- Total time until original behaviour resumed

- Notes

2.34 In order to ensure accurate and consistent estimation of distances (both the distance from the source of disturbance to the birds and the distance the birds were displaced), all fieldwork was undertaken by two surveyors (with the majority of visits being undertaken by JW). In the field, surveyors used the aerial photographs with the distance bands plotted to ensure they were familiar with the 'layout' of the focal area and the distance of different features from the shore. Surveyors also used laser range finders to measure distances and at the end of fieldwork, distances could be paced exactly as an additional check.

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

**Table 2: Response Codes**

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

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

- Distance
- Activity type (simplified groupings – see results)
- Species (ten species with the most observations only – see results)
- Zone disturbance event occurred in (intertidal, shore or water)
- State of tide (falling, high, low, rising). Counts were categorised as low tide counts if the count started within 1.5 hours of low tide and as high tide counts if high tide was within 1.5 hours of the count start.
- Group size (number of people in group)
- Number of birds present
- Number of dogs off lead
- Dog present (Yes or no)

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

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

### High Tide Roost at Dawlish Warren

2.38 While counts were undertaken at all states of the tide at the standard watch locations, these locations were predominantly areas of open mudflat and the data largely involves foraging birds. We therefore included some additional work to consider disturbance at Dawlish Warren, perhaps the main roost site within the estuary.

2.39 The roost is wardened during the winter, with the warden actively engaging with visitors and policing the area, ensuring that disturbance is minimised. The warden staff collect data on the number of disturbance events recorded while they are on duty. Duplicating recording and survey effort was therefore of little merit. However, the wardening does not commence until September . We therefore undertook some visits to the roost in August, coinciding visits with the high tide and observing the roost over high tide period. All disturbance events were observed. As the birds move with the tide and as a result of disturbance a vantage point in the dunes was used. All roosting birds were mapped and counted at thirty minute intervals and all disturbance events recorded. Activities were categorised as with the focal groups and a stopwatch was used to record the length of time birds spent in flight.

## Analysis and Structure of the Report

2.40 We structure the report by commencing with a summary of access infrastructure and detailed consideration of the different types of human activity occurring around the estuary. We consider each activity/type of use separately. Subsequent sections then consider the effect of disturbance on the distribution of the birds, the effect of disturbance on the behaviour of birds and finally the results of the watches of the high tide roost at Dawlish Warren.

2.41 We present much of the information on a series of maps, most of which are presented at a standard scale to allow direct comparison of access and bird data. The maps are presented as a separate map annex rather than embedded within the report.

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

- Horizontal line: indicating the median value for that group

- Box: indicating the 25th and 75th percentiles (i.e. half of all the data falls within between these two lines)
- Vertical lines: “whiskers” indicating the upper and lower limits of the data
- Asterisks: indicating outlier values (i.e. any data points that fall outside the upper and lower limits of the data).

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

# 3. Recreation and Other Activities around the Exe

## Overview

3.1 In this section we present information on recreational use and summarise how people use the estuary. In order to understand disturbance issues it is fundamental to understand how different activities take place and how use of the estuary varies along its length. We draw on interviews, GPS routes and count data to show which activities occur on the Exe and compare between activities. We also summarise the access infrastructure.

3.2 A complex pattern of use emerges. The estuary is a busy place. There is a wide range of use and different activities take place in different locations. Key locations for access are:

- **Exmouth Seafront**: Popular for beach walks, families, dog walking in the winter and beach activities during the summer. Kitesurfers and windsurfers launch from the area in front of the Maer. The slipway at the western end of the beach is used to launch jet skis. Ferries run to Dawlish Warren and Starcross, plus cruises up and down the estuary. Sailing club.
- **Exmouth estuary shore/Duck Pond/LNR**: Popular area for dog walking, kitesurfing, windsurfing and bait digging. Parking at the recreation ground and some vehicles drive down the slipway onto the beach. Much of the mudflats here are sandy and firm to walk on. Sailing Club.
- **Lympstone**: Shore popular with families and dog walkers. Sailing club and slipways for access to water.
- **Exton:** Access onto shore under railway bridge.
- **Topsham**: Goat Walk provides a popular walk, used by families, dog walkers, bird watchers and others. Access to Bowling Green Marsh RSPB Reserve.
- **Turf Locks area**: Canal and access onto estuary shoreline. Hotel with garden on shore (the hotel is usually closed November-March most years). Adjacent to canal. Access largely on foot, by boat or bicycle.
- **Powderham**: Walking and cycling along river wall.
- **Starcross**: Ferry to Exmouth. Shoreline access over railway, mud here soft and access onto intertidal mainly crab tillers. Sailing Club to the north of the village.
- **Cockwood**: Lay-by and railway crossing provides access to mudflats. No facilities.
- **Dawlish Warren**: Holiday village and tourist infrastructure. Two large car-parks, visitor centre for the nature reserve. Access to beach, dunes and estuary shore.

3.3 Overall water-based activities are centred around Exmouth seafront and the Duck Pond with an additional focus at the head of the estuary near Topsham and the Turf Inn. The focus for power boats is around Exmouth but also further up the estuary around Topsham. Kitesurfing and windsurfing are focussed around the Duck Pond and seafront off the Maer. Windsurfers appear to often use the areas closer to Dawlish Warren. Experienced kitesurfers will occasionally surf the length of the estuary when conditions are right. Canoes and kayaks are less commonly recorded than kitesurfing, windsurfing and canoes were most frequently recorded around Exmouth or at the top of the estuary. Jet ski use appears to be concentrated around Exmouth seafront, but jet skis were recorded within the estuary on occasion and jet skiers do apparently launch at Exmouth to visit Topsham and the Turf Locks area. Sailing is centred around the channels and clubs with particular emphasis around the Exe Sailing Club at Exmouth.

3.4 Data collected on water based recreation are summarised in Table 3. An added benefit of the GPS units is that they can provide information about the length of time on the water, the distance covered and the area covered. These figures are described under each activity section where routes are available and are displayed in Table 3.

**Table 3: Data collected on water based recreational activities.**

| Activity | Data from GPS units | | | | Total count observations |
|---|---|---|---|---|---|
| | Number of routes collected | Average time on water (minutes; range) | Average distance covered (km; range) | Average area covered ($km^2$; range) | |
| Kitesurfing | 36 | 86 (13-336) | 9.28 (0.02-25.46) | 0.32 (0.00012-2.2) | 49 |
| Sailing/yachting | 24 | 136 (58-517) | 13.03 (0.55-46.28) | 8.73 (0.001-155.1) | 21 |
| Canoeing / kayaking/ rowing / paddleboard | 10 | 60 (13-97) | 4.03 (0.59-10.16) | 0.71 (0.00013-3.23) | 12 |
| Windsurfing | 9 | 93 (49-155) | 17.74 (4.99-36.65) | 0.43 (0.093-1.66) | 9 |
| Jet skiing | 4 | 121 (35-185) | 29.68 (8.3-45.04) | 4.43 (1.19- 9.4) | 10 |
| Beach recreation/ swimming | 4 | 59 (39-93) | 4.69 (1.48-10.47) | 0.46 (0.01-1.65) | 0 |
| Motor cruising | 0 | | | | 21 |
| Powerboating and waterskiing (including RIBs) | 0 | | | | 44 |
| **Total** | **87** | | | | **166** |

3.5 Data on land based recreation has been collected from total counts, interviews and routes drawn as part of the visitor survey (Table 4). The best coverage from the total counts was for walking with over 500 observations whilst dog walking yielded the most visitor survey routes. Expert scores and total counts indicate that land based recreation is more widely spread around the shores of the estuary than watersports (due to

access) although by far the busiest location is Exmouth seafront. Combining all the data for land based activities up to the line between Powderham and Lympstone, the busiest areas are the seafront, Dawlish Warren and the Duck Pond.

**Table 4: The number of visitor survey routes (hand drawn) and total count points collected for land based activities (* includes people sitting on the beach, picnics, kids playing, jogging, horse riding and metal detecting).**

| Activity | Visitor survey routes | Total count observations |
|---|---|---|
| Walking | 192 | 502 |
| Dog walking | 225 | 318 off lead, 33 on lead |
| Cycling | 52 | 12 |
| Angling | 1 | 21 |
| Beach recreation* | 19 | 205 |
| Bird watching | 26 | 6 |
| Motorised vehicles | 0 | 12 |
| **Total** | **515** | **1109** |

## Access Infrastructure

3.6 Slipways and other infrastructure relating to water based access are shown in Map 4. Slipways provide access for small craft etc to the water. It can be seen that slipways are distributed around the estuary, with concentrations at Exmouth, Lympstone and Topsham. There are fewer slipways (just four) on the western side of the estuary. The map also shows clubs – such as sailing clubs etc. that are located round the estuary, boat yards and 'other' access such as private slipways or similar. In general terms it can be seen that most of the access for craft to the estuary is centred around the top of the estuary (around Topsham), at Lympstone and at Exmouth.

3.7 Across the whole estuary there is a 10 knot speed limit for all watercraft which is administered by Exeter City Council. A patrol boat was reinstated in 2011 and was run by volunteers on a limited number of weekend/holidays over the summer.

3.8 Current zoning is shown in Map 5. There is a current voluntary kitesurf exclusion zone, which is marked by yellow buoys and runs from September-December. The zone is promoted through a voluntary code of conduct and through signs on the shore at the Recreation Ground. The exclusion zone for kitesurfers has been marked by yellow buoys in the past but at present there are no signs or buoys indicating the zone. The voluntary exclusion zones on Warren Point are managed by the wardens. Offshore from the Recreation Ground at Exmouth there is a dedicated water-ski zone, which is clearly marked.

3.9 Around two-thirds of people interviewed during the visitor survey work on the Exe Estuary (Liley & Cruickshanks 2010) had arrived by car, and parking provision is therefore important in dictating how many people access the estuary. Car-parking is

shown in Map 6, where the size of the dots represents the amount parking available. It can be seen that parking is focused at Exmouth and at Dawlish Warren, with the Dawlish Warren car-parks being the largest. Away from the mouth of the estuary there is relatively little parking and in particular there is little parking availability on the west shore of the estuary.

3.10 Access for people travelling by train or bicycle is excellent. There are train stations at Exmouth, Lympstone, Exton, Topsham, Starcross and Dawlish Warren. The Exe Estuary Trail is a cyclepath and walkway, which when completed, will run around the entire Exe Estuary linking Exmouth, Exeter and Dawlish Warren. The route has been developed and constructed by Devon County Council as part of the National Cycle Network Route 2. The final route will cover 26 miles around the edge of the estuary with optional shorter routes making use of the summer ferry services. The stretch between Exton to Topsham and the stretch between Cockwood and Dawlish Warren have recently been completed. Turf Locks Hotel to Powderham Church will be the final section for completion on the western side (but note this stretch is currently used by cyclists, who use the sea wall. Bicycles are available to hire from a number of locations, including Exeter and Exmouth. Existing sections of the Trail, and other paths and shore based routes are shown in Map 7. It can be seen that much of the estuary also has public rights of way along the shore/sea-wall. The only sections without access are between Cockwood and Dawlish Warren and near Exton.

## Types of Use: Levels of Use, Patterns of Use and Distribution within the Exe

### Introduction

3.11 In the rest of this section we consider different types of activity, drawing on information collected through informal interviews, discussion with users, GPS tracks and count data. A series of maps within the map annex provide additional information. Maps 8-12 show GPS route data (with Map 8 showing GPS tracks for jet skiers, Map 9 for kitesurfers, Map 10 a selection of kitesurfing routes, Map 11 windsurfing routes and Map 12 canoe/kayak/paddleboard routes). In Maps 13-26 we summarise the expert scores, showing scores for overall 'busy-ness' (Map 13); dogs off leads on the intertidal (Map 14); dog walking along the shore (Map 15); walking (Map 16); Motor-vehicles on the intertidal/seawall (Map 17); bait digging (Map 18); crab tiling (Map 19); shellfishing (Map 20); kitesurfing (Map 21); windsurfing (Map 22); canoeing/kayaks (Map 23); RIBs/small boats on outboard motor (Map 24); Other boats (Map 25) and birdwatching (Map 26). For many of the expert score maps we have also added the point data from our total counts and in the crab tiling map we have shown the distribution of tiles. In all maps the count data etc seems to support the scores well.

### Motor cruising

3.12 Motor cruising can be described as any form of boating other than sailing or power boating and in general, motor cruisers can be used for pleasure cruising or fishing. This activity is mainly undertaken on the Exe by individual users rather than through a club with the exception of Starcross Fishing and Cruising Club (SFCC). The SFCC is for privately owned cruisers and is based in Starcross. SFCC run boat fishing competitions

monthly between April and November and they have a separate cruising section which runs cruises every weekend throughout the season. The club also have visitor moorings available and can accommodate vessels up to 33ft long.

3.13 The majority of motor boats using the Exe are moored on the Exe although a number of day trippers arrive in with boats on trailers to launch at the public slipways. Around 80-90% of boats moored on the Exe are in the water between April and October/November at the latest. Motor boats moored on the Exe are often maintained by a local company such as Trout's Boatyard at Topsham. Trout's is very well connected to the motor cruising community and alongside the SFCC, represents a possible communication channel to provide information on future management measures to this user group.

3.14 An additional means of contacting motor boat users is via the mooring associations. There are four main mooring associations on the Exe, they include the Lower Exe Moorings Authority with around 750 moorings, Lympstone Harbour Board with 130 moorings reserved for residents of the village, Powderham Estate Moorings with 450 moorings in the Starcross and Powderham area, and Topsham Mooring Owners Association with 400 moorings at Topsham.

3.15 Fishing cruises also take place on the Exe. Boats are either privately owned or they can be chartered. The main fishing charter company on the Exe is Tiger Charters who offer fishing cruises seven days a week. They have three boats which can be chartered; two 35ft Offshore 105s which both carry 10 passengers and a 54ft wooden coastal angling boat. There are 4 other charter boats available in Exmouth run by individuals.

3.16 Sea fishing can be undertaken all year although bass fishing from any vessel is banned between April 1st and November 1st, the Exe Estuary is a designated Bass Conservation Area.

3.17 There is an Exe Estuary water code which incorporates the Exe Estuary navigation byelaws. These include a speed limit of 10 Knots maximum in the estuary, and advice to avoid disturbing wildlife. There is a voluntary code of practice for marine craft on Dawlish Warren. Crafts are requested not to land outside of the 'Defined landing area' at Warren Point and only land there between 1st April and 4th September. The voluntary exclusion zone is to be avoided all year around high tide. Between 5th September and 31st March all craft should avoid navigating within 100 metres of the voluntary exclusion zone around high tide.

### Power boating and water skiing

3.18 Information on the location of power boating activity (including small RIBs) was collected via the total count observations.

3.19 Power boating and water skiing is frequently undertaken by individuals based locally (as opposed to club members) or by users travelling from further afield. There is one organised group, the Exe Power Boat and Ski Club affiliated to the South West Association of Ski Clubs SWASC).The Powerboat and Ski Club is situated at the entrance

**Figure 1: Water skiing within the water ski zone, March 2011**

of Exmouth Marina, and the membership is active in offshore and inshore powerboating, water ski racing, classic waterskiing, wakeboard and slalom. The club has a moored pontoon within the zoned water skiing and powerboating areas (Map 5) and members are encouraged to launch from the public slipways in Exmouth. The club also has a slalom course located within a designated waterskiing area where regular club and interclub competitions are held.

3.20 Exe Wake in Exmouth offers wake boarding and water skiing tuition or ringo ride trips for groups or individuals. There is also one company which specialises in servicing and selling powerboats in Exeter, South Coast Powerboats.

3.21 Powerboat racing and water skiing mostly take place in the summer, when the conditions are safer and the water is warmer for water skiing. Inshore powerboat meetings take place within the River Exe on the Duck Pond, off the Recreation Ground, Exmouth. Typical craft in use is the "Bristol" type monohull, powered by 50/60hp outboard motor. Inshore races occur around six times a year between July and October on a Friday, Saturday or Sunday evening. Offshore powerboat meetings are held along the South Devon coastline from Exmouth, westward to Torbay, or eastward to Lyme Regis. There is an annual New Years Day race that includes the areas off Warren Point.

3.22 Waterskiing and wake boarding are more popular in the summer months although with all recreational water activities, improvements in equipment, information available and wetsuits means that use is extending and increasing during the winter months.

3.23 The powerboat, water ski and jet ski zones in Map 5 are taken from the club website. Water-skiing use is controlled by byelaws (Byelaw 5), which requires waterskiing to only take place in the dedicated area. Users are expected to follow the Exe Estuary water code which incorporates the Exe Estuary navigation byelaws. These include a speed limit of 10 Knots maximum in the estuary, and advice to avoid disturbing wildlife.

### Jet skiing

3.24 There are no clubs in Exmouth which specifically cater for jet ski users. There is a designated jet ski area along the seafront between two groynes (Map 5). Some stand-up

skis launch directly from the beach and use the slipway along Queens Drive. Recommendations on some forums suggest launching jet skis from Shelly Beach, but this is not recommended by the relevant authorities/Exe Estuary Management Partnership.

**Figure 2: Jet skis off the Maer. January 2010**

3.25 Jet skis were not encountered very often during surveys of the estuary or whilst targeting users to take GPS units out with them on the water. Four GPS routes were collected (Map 8), the average length of time spent jet skiing on the Exe is 2 hours and users cover an average distance of 30km over 4.4km$^2$ of the estuary. While the maps show use around the dedicated jet ski zone, the zone is clearly much smaller than the area encompassed by the routes. If the routes shown are typical then it would appear that much of the jet ski use is focussed around the main channel, with jet skis moving backwards and forwards in front of Exmouth Seafront. Jet skis were occasionally also observed within the Duck Pond area at high tide, during the bird fieldwork.

3.26 Jet skiing generally takes place in the spring and summer months (hence the relative lack of observations and GPS data) although a few watercraft have been observed in good conditions in the autumn and winter. Jet skiers often prefer to ski on waves for jumping and therefore launch within the estuary but spend the majority of their trip further along the seafront, out to sea or within the designated area. The maximum speed on all four routes collected for jet skis ranged between 34 and 44mph.

3.27 There is a designated jet ski area along the seafront between two groynes in front of Maer Rocks. Users are expected to follow the Exe Estuary water code which incorporates the Exe Estuary navigation byelaws.

### Yachting and sailing

3.28 Data on the location and level of use of the estuary for sailing and yachting has been collected from GPS unit route information and total count observations. Sailing trips on the Exe last on average 2 hours and 16 minutes and cover an average length of 13km and an area of 8.7km$^2$ over the estuary.

3.29 Sailing is an extremely popular activity on the Exe with four highly active sailing clubs. Yacht and boat moorings on the Exe are privately owned and may be purchased or rented but many users belong to one of the four sailing clubs which operate in the local

area; Topsham, Starcross, Lympstone and Exe. The largest club on the Exe (Exe Sailing Club) is based in Exmouth with around 1500 members utilising 40 yachts and 150 dinghies. The club holds dinghy races most Mondays, Wednesdays and weekends and cruising races are held most Tuesdays, Thursdays and weekends. The Exe Sailing Club also offers training courses. On weekdays in the summer around ten boats (10-15 people) will be out on the Exe from the club whereas around 20+ boats per day can be expected at the weekend. Between April and September youth evenings are held, these can involve up to 80 children out on the water. There are a further two training centres based in Exmouth, Spinnakers and Sail Exmouth. Spinnakers have been based in Exmouth for 12 years and provide sailing courses. Sail Exmouth is based in Exmouth Marina, with moorings in the Estuary providing RYA training courses.

3.30 Topsham Sailing Club is located on the upper tidal reaches of the Exe and members have cruisers, dinghies and yawls that take part in weekend and weekday evening races, often involving 60 boats. The Topsham club regularly hosts national events for its yawl and cruiser fleet.

3.31 Starcross Yacht club is based at Powderham Point, which is on the west bank of the Exe Estuary it also has links to Haven Banks outdoor education centre which runs sailing sessions and courses on the Exe often sailing down to Dawlish Warren and Exmouth.

3.32 Lympstone sailing club is based on the Eastern shore of the Exe Estuary, where mixed dingy, dayboat and cruiser fleets will race.

3.33 Most of the Sailing in the Estuary is carried out 2-3 hours on either side of the high tide. The mouth of the Exe is affected by strong currents and the sand banks can shift, resulting in complex navigation. It is possible to sail from the Exe Sailing club on all states of the tide, though more advanced skills are required when there are fast flowing tides. On the eastern side of the estuary around Lympstone the sailing times are high tide dependent, being two hours on either side.

3.34 Overall the Exe is busier with sailing boats and events in the summer although Exe and Starcross Sailing Clubs remain busy throughout the winter (Table 5). The River Exe Regatta has taken place during July annually since 2001 with responsibility for organising the event rotating between the four sailing clubs of the Exe.

**Table 5: The number of days in each month on which each sailing club holds events such as races. Information on the year's sailing programme was taken from the club websites and spans the period April 2011 until March 2012.**

| Year | Month | Number of days with events | | | |
|---|---|---|---|---|---|
| | | Starcross | Exe | Topsham | Lympstone |
| 2011 | April | 10 | 15 | 11 | 4 |
| | May | 11 | 27 | 14 | 12 |
| | June | 12 | 27 | 13 | 14 |
| | July | 12 | 24 | 12 | 16 |
| | August | 13 | 25 | 15 | 24 |
| | September | 9 | 14 | 10 | 8 |
| | October | 9 | 5 | 5 | 4 |
| | November | 5 | 4 | 2 | |
| | December | 2 | 4 | | |
| 2012 | January | 6 | | | |
| | February | 4 | | | |
| | March | 4 | | | |

3.35 Boat users are expected to follow the Exe Estuary water code which incorporates the Exe Estuary navigation byelaws. These include a speed limit of 10 Knots maximum in the estuary, and advice to avoid disturbing wildlife. There is a voluntary code of practice for marine craft on Dawlish Warren. Craft are requested not to land outside of the 'Defined landing area' at Warren Point (see Map 5) and only land there between 1st April and 4th September. The voluntary exclusion zone is to be avoided all year around high tide. Between 5th September and 31st March all craft should avoid navigating within 100 metres of the voluntary exclusion zone around high tide.

### Kitesurfing

3.36 Route data for kitesurfing was collected from 36 trips with an additional 23 free hand routes provided as part of the visitor survey. Kitesurfers were frequently encountered during the total counts (n=49) (but note that the total counts were made during trips to the Exe when kitesurfing and windsurfing conditions were optimal to collect GPS route data). Map 9 shows the concentration of activity around the seafront and the Duck Pond. Data collected from the GPS units shows that on average kitesurfing trips last 1 hour and 26 minutes and cover an average distance of 9.3km whilst the area covered is relatively small at 0.32km$^2$.

3.37 Kitesurfing is a popular and growing activity on the Exe. The sport began in the area over 10 years ago and today more than 100 kites can be seen on the water at the Duck Pond and 50 kites on the seafront on a perfect day. There are two companies offering tuition and supplying equipment for hire (Edge Watersports and Waterfront Sports).

3.38 Generally kitesurfers need wind speeds of at least 12-15 mph (10-13 knots). The windspeed depends on the equipment used, body weight of the rider and type of riding, as greater wind speeds are required for jumping. In addition to sufficient wind, each location has specific tidal and wind conditions which favour kitesurfing. The two key locations for are the Duck Pond area which is particularly suitable for beginners and the area off (and to the south of) Exmouth Seafront. .

3.39 The Duck Pond is most suitable on a north westerly wind as the wind funnels from the direction of Exeter and is very clean by the time it reaches the Duck Pond[3]. The best time to arrive for optimum conditions is 2-3 hours before high tide (except neap tides). Arriving when the tide is coming in has the benefit of allowing kitesurfers to launch from the sand banks out in the estuary as opposed to the shore or grass area. Kitesurfers are drawn to the Duck Pond as it has good parking (although this is limited to a maximum of 3 hours and costs £3) and Imperial Recreation Ground provides a good space for preparing equipment.

3.40 At the Seafront, the area used by kiters is in front of the beach and funnels out into the sea south of Dawlish Warren. Equipment can be prepared on the beach and there is a voluntary launch area opposite the Queens Road car park and along from the green buoy number 11. There is extensive parking along the promenade and within the car parks around the Maer. This area is popular with a variety of levels of kitesurfer but it is not advised for beginners. The main area is relatively calm as it is sheltered by the extensive sand bar (Pole Sands). The Pole Sands are naturally shifting and used to run along the beach and out past Orcombe Point but now turns sharply to head out to sea in front of the lifeboat station[4]. Keen kiters ride the seaward side of the sand bar to make use of the waves for more technical jumps. More experienced kiters make use of the deep and fast flowing navigation channel which runs along the beach. The sand bars themselves, if exposed, are used by kitesurfers as an area to land, check equipment etc.

3.41 The Seafront can be surfed on any state of the tide but it is optimal on a falling tide 2-3 hours before low water. It is under these conditions that the channel runs very flat and the sand bar is effective for tricks and jumps. In terms of wind direction, the Seafront can be surfed on a southerly / south easterly and east/south easterly which provides clean on shore wind. Kitesurfers also use the seafront in south westerly conditions but the wind can be gustier.

[3] www.britishkitesurfingassociation.co.uk/kitesurfing-guides/where-to-go/south-coast.html

[4] www.exe-kiteboarders.co.uk/news/11/59/Seafront-Ban.html

**Figure 3: Kite surfers at the Duck Pond, Feb 2011.**

3.42 Map 9 shows the GPS route data collected from kitesurfers. The use of the Duck Pond area and the seafront area is clear. Comparing the routes in the two areas it appears that the kitesurfers using the seafront tend to spread out more and use a bigger area of water, whereas relatively few of the routes from the Duck Pond show use out into the middle of the estuary. A number of routes are of particular interest. The dark green route in the Duck Pond shows a track in a moderate north-westerly wind from September 2009. The route involves repeated tacks close to the shore and this route also shows the user utilising areas well to the north of many of the other routes.

3.43 Looking at the routes off the seafront, the lime green route stands out as this route brings the user well to the west of the other routes, close to Dawlish Warren. The route was recorded in April 2011, during a south south-westerly wind. Four routes are shown in Map 10, this subset provides good examples of how routes may vary in different winds. For example the red route is one off the sea-front in a south-westerly wind while the light blue route, which takes the user out more to the south-west, is during an easterly wind.

3.44 With advances in equipment, kitesurfers have been able to surf shallower water and undertake more up wind trips. Due to equipment improvements and a growing local culture of keeping an eye out for each other there is a general increase in the confidence of local users of the Exe. Some kitesurfers undertake trips up wind on a north westerly along the length of the estuary from Exmouth to Topsham and returning down wind. Whilst this kind of trip has been organised by Edge Watersports as part of their events it requires a level of knowledge of the estuary, tide and wind conditions. This kind of trip is generally undertaken in the summer months with Edge as the organiser although more confident users have been observed surfing the whole estuary in March.

3.45 Edge Watersports is at the centre of the kitesurfing community on the Exe. The proprietors, Steph and Eric Bridge, are very well respected amongst kiters and they promote considerate and safe use of the estuary. They also support their customers with organised trips and are also on hand to help kiters that get into trouble out on the water. They are very well connected to the kitesurfing community locally but also further afield through their regularly updated website[5] and Twitter[6] sites.

3.46 A voluntary code of conduct exists[7] which advises that kitesurfers have insurance and provides details about navigation, rights of way, zoning, safe distances between users, equipment checks, general competency and safety procedures. The kitesurfing community using the Exe are united in wishing to protect their right to use the area and are willing to promote best practice and police themselves. There is a voluntary exclusion zone in place within the Exmouth Local Nature Reserve which is in effect from September through to December (Map 2).

3.47 There is a 'Guide for Water Users' regarding activities around Dawlish Warren and kitesurfers are asked to follow the voluntary code and observe Nature Reserve byelaws. Kitesurfers generally have no need to land on Dawlish Warren except where their safety may be compromised. However there is a 'no landing' restriction all winter and a limited area for landing at Soft Sand Bay between 1st April and 4th September inclusive. The year round voluntary exclusion zones (Map 5) advise that all users should avoid navigation within 100m of the high tide line, two hours either side of high tide (particularly in the winter months).

3.48 There has been concern from the Harbour Authority that the launching of kites on the seafront and use of the channel has led to crowding and interference with the passage of boats in and out of the estuary. Therefore discussions have been taking place between the kitesurfing community and the authorities and there is a proposal to create a zone on the beach for launching which covers the existing area used for launching. Signs will be erected describing the kitesurf launch area and the preferred sailing zones and additional restrictions are proposed such that:

1) Kites may only be launched / landed in the marked zone
2) Kite-surfers must be members of Exe Kite-boarders[8] and conform to the code of conduct
3) Kite-surfers will have to display proof of membership (e.g. a harness tag)

3.49 Users are expected to follow the Exe Estuary water code which incorporates the Exe Estuary navigation byelaws. These include a speed limit of 10 Knots maximum in the estuary, and advice to avoid disturbing wildlife.

[5] www.edgewatersports.com
[6] twitter.com/edgewatersports
[7] www.exe-kiteboarders.co.uk/code-of-conduct.html
[8] www.exe-kiteboarders.co.uk


**Figure 4: Sign relating to kite surfing at the Duck Pond**

### Windsurfing

3.50 Nine GPS routes were collected for windsurfers along with nine observations as part of the total counts. Data collected from the GPS units shows that on average windsurfing trips last 1 hour and 33 minutes and cover an average distance of 17.7km whilst the area covered is relatively small at 0.43km$^2$. The conditions for windsurfing are similar to that for kitesurfing and therefore the routes show similarities between the two activities (Map 11). However, direct comparison of the routes would seem to indicate that windsurfers go closer to Dawlish Warren when launching off the Maer and when in the Duck Pond the routes suggest that users tend to head out into the estuary more. The green route in Map 11 that repeatedly tacks over Pole Sands and comes in close to Dawlish Warren was recorded in October 2010, during a southerly wind. The yellow route, with the tacks running parallel to the Warren was undertaken in an easterly wind.

**Figure 5: Windsurfing at the Duck Pond, November 2011**

3.51 There are two schools offering windsurfing lessons, equipment and hire. They are Edge Watersports and Waterfront Sports. Waterfront Sports have been teaching in the area since 1985. Windsurfing has become less prevalent since the popularity of kitesurfing has increased, but there are still a number of windsurfers out on the Exe due partly to the efforts of Waterfront Sports.

3.52 Windsurfing is best with a windspeed of 15mph (force 4) and pleasant weather. A minimum of 750mm water depth is required for safe sailing. There are two main areas where windsurfing takes place on the eastern side of the Exe, the Duck Pond and the Seafront. Further up the estuary experiences less use due to tidal restrictions and less sailing is observed to the west due to the presence of the channel and moorings. The Duck Pond is the most suitable area for beginners and this is where teaching takes place due to the sandy bottom and water depth at a maximum of waist height. Its suitability is further compounded with its ability to be sailed in most wind directions, though it is best in south, south-westerly, north-westerly and south-easterly winds. The drawback to the Duck Pond is that it can only be used for a couple of hours either side of high tide. On a westerly wind it is possible for windsurfers to sail up and down the estuary although these conditions rarely arise.

3.53 The seafront is suitable for more advanced windsurfers due to its more complex conditions. It can be sailed in winds from an easterly to a north-north-westerly. The best conditions are on a north-west, westerly and south-easterly wind, though southerly and easterly winds can also be sailed. The winds combined with the tides offer a range of different conditions. The sandbar offshore is exposed at low tide and shelters the low tide channel providing a protected sailing area. With an onshore southerly wind it is possible to speed sail for a mile on flat water. There are more waves on the far side of

the sand bar, and in easterly to westerly winds it is possible to get cross shore jumping waves. When the wind is further round to the north the waves become flatter.

3.54 Concerns over the impact to wildlife and danger to navigation agreements have been made with the local clubs and a voluntary exclusion zone has been put in place within the Exmouth Local Nature Reserve, which operates between September and December. Windsurfers are also expected to comply with the Exe Estuary navigation byelaws. There is a voluntary code for water users that has been developed in partnership with estuary users around Dawlish Warren. There is a defined landing area between 1st April and the 4th September and a voluntary exclusion zone for navigating within 100m of the high tide mark between 5th September and 31st March.

3.55 Users are expected to follow the Exe Estuary water code which incorporates the Exe Estuary navigation byelaws. These include a speed limit of 10 Knots maximum in the estuary, and advice to avoid disturbing wildlife.

### Canoeing/ Kayaking

3.56 Combining canoeing, kayaking, rowing and paddleboarding a total of ten GPS unit tracks were collected and 12 total count observations. These routes are shown in Map 12. Like all watersports, Exmouth is a hub for canoeing activity but the head of the estuary is also a very busy part of the estuary for this activity. From the GPS route data the average canoeing trip last 1 hour and cover an average distance of 4km over an average of 0.71km$^2$ of the estuary.

3.57 Canoeing is popular on the Exe with many different kinds of craft being used including sea kayaks and open canoes for which at least 500mm water depth is needed. There are three places where canoes can be hired and lessons are provided; Exeter Canoe Club, Haven Banks Outdoor Education Centre and Saddles and Paddles. However, like many other watersports, people taking part in canoeing often have own their own equipment and bring it to the Exe by car from the local area and further afield to launch from a public slipway or shoreline with adjacent parking such as the Duck Pond or Swing Bridge. The majority of canoeists on the Exe are local but the area also attracts visitors from further afield particularly in the summer when the Turf Lock Inn becomes the focus of activities.

3.58 Canoeing/Kayaking can take place in most conditions provided there is an understanding of the local tides and currents although it is more commonly undertaken during the summer months when the water is warmer. Whilst most activity takes place in the upper reaches, a smaller proportion launch from the Duck Pond and only experienced canoeists move out beyond the mouth of the estuary as difficult currents can cause problems out along the Pole Sands. Overall the western shore is not used for launching canoes as there is little access to the shore.

3.59 The Exe is part of a canoeing circuit which starts at Exeter quayside and runs down the Exeter shipping canal and joins the Estuary near Turf Locks Hotel. A series of four self guided canoe loops made in partnership between the Environment Agency and Exeter City Council, which take in this 17km circuit which can be paddled from different access

points and in different combinations. The four loops are created by the three points at which users can cross from either the canal to the river or vice versa to complete the loop by carrying their canoes[9]. In total the loops run from Exeter via St James's Weir, Countess Wear Bridge, Topsham Ferry, the Turf Locks Hotel and back up the canal through Double Locks.

**Figure 6: Canoeing off Exmouth. October 2009**

3.60 There is a voluntary code for water users that has been developed in partnership with estuary users around Dawlish Warren. There is a defined landing area between 1st April and the 4th September and a voluntary exclusion zone for navigating within 100m of the high tide mark between 5th September and 31st March.

### Diving

3.61 Three dive clubs use the Exmouth area to dive. One, Jurassic Coast Dive Club is based in Exmouth. The other two are based in Exeter (Exeter BSAC and Aquanaut). Due to the nature of the sport, few observations of diving were collected with just one route from the visitor survey work.

3.62 There are many good dive sites around the Exe incorporating shore dives such as the Pier Head and the River Run. There are also wreck dives and reef dives such as Long ledge. It is important for divers using the Exe to fully understand the tides and currents. Most sites are best dived at high tide. Exmouth Pier Head is an example of this where it is best dived just before high tide while there is slack water and the tides can be very

[9] www.canoe-england.org.uk/media/pdf/Exeter%20Canoe%20Loops.pdf

swift so surface marker buoys are required. Average depths are around 12 metres but this can reach 18 metres in the channel.

3.63 Jurassic Coast Dives is based in Exmouth which recommends dives within the Exe Estuary including the Pier Head and the River Run drift dive (floating downstream on the ebb). Exeter BSAC organises one shore dive per month between April and September from Exmouth or Dawlish.

**Beach recreation**

3.64 Exmouth has two miles of sandy beach, which can become very busy in the summer months. Beach huts, windbreaks and deckchairs can be hired along the seafront. There are also rock pools towards Orcombe Point and the area is often visited by wildlife and bird watchers, particularly in the winter for the wading birds. There is a cycle path which runs along the seafront and continues up the Estuary to Exeter, it is possible to hire bicycles in the town centre.

3.65 The total count data for beach recreation (people sitting on the beach, picnics, kids playing, jogging, horse riding and metal detecting) shows that the busiest area for these activities is along the seafront down towards the Maer with additional activity continuing to the north around the point and into the Duck Pond.

3.66 There are several annual events which attract tourists in large numbers. These include the Art And Music Festival, KITE FESTIVAL and New Years Eve Fireworks on the Seafront, there is a Christmas Day swim which attracts hundreds of participants. There are more regular events such as a farmers market every other Wednesday and an indoor market. There are several attractions in the town including a model railway, children's play area, family amusement park, marina, cinema, boating lake, cricket, crazy golf and several shopping areas. There are several places to eat out.

3.67 Dawlish Warren has 1.5 miles of beach and sand dunes, with the first 300m a 'Blue Flag Beach'. Dawlish Warren is a popular destination in the summer with several thousand visitors annually. There are RNLI lifeguards on the beach. The Dawlish Warren Nature Reserve is a 1.5 mile sand spit across the estuary. It has its own visitor centre where many wildlife and birdwatchers come to as well as local schools and universities for nature studies.

3.68 There are several tourist attractions around Dawlish Warren including a go kart track, two amusement parks, and a 18 hole golf course. There are also annual events which attract large numbers including the Carnival week and an International Air show in August at the neighbouring town of Dawlish which attracts around 80,000 visitors in one afternoon. In Dawlish Warren regular annual summer events include car boot sales and open air markets, steam train tours, horse show, arts festival and a fireworks display in August with family entertainment.

3.69 There is open access to much of Dawlish Warren nature reserve, but no public access to the golf course and mudflats. The visitor centre is open most days between April and September and weekends between October and March.

3.70 In both Exmouth and Dawlish Warren, highest user visitor numbers are in the summer months, as both towns are advertised as seaside resorts. The summer events that are put on during this time also increase visitor numbers, in particular the August Air Show.

3.71 In Exmouth there is no swimming allowed between the red flags on the Seafront due to dangerous currents. There is a zoned swimming area which is manned by a voluntary beach rescue service on weekends and bank holidays. There is a dog ban on the beach between Maer Rocks and Octagon kiosk between 1st May and 30th September.

3.72 At Dawlish Warren, in winter, large bird flocks roost on the beach north-east of groyne nine. All visitors are asked not to walk along the beach here for approximately 3 hours either side of 'medium' to 'spring' high tides when roosting birds will be present. Instead, visitors are asked to walk along the dune path. Tide times and heights are posted on notices at groyne nine on site, or visitors are asked to consult tide tables for Exmouth. Dawlish Warren allows no fires or barbeques anywhere along the reserve and all litter must be taken home. There is no swimming around Warren Point due to dangerous currents.

3.73 There is also a dog policy which allows no dogs beyond Groyne nine to Warren Point all year, this includes not only the beach but the sand dunes and mud flats as well. Between groynes three and nine dogs can be let off the lead on the beach. In the summer between 1st April and 31st August no dogs are allowed on the beach from the start of the beach to Groyne three. On the rest of the reserve dogs must be on leads not exceeding two metres in length at all times.

3.74 The Exe is a very popular location for walking and it was the most common activity recorded in the total count surveys followed by dog walking. Groups of walkers were recorded 502 times whereas dog walkers with dogs off the lead were recorded 318 times and 33 times on the lead.

### Angling

3.75 Sport angling for estuarine bass, salmon, flounder and mullet is a very popular activity on the Exe. The River Exe Salmon Action Plan was published in December 2003 by the Environment Agency and sets out the byelaws regarding national salmon and rod fishing:

- Limited fishing season from 14th February to 30th September
- No salmon to be retained before 16th June
- Use of artificial lures are only allowed before 16th June
- No fishing is permitted with worm or maggot
- No spinning on the Exe above Exe Bridge

3.76 Anyone using a net to fish for salmon must have a licence issued by the Environment Agency, anybody caught netting without a licence will be prosecuted. There are currently 10 net licenses issued for the Exe for the use of seine nets.

3.77 There is a fishing code for sea anglers around Dawlish Warren. The area between groynes one and nine can be fished at any time all year round. Restrictions between groyne nine and Warren Point allow fishing only for the period 1st April to 31st August.

### Sports/social events

3.78 The Exe is at the heart of a thriving community on both sides of the estuary and as a top destination for tourists. A number of sporting and celebration events take place on the Exe every year and the Exe Estuary Management Partnership has been central to promoting these activities. The Spirit of the Exe: Exe-Travaganza event is an annual festival which aims to celebrate and showcase the Exe Estuary and all of the clubs, businesses and community groups. The event was held in Exmouth in 2009 and at Dawlish Warren in 2010. Dawlish Air Show is an annual event held in mid August with aeroplane displays attracting around 80,000 visitors to Dawlish Warren and beach. Sports tournaments are held by a variety of clubs including volley ball events, life guard events and annual swimming competitions. Beach cleaning events take place in the spring.

### Bird watching

3.79 The Exe Estuary is a popular place for bird watchers and can provide excellent views of a large variety of wintering wildfowl and waders utilising the mudflats. Principle locations for bird watching are shown in Map 18 and many centre around nature reserves such as Dawlish Warren, Bowling Green Marsh RSPB Reserve and Exminster and Powderham Marshes RSPB reserve.

3.80 Total count points and expert scores for the level of birdwatching activity across the estuary are shown in Map 26. Very few total count observations were recorded and those on the water are records for the RSPB Avocet cruise. The lack of total count observations potentially reflects the way in which the counts were collected, as many of the locations where birdwatchers would be most likely to linger (such as the dunes/hide at Dawlish Warren, the RSPB hides near the top of the estuary and Goat Walk) were not included in the total counts.

### Motorised vehicles

3.81 The use of motorised vehicles on the foreshore is often part of loading or unloading boats or equipment for watersports or undertaking boat maintenance. In addition bait diggers are known to leave their vehicles on the foreshore whilst out collecting bait south of Lympstone possibly in response to parking charges and limitations. From expert opinion and total count observations, the busiest area is the Duck Pond where access is via the slipway and people parking here are accessing the area for dog walking and bait digging. In the north of the estuary the access is mainly associated with sailing and general parking whereas along the western shore the observed vehicles will most likely be present due to crab tiling and bait digging (Map 20).

### Golf

3.82 There has been a golf course on Dawlish Warren since 1892. Warren Golf Club has around 580 members and is open all year. On average there are 13 competition event days per month between October and February (based on 2011 diary of events[10]). The actual course is owned by Devon Wildlife Trust and management of the course off the fairway is, to some extent, influenced by the wishes of the Devon Wildlife Trust.

### Wildfowling

3.83 Wildfowling on the Exe Estuary is controlled by the Devon Wildfowling & Conservation Association (DWCA). The club has 70 members, 40 of whom take part in shooting. Certain duck and geese quarry species are pursued during the season of September 1st - February 20th. The DWCA is affiliated to The British Association for Shooting and Conservation (BASC) and owns and manages 30 acres of marshland in the River Exe area.

3.84 The land available for shooting on the Exe is leased from the Crown Commissioner and consents are issued by Natural England. The number of permits issued in each area is decided on an annual basis. In the Exmouth area including Lympstone there are 12 permits and across the estuary there are around 15 permits covering the eastern shore from Exmouth Station up to Greenland Bank and from the bank up to within 100m of the railway bridge over the River Clyst. On the western shore there is consent from north of the Turf Lock Hotel and ends in line with the Topsham Quay car park.

### Commercial Activities

3.85 The Exe Estuary provides a variety of habitats for shell and fin fish fisheries. The site is used for commercial shellfish production and is an important nursery for bass. In addition there is widespread collection of peeler crabs, lug worms and rag worms for non commercial fishing purposes. The Marine and Coastal Access Act 2009 has modernised the way that inshore sea fisheries resources are managed in England by replacing Sea Fisheries Committees with Inshore Fisheries and Conservation Authorities (IFCAs) from April 2011. The Exe falls within the Devon and Severn IFCA; IFCAs are required to ensure effective management of marine habitats in the inshore area. This includes amongst other things activities such as recreational sea angling, bait digging and seaweed gathering.

#### Mussel fishing

3.86 Mussel and oyster beds are present on the Estuary between Powderham and Starcross, in the mouth of the Estuary and on the East of the estuary near Lympstone, representing the largest single commercial fishery on the Exe. Exmouth Mussels operates a commercial mussel and cockle fishery within the estuary. The company has a lease from Lord Devon to lay and retrieve shellfish. Operations to harvest mussels run six days a week all year with the boat staffed by three crew members. The shellfish are

[10] www.warrengolfclub.co.uk/warrengolf/downloads/1288112157-DiaryDates2011Web1.pdf

collected and processed on the barge located south of Great Bull Hill. In addition, cockle harvesting takes place twice per week or more on spring tides.

**Fishing**

3.87 There are approximately ten commercial fishing boats operating out of the Exe. The Exe Estuary is a bass conservation area meaning that no netting for bass may take place. There is a minimum catch size of 36cm and illegal netting for bass results in prosecution. Fishing for bass from any vessel is prohibited from 30th April to 1st November. There are some small scale recreational or low scale commercial gathering of whelks, winkles, cockles, clams and oysters which are currently unregulated.

**River cruises**

3.88 There are seven ferries which operate on the Exe, three of these ferries are from Exmouth. From Exmouth the Stuart Line Cruises take circular scenic cruises all year, and guided bird watching. In the summer they have coastal cruises and day trips to local towns such as Topsham, Sidmouth and Torbay. The Exe to Sea Cruises include the Starcross to Exmouth ferry, trips to Brixham, coastal cruises, fishing and bird watching cruises. There is also the Exmouth to Dawlish Warren water taxi, which runs from April to September.

3.89 There are various ferry/cruise companies operating on the river. Stuart Lane Cruises operate daily all year round. The two other ferries from Exmouth run during the summer, one running April to August and the other April to October. Two companies offer winter avocet cruises. The remaining ferries are daily in the summer and then offer weekend and bank holiday services in the spring and autumn.

**Bait digging and crab tiling and other shellfishing**

3.90 Bait digging and crab tiling expert scores and total count observations are shown in Maps 18 and 19. Note that the dots in Map 18 refer to all observations of people working on the mud. Given the distances involved it was not always possible to separate those shellfishing/bait digging/crab tiling. Crab tiling and bait digging was recorded 32 times during the 28 estuary counts. The results are in accordance with the results of the 200 crab tile survey. Map 18 highlights the use of the Duck Pond by bait diggers.

**Figure 7: Crab tiling at Starcross**

3.91 Crab tiling or potting is the collection of peeler crabs from the intertidal mudflats on the estuary for use as bait by fishermen and anglers. The crabs utilise the tiles and drain pipes laid down by the fisherman as protection whilst they moult and can hence be collected for use as bait. Crab tiling is a long standing activity on the Exe which is now managed by the Devon and Severn Inshore Fisheries Conservation Authority. Crab tiling is limited by bye law to south of a line drawn from Starcross Yacht Club across to Exton and north of Warren Point. Within the permitted area there is a voluntary code of conduct which states that no more tiles should be laid above the level recorded in the 2001 crab tile survey. In 2001 there were 26,800 tiles which rose by 13% to 30,302 in 2004 but declined to pre-2001 levels in 2008 (Lockett 2008). The distribution of crab tiles across the estuary observed in the 2008 survey is shown in Map 19.

3.92 Whilst the number of tiles has declined, there have been changes in the distribution of tiles. An increase in tiles has been observed since 2004 only on one area between Dawlish Warren and Cockwood whilst adjacent areas have seen marked declines. Furthermore there has been a decline of almost a quarter of the tiles surveyed in the 2004 report in the area from Cockwood to Powderham.

3.93 Other issues addressed in the voluntary code include specifications on the types of tile, location of tiles with respect to commercial shellfish beds, minimising disturbance whilst on the foreshore and advice regarding immature and berried crabs.

3.94 Informal discussion with three diggers collecting winkles at the Duck Pond area in early December 2009 revealed that they had travelled from Cornwall and that the shellfish would be sold and go to Spain. Each had collected four sacks, each of around 20kg. It is clear that some of the use does not involve people local to the area.

# 4. Effect of disturbance on the distribution of birds

## Overview

Wintering waterfowl build from late summer (August), peaking in mid winter, with the highest number of birds present in December. We summarise the distribution of birds within the estuary drawing on WeBS data and a distribution survey conducted in the winters of 2006/07 and 2007/8. Mapping bird distributions allows us to highlight key areas for birds and these maps allow direct comparison with the maps showing routes and access levels.

Visual comparison suggests that bird distributions may be related in part to access. At low tide numbers of birds off the Duck Pond appear to be low, given the extensive intertidal area available here. This area is also particularly 'busy' with a wide range of different recreational activities. Similarly numbers of birds feeding in the Topsham section along the eastern side of the estuary also seem low compared to adjacent sections which have similar habitat (soft mud) and numbers of feeding dunlin appear particularly low here by comparison. This part of the estuary is also one of the busiest.

Bird numbers are particularly high in the section to the north of Dawlish Warren, around Shutterton Creek - an area with very little access. It provides both roosting sites and feeding areas and is used by a high proportion of the estuary's brent geese, oystercatchers, bar-tailed godwits, wigeon and teal. On the upper estuary the mudflats a appears to hold high numbers of waders at certain tide states, in particular high numbers of dunlin and black-tailed godwit feed in this area on the rising tide.

Using the counts of people and birds undertaken in this project for each survey location we find evidence that the number of birds fluctuates in relation to levels of access at Lympstone, Powderham, the Duck Pond and at Starcross South. Numbers of birds at these locations are lower on particular visits when levels of human activity were higher. The sites where no effect of disturbance is apparent were mainly ones with relatively low levels of activity (Starcross North) or consistently very high levels of activity (Exmouth Channel and Exmouth Maer), and therefore any pattern would be potentially difficult to determine. The Topsham and Turf survey locations stand out in that high numbers of birds were sometimes counted and, particularly at Topsham, high numbers of people were also regularly counted. Particularly at Topsham there was consistently high levels of access, and little variation between visits. While bird numbers did appear to vary here, they did not appear to vary with access.

## WeBS Data: Numbers of birds and seasonal variation

4.1 The WeBS data for the Exe is summarised by month in Figure 8 and Figure 9. These graphs use the maximum count for a given month, extracted from the WeBS data held by the BTO and covering the period 1990-2006. It can be seen that peak numbers of birds occur in mid winter but that the patterns of abundance and use vary for each species. For example dunlin numbers are highest for the period from November-February, whereas oystercatchers are present in reasonably high numbers from August-March, but with a marked peak in December. The highest wildfowl numbers have been in the middle of the winter with the maximum counts for wigeon and brent geese occurring in November and for Teal in November.

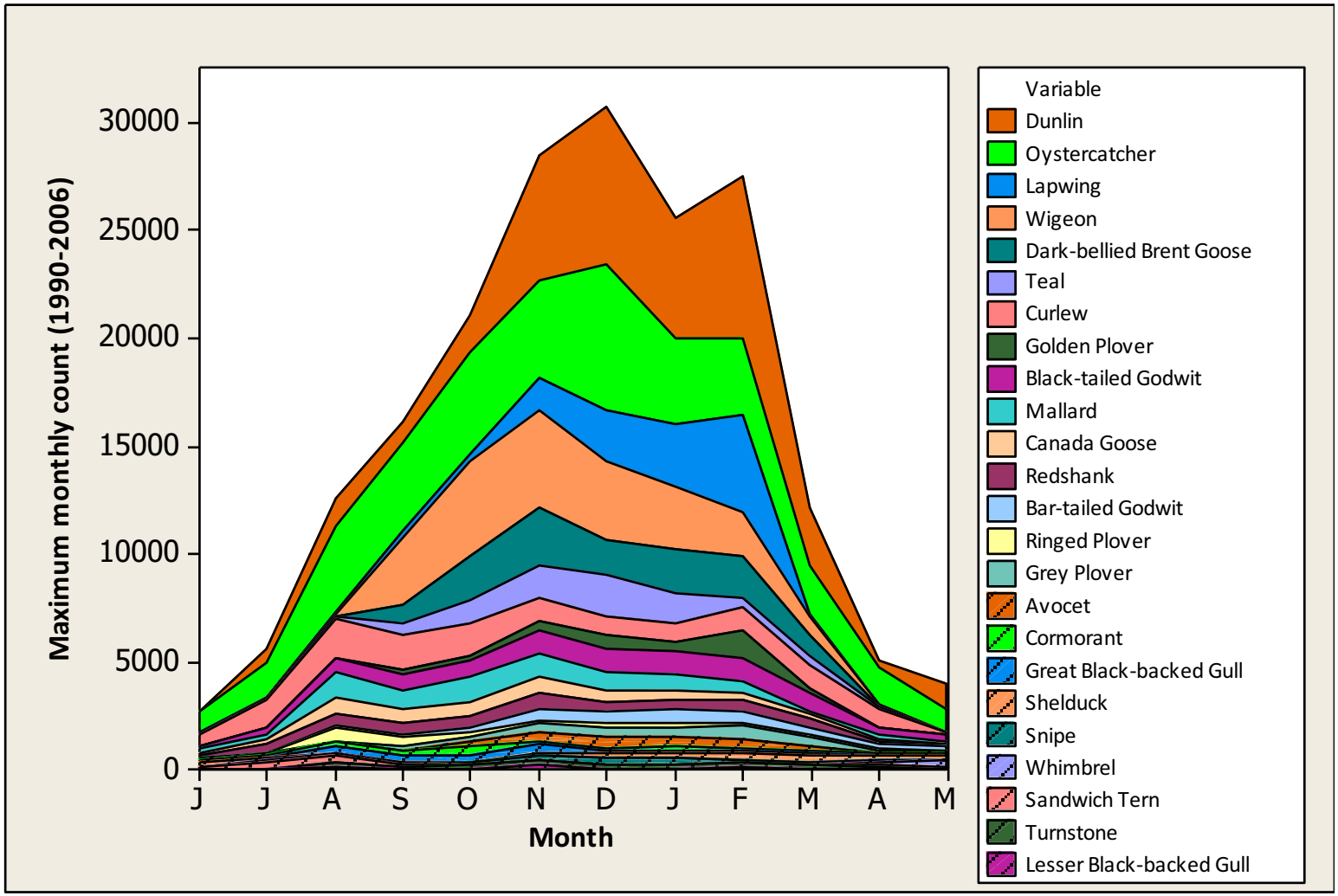


**Figure 8: Peak counts for a range of species by month, from BTO WeBS data, 1990-2006. All species with a maximum count of at least 200 birds in any one month are included.**

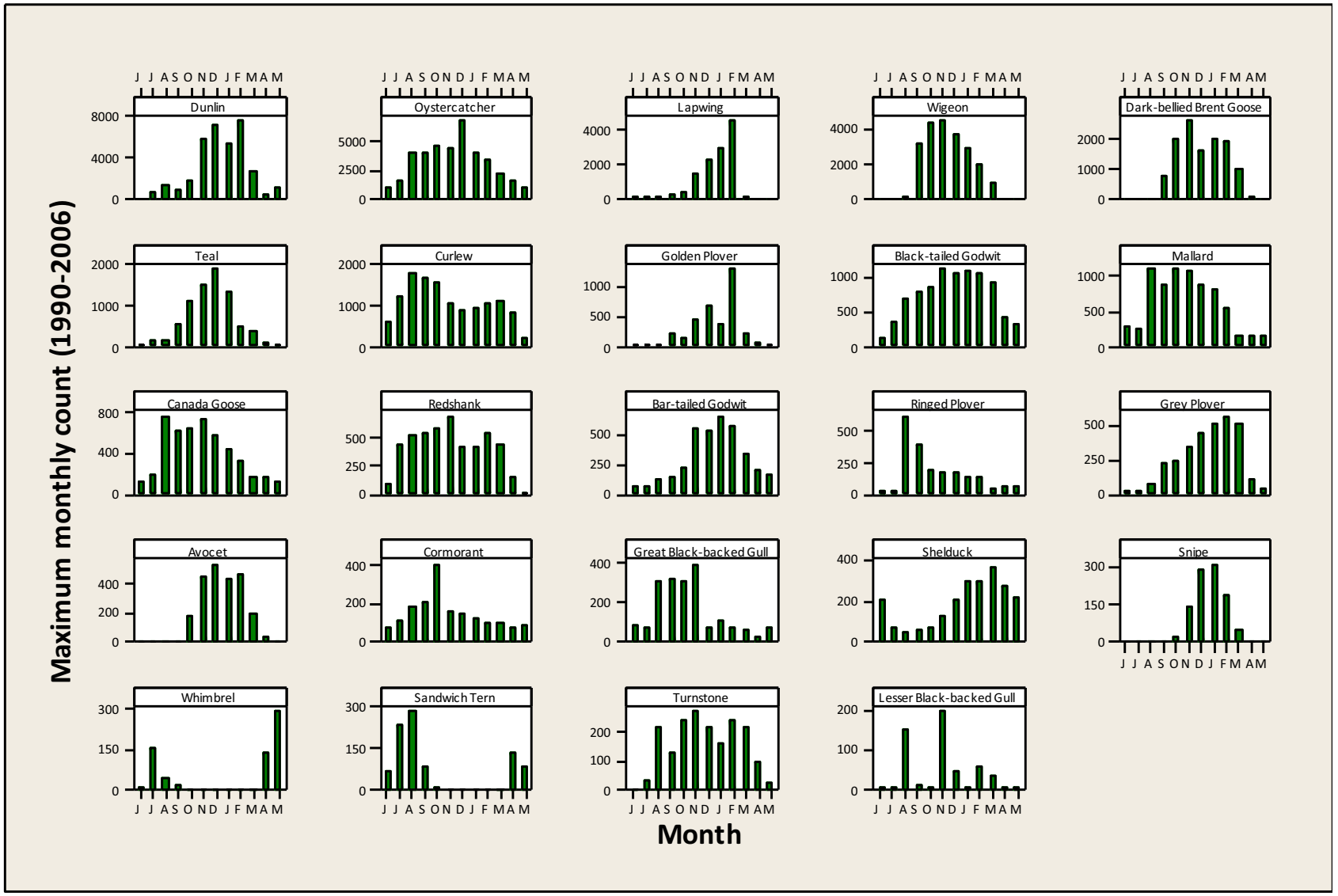


**Figure 9: Maximum counts by month from WeBS data. Data as in Figure 8.**

## WeBS/Bird Distribution Study

4.2 Data from the distribution study is shown in Maps 27-33. The distribution survey was undertaken by local WeBS counters during the winters 2006/7 and 2007/8. The results show the distribution of birds and allow comparisons of the distribution of birds and access. The maps are therefore produced at the same scale as the maps that show the matrix scores. In Maps 27-32, the graduated symbols show the total number of birds counted in each sector, with the colours showing different species (with species listed individually or within the SPA assemblage shown on the maps). The same colours indicate the same species in each map, however note that the scale for the symbol size varies between maps.

4.3 At high tide (Map 27) high numbers of birds occur at three main locations, Dawlish Warren, Bowling Green Marsh and Exminster Marshes. The majority of birds at this time use these sites for roosting. The Dawlish Warren roost is particularly favoured by oystercatcher, dunlin, bar-tailed godwit, redshank and grey plover, whilst brent geese typically feed here in the shallow water at this time. On the upper estuary at high tide, the marshes have a wider range of species, many roosting, but others taking the opportunity to continue feeding whilst the estuary is inundated. Black-tailed godwit, curlew, redshank, and on occasions lapwing are the most numerous wading species whilst wigeon, teal and brent geese are the predominant wildfowl.

4.4 On the falling tide (Maps 28 and 29) roosting birds initially stay around their roosting sites at Dawlish Warren and on the marshes (Exminster Marshes and Bowling Green Marsh). Many waders, but in particular dunlin, initially start to feed on the lower estuary as the tide falls and move across to Exmouth, though some will also start to move to the Clyst and the emerging mudflats upstream. Bar-tailed godwits predominate on the exposed intertidal just north of Dawlish at this stage, whilst brent geese and wigeon continue to feed on Cocklesands and around Shutterton Creek until the tide recedes. Whilst the tide is still falling the middle sections of the estuary, which are largely still covered by water have few birds.

4.5 At low tide (maps 30 and 31), when the majority of birds are feeding the general pattern is one of birds spread fairly evenly over the estuary, with slightly higher total numbers on the upper estuary. The upper estuary provides extensive areas of wet mud and the majority of the estuary's dunlin feed here, along with many of the avocets and black-tailed godwits. Oystercatchers can be seen to be utilising the mussel beds off Lympstone and the mid-stream banks of the lower estuary. The marshes at Exminster and Bowling Green attract feeding birds during mid-winter, particularly when well flooded, with high numbers of black-tailed godwits, wigeon, teal and brent geese at this time. Many of the wildfowl feed at high tide (by up ending in shallow water) and therefore at low tide there are notable numbers of roosting wildfowl, particularly to the north of Dawlish Warren and at Cockwood. Lapwing, which are tide independent feeders, may also be roosting in numbers at low tide particularly on the marshes.

4.6 The map showing feeding birds on the rising tide (Map 33) shows high numbers of birds feeding on the mudflats. Dunlin dominate on the upper sections, around Topsham and

down to Powderham and Lympstone. Brent geese and wigeon use the lower estuary as the tide rises to feed on the *zostera* on Cockle Sands (Exmouth) and on the north side of Dawlish Warren, and numbers begin to concentrate here. As the tide rises oystercatchers lose their mussel feeding beds and increasingly begin to roost and move to Dawlish Warren, dunlin tend to move back down the estuary, particularly down the eastern side, feeding where they alight at the edge of the incoming tide.

4.7 All intertidal habitats within the SPA are potentially used by birds, and it is clear from the maps that different sections are used by different species as the tide changes. We can however highlight particular areas that are clearly of particular importance:

- The section to the south of Dawlish Warren, including Pole Sands, is used at low tide, particularly by oystercatcher (Map 31) and at high tide by roosting waders, including dunlin (Map 27).
- The saltmarsh and mudflats around Shutterton Creek hold high numbers of birds: the two sections here hold high numbers of birds at all tide stages.
- The mussel beds (present at Lympstone, Bull Bank and to the south of Starcross) are important feeding areas for oystercatcher and a number of other species.
- Mudflats off Powderham and in the upper parts of the estuary can hold high numbers of feeding birds, particularly at low tide and as the tide starts to rise (Map 31).
- The upper estuary, particularly around Topsham holds the highest numbers of avocet.
- Dawlish Warren is the main roost, particularly for oystercatcher, dunlin and grey plover.
- The marshes on the upper estuary (Exminster Marshes and Bowling Green Marsh) are clearly important for a range of species and a range of tide conditions.

4.8 A key question is whether disturbance influences the distribution of birds. We do not try to test for correlations with matrix scores and bird densities within each section, as any results are potentially spurious due to the different prey densities and different habitats present. We also cannot tell the area of mud that is exposed in different parts of the estuary, and therefore the actual area of habitat available to birds at different tide states.

4.9 Visual comparison of the maps of people numbers and bird numbers does highlight the following:

- At low tide numbers of birds are generally low on the southern parts of the estuary, however numbers of birds off the Duck Pond appear to be particularly

low, given the extensive area of mudflats here. This area is also 'busy' (Map 13), with a wide range of different recreational activities. At low tide these include bait digging (Map 18) and dog walking (Maps 14 and 15).

- Numbers of birds feeding in the Topsham section of the estuary also seem low compared to adjacent sections which have similar habitat (soft mud). This area is particularly favoured by avocet, but compared to adjacent sections, numbers of feeding dunlin appear low. This part of the estuary is also one of the busiest (Map 13), particularly with walkers, birdwatchers and dog walkers.

- Bird numbers are particularly high in the section immediately to the north of Dawlish Warren, around Shutterton Creek, an area with very little access (in fact in Map 13 it can be seen that this area was scored the lowest for 'busy-ness' of all the southern sections). Bird counts in this area are high at all tide states, but in particular the high counts of birds here are evident in Map 30 (roosting, rising tide), Map 31 (feeding birds, rising tide) and Map 32 (roosting, falling tide). The high counts of birds recorded here include brent goose, oystercatcher, bar-tailed godwit, dunlin, 'other' waders and 'other' wildfowl.

- The area off Powerderham at Greenland Bank and towards the Turf appears to hold high numbers of waders at certain tide states, in particular high numbers of dunlin and black-tailed godwit feed in this area on a rising tide (See Map 31). This section is comparatively 'quiet' in terms of recreational use – access is focused along the seawall and there are large areas of mudflats well away from the shore where access is minimal.

### Counts of birds

4.10 The count data undertaken for this project, as part of the standard watches involved counts of birds within 500m arcs, with repeat counts over many different dates and times – essentially 'snapshots' of the number of birds present. These counts are different to the WeBS low tide counts summarised above, where the counts were for a wide count area over an extended period of time. Data from the standard watches are summarised in Appendix 2, broken down by species. In Figure 10 we summarise the number of birds at each location, grouping species into waders, wildfowl and divers/grebes. It can be seen that there were relatively low numbers of birds counted at the Exmouth Maer and Exmouth Channel survey locations. The highest numbers of birds tended to be counted at the Turf, Topsham and Exmouth Duck Pond survey locations, although it is clear that at most locations, and particularly the Duck Pond, there was a wide variation in the number of birds present.

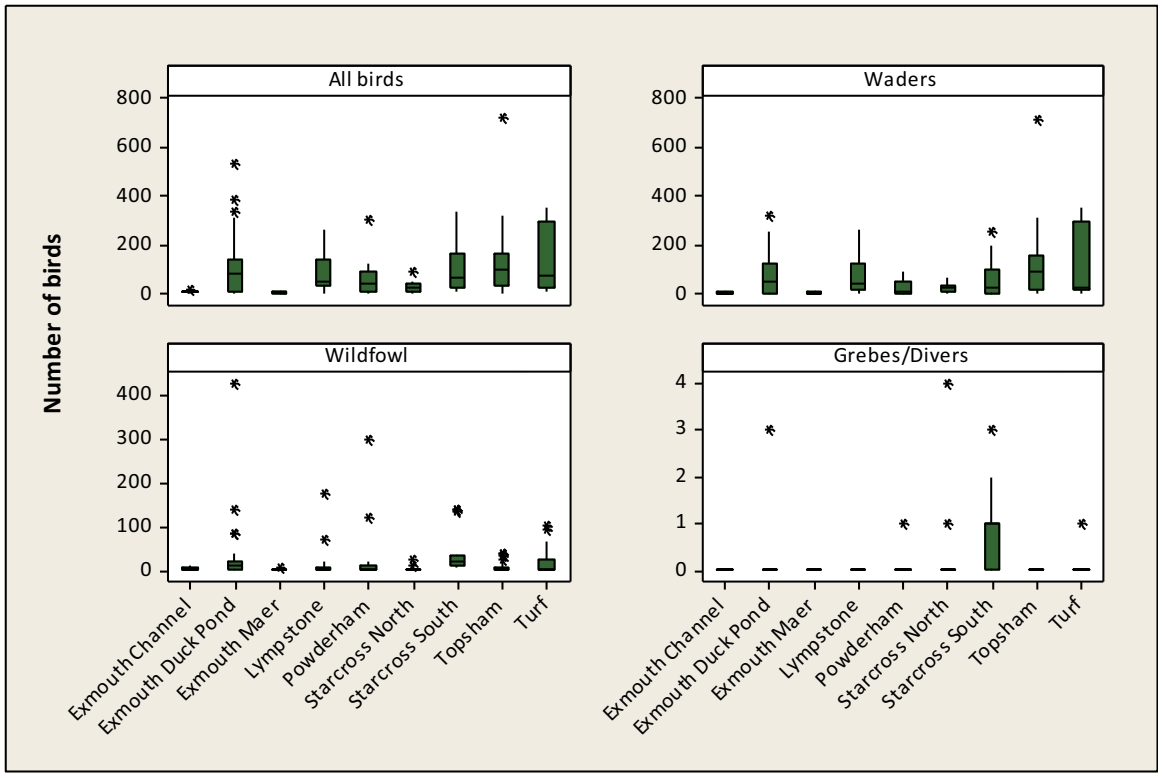


**Figure 10: Numbers of birds recorded at each survey location. Count data from the end of each survey visit.**

4.11 For each of the standard watch locations we took the count data relating to the number of birds present at the end of the count and tested for correlations with the level of human activity recorded during the count (i.e. the preceding 45 minutes). The types of activity and variation between survey locations in the level of access are shown in Map 34.

4.12 In testing for correlations we used actual count data rather than densities as we tested each location separately. The correlation coefficients are given in Table 6, where for each site we give the correlation coefficients for all wader species grouped together, all wildfowl and all species together. For the levels of disturbance we used various measures, all taken from the 'diary' data collected at each count. We tested for correlations using all activities (i.e. total number of events), water-based activities only, intertidal activities only, the number of dogs counted over the forty-five minute period and the total number of people.

4.13 Correlation coefficients can range from -1 to 1, and the closer the value to 0 the weaker the correlation. Negative values would indicate that, with higher levels of recreational activity, the number of birds is less. Looking at the table, cells shaded in grey indicate correlations with a significance of at least 0.05. Some care should be taken with the interpretation of these p values as the tests 'overlap', i.e. we are essentially repeatedly testing similar data sets and therefore the probability of there being significant results increases.

4.14 It can be seen that in most cases values are negative, indicating that lower densities of birds occurred when levels of human activity were high. In fact for 71 of the

correlations, the coefficients are negative, with positive or values of 0 in 25 cases. The Turf was the only location with no significant correlations and even here there are a number of relatively high negative coefficients. In particular it would appear that fewer birds tend to occur at the Duck Pond, Lympstone and Powderham when activity levels are high. There are positive coefficients for the two Starcross sites, potentially indicating that more birds occur here when there are more events on the intertidal. Scrutiny of the data reveals that events on the intertidal at these sites occured when exposed mud was present and birds were therefore also present. The number of events on the intertidal at these sites was always relatively low. Given that bird numbers also vary with the tide and a range of other factors, and that the sample sizes for some locations are relatively small (meaning it can be harder to detect significant results), there is good evidence that use of some parts of the estuary does seem to be affected by the level of human activity.

4.15 The data are plotted in Figure 11, which shows the data by site and by tide state, for all activities and all bird species combined. At the Duck Pond, Lympstone, Powderham and Starcross South the higher counts tend to be at the lower disturbance levels and as disturbance increases the number of birds counted decreases.

4.16 Where these negative correlations indicate that a pattern of lower bird numbers occurs with higher levels of access, this indicates that birds are trying to use these areas and vacating the sites when access levels are high. Areas with consistently high levels of access might be expected to always have low numbers of birds (and therefore no correlation between bird numbers and access), and similarly areas with consistently low numbers of people might be consistently expected to have high numbers of birds and again no correlation would be apparent. Negative correlations are likely to be detected where there is variation in access levels, which the birds then exploit. It is perhaps to be expected that sites like the Duck Pond area, where access varied markedly according to weather conditions and tide, that the clearest pattern emerges. By contrast at Topsham, access levels are high and reasonably consistent, with Goat Walk busy on most visits and access consistent in that people tend to walk slowly along the same route. As discussed previously, at Topsham numbers of birds appear to be lower than adjacent WeBS sectors – potentially indicating a pattern where bird density is slightly reduced here, yet bird numbers fluctuate relatively little with access.

**Table 6: Rank Spearman correlation coefficients for different categories of disturbance and the number of birds present at six main sites within the estuaries. Data for counts made at the end of the survey and the disturbance data relating to the number of recreation events in the preceeding 45 minutes. Data for all tide states. Pale grey shading indicates significant correlations at p>0.05 and dark grey indicates those where p<0.01.**

| Species group | Activity | Duck Pond | Lympstone | Turf | Powderham | Starcross N. | Starcross S. | Topsham |
|---|---|---|---|---|---|---|---|---|
| n | | 43 | 23 | 16 | 17 | 17 | 18 | 28 |
| All Birds | All | -0.0351 | -0.393 | -0.049 | -0.407 | 0.003 | -0.049 | -0.072 |
| Waders | All | -0.26 | -0.424 | -0.144 | -0.289 | 0.086 | 0.038 | -0.099 |
| Wildfowl | All | -0.52 | 0.238 | 0.236 | -0.61 | -0.342 | 0.04 | -0.1 |
| All Birds | Water | 0 | -0.423 | -0.342 | -0.592 | -0.375 | -0.141 | -0.181 |
| Waders | Water | -0.022 | -0.354 | -0.304 | -0.307 | -0.298 | -0.103 | -0.221 |
| Wildfowl | Water | -0.034 | 0.096 | 0.067 | -0.779 | -0.266 | -0.084 | -0.066 |
| All Birds | Intertidal | -0.178 | 0.033 | 0.324 | -0.523 | 0.425 | 0.426 | 0.021 |
| Waders | Intertidal | -0.074 | 0.232 | 0.383 | -0.453 | 0.503 | 0.536 | 0.036 |
| Wildfowl | Intertidal | -0.38 | -0.206 | 0.279 | -0.354 | -0.193 | 0.197 | -0.396 |
| All Birds | Dogs | -0.199 | -0.039 | -0.068 | 0.001 | -0.262 | | -0.043 |
| Waders | Dogs | -0.115 | -0.122 | -0.238 | -0.317 | -0.205 | | -0.136 |
| Wildfowl | Dogs | -0.33 | 0.211 | 0.105 | 0.192 | -0.262 | | -0.26 |
| All Birds | Total People | -0.324 | -0.362 | -0.406 | -0.268 | 0.301 | 0.282 | -0.101 |
| Waders | Total People | -0.268 | -0.336 | -0.318 | -0.182 | 0.368 | 0.347 | -0.136 |
| Wildfowl | Total People | -0.441 | 0.158 | -0.055 | -0.475 | -0.021 | 0.188 | -0.023 |

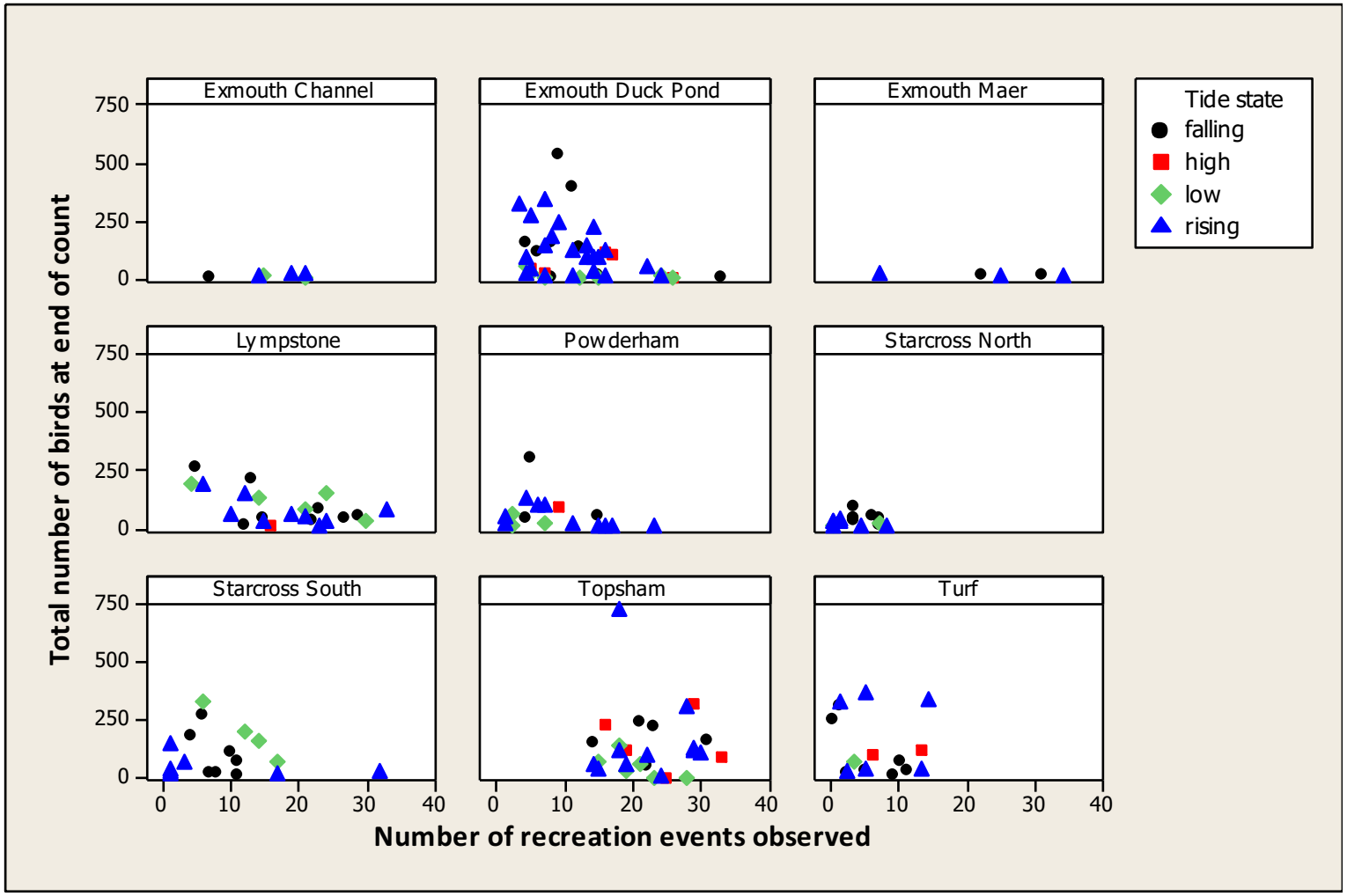


**Figure 11: Levels of recreation and number of birds (counted at the end of the visit) for different sites and different states of the tide. Number of events observed is the total from the 'diary'. The x axis is truncated at 40: at both Exmouth Channel and Exmouth Maer there were counts of more than 40 recreation events and no birds.**

# 5. Flushing and direct observations of birds responding to activities

## Overview

Around 14% of groups/recreational events observed across the survey locations result in birds being flushed and undertaking a major flight (more than 50m). Just under two-thirds (62%) of events evoked no response from the birds.

After controlling for distance, tide and location, birds were more likely to take flight when the activity took place on the intertidal or on the water compared to the shore. The probability of major flight events was lower at Topsham and Powderham compared to other sites and the probability of a major flight event occurring was lower at low tide. Bait digging on the intertidal, dog walking with dogs off leads on the intertidal, walking on the shore and intertidal and kitesurfing are the activities which account for the majority of major flight events. It is dog walkers with their dogs off leads on the intertidal that caused the highest percentage of major flights from all the observed potential disturbance events.

We use the actual route data from visitor work (GPS tracks and face to face interviews) and the analysis of flight response to calculate the 'area' of intertidal habitat lost as a result of different activity types. These calculations suggest that, at intermediate tide stages, the average area lost to a windsurfer or kitesurfer would be around 8ha, while a dog walker on the mudflats at the duck pond results in an area lost of around 3ha (note that this figure is likely to underestimate the impact of dogs as we only have route data for the owners rather than the pet). By contrast the disturbance caused by someone walking along the shore path at Goat Walk at low tide equates to an equivalent impact of the loss of 0.1ha of intertidal habitat to the birds.

## Levels of disturbance: behavioural response to people

5.1 During each survey visit the diary element essentially recorded all human activities and potential disturbance events that might affect birds within the focal recording area. This diary was maintained even when no birds were present within the recording area (for example some prior disturbance or changes in the tide might have pushed birds out of the recording area). Some of the diary events could also result in different disturbance events, involving multiple species specific observations: a single person might disturb different birds in different parts of the survey area and different species may respond differently (e.g. some might take flight, while others show no response). The data therefore consist of a number of unique diary entries, some of which could result in multiple potential disturbance events, each of which we treat as a unique observation. We use the term potential disturbance event to highlight diary entries that resulted in people/activities occurring within 200m of birds within the study area. Each of these potential disturbance events could be associated with multiple observations.

5.2 The diary data from the standard watches are summarised in Map 34. The map is adjusted for survey effort at each location, and shows the hourly rate for a range of the more commonly recorded activities (the activities shown are those where the

rate was at least one per hour at one location or those where across all locations combined the rate was at least two per hour).

5.3 Across all sites and all visits there were 2977 diary entries, of these 2252 took place when no birds were present within the focal area or the people noted were not within 200m of birds in the focal area. The remaining 725 entries are potential disturbance events and occurred within 200m of the birds, however two events caused the movement of all bird species present (which was impossible to record accurately) and so these two events have been excluded from this table and within the focal area.

5.4 Data are summarised in Table 7. The 725 potential disturbance events generated a total of 1299 species specific observations. Of these, 841 (65%) resulted in no visible change in behaviour or any kind of response from the birds. Just over a third (36% or 458 observations) of these observations resulted in a disturbance of a given species, with 180 (14%) involving birds undertaking a major flight (displacement of over 50 metres).

**Table 7: Summary of response data. We treat each potential disturbance event as a unique event. In order to calculate the totals for the diary events we attributed a single response category to each event in the diary. If an event caused a range of responses (e.g. a major flight for one species but no response for other species, then we categorised each diary event according to the most extreme response)**

| Response | Number (%) Observations | Potential disturbance events: number (%) diary entries |
|---|---|---|
| No Response | 841 (65) | 445 (62) |
| Alert | 75 (6) | 69 (10) |
| Walk/Swim | 105 (8) | 46 (6) |
| Short Flight | 98 (8) | 60 (8) |
| Major Flight | 180 (14) | 103 (14) |
| Total | 1299 (100) | 723 (100) |

## Types of activities and disturbance

5.5 There was a very wide range of different activities observed during the standard watches. Across all counts there were 1299 observations of potential disturbance events (including birds of prey) involving an individual (or individuals) of a particular target species. Figure 12 details the response of all birds to each activity and Table 8 shows the number of groups recorded per activity. Kite and windsurfing, bait digging and dogs off leads were the four activities which resulted in the most response from the birds.

5.6 Table 8 summarises all potential disturbance events according to both zone and activity. Just over half (55%) of all observations involved activities on the shore (714 observations), while just over a third (36%, 473 observations) took place on the intertidal and the remaining 8% (103) of observations were from activities which took place on the water.

5.7 For shore-based events, just 2% (31) resulted in major flight and the majority (45% or 585 observations) resulted in no response from the birds. By contrast, of the 473 potential disturbance events observed on the intertidal 10% (127) resulted in a major flight by the birds. The proportion of potential disturbance events observed on the water that resulted in a major flight was less than those observed on the intertidal (one in five compared to one in three).

5.8 On average 1 in 25 events on the shore resulted in a major flight. Of the total 180 major flight observations, 71% were attributed to events on the intertidal, 17% to those on the shore and 12% to events on the water. The number of potential disturbance events which occurred in the different coastal zones was not equal, so direct comparison between the impact of activities in different zones needs careful consideration.

5.9 There were a total of 67% more potential disturbance events recorded on the shore than on the intertidal, yet five times as many major flights were caused by activities on the intertidal. This suggests that although fewer activities are taking place on the intertidal, these activities are much more likely to result in a behavioural response by the birds.

5.10 Bait digging on the intertidal, dog walking with dogs off leads on the intertidal, walking on the shore and intertidal and kitesurfing are the activities which account for the majority of major flight events. Of all the major flight events, walking on the shore (without a dog) accounted for 10%, bait digging 16%, dog walker with dogs off lead on the intertidal 31%, walkers without dogs on the intertidal 15% and kitesurfers 4%. It is dog walkers with their dogs off lead on the intertidal that caused the highest number of major flights of all the observed potential disturbance events.

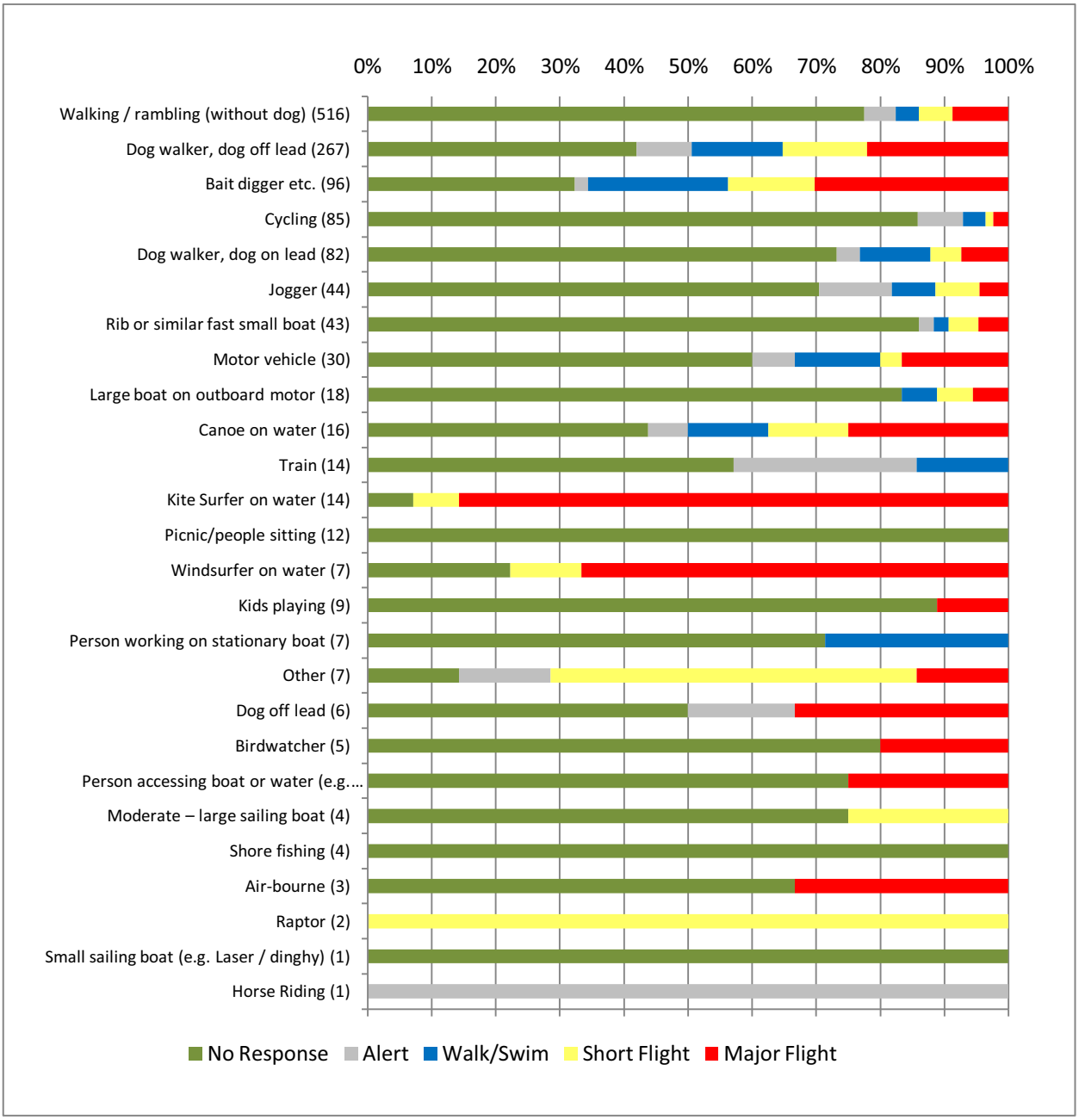


**Figure 12: Responses of birds (grouped across all sites and all species) according to activity. Activities are listed in order of sample size (the sample size being the number of species specific observations, given in brackets).**

**Table 8: Number (%) of potential disturbance events and response of birds, by activity and zone. Zones were classified in the field, but where events occurred across multiple zones we simplified these to a single zone: events that took place on both the intertidal and the shore were simplified as intertidal only and events which took place on the intertidal and on the water were simplified as water only.**

| Activity by zone | No Response | Alert | Walk/Swim | Short Flight | Major Flight | Total |
|---|---|---|---|---|---|---|
| **Shore** | | | | | | |
| Birdwatcher | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Cycling | 72 (6) | 6 (0) | 3 (0) | 1 (0) | 2 (0) | 84 (6) |
| Dog walker, dog off lead | 50 (4) | 5 (0) | 6 (0) | 4 (0) | 4 (0) | 69 (5) |
| Dog walker, dog on lead | 43 (3) | 1 (0) | 7 (1) | 2 (0) | 4 (0) | 57 (4) |
| Jogger | 31 (2) | 5 (0) | 3 (0) | 3 (0) | 2 (0) | 44 (3) |
| Kids playing (with or without parents) | 3 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 3 (0) |
| Motor vehicle | 6 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 6 (0) |
| Other | 0 (0) | 1 (0) | 0 (0) | 3 (0) | 1 (0) | 5 (0) |
| Picnic/people sitting | 12 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 12 (1) |
| Train | 8 (1) | 4 (0) | 2 (0) | 0 (0) | 0 (0) | 14 (1) |
| Walking / rambling (without dog) | 359 (28) | 15 (1) | 10 (1) | 17 (1) | 18 (1) | 419 (32) |
| Shore total | 585 (45) | 37 (3) | 31 (2) | 30 (2) | 31 (2) | 714 (55) |
| **Intertidal** | | | | | | |
| Bait digger etc. | 31 (2) | 2 (0) | 21 (2) | 13 (1) | 29 (2) | 96 (7) |
| Birdwatcher | 3 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 4 (0) |
| Cycling | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Dog off lead | 3 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 4 (0) |
| Dog walker, dog off lead | 61 (5) | 17 (1) | 32 (2) | 31 (2) | 55 (4) | 196 (15) |
| Dog walker, dog on lead | 17 (1) | 2 (0) | 2 (0) | 2 (0) | 2 (0) | 25 (2) |
| Fishing (from shore) | 4 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 4 (0) |
| Horse Riding | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Kids playing (with or without parents) | 5 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 6 (0) |
| KiteSurfer on water | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 4 (0) | 5 (0) |
| Motor vehicle | 12 (1) | 2 (0) | 4 (0) | 1 (0) | 5 (0) | 24 (2) |
| Person accessing boat or water (inc e.g. windsurfers walking across mudflat) | 3 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 4 (0) |
| Person working on boat (boat stationary) | 4 (0) | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 5 (0) |
| Rib or similar fast small boat | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Walking / rambling (without dog) | 39 (3) | 10 (1) | 9 (1) | 10 (1) | 27 (2) | 95 (7) |
| Windsurfer on water | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 2 (0) |
| Intertidal total | 184 (14) | 35 (3) | 69 (5) | 58 (4) | 127 (10) | 473 (36) |
| **Water** | | | | | | |
| Canoe on water | 7 (1) | 1 (0) | 2 (0) | 2 (0) | 4 (0) | 16 (1) |
| Dog off lead | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 1 (0) | 2 (0) |
| Dog walker, dog off lead | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Kitesurfer on water | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 8 (1) | 9 (1) |
| Large boat on outboard motor | 15 (1) | 0 (0) | 1 (0) | 1 (0) | 1 (0) | 18 (1) |
| Moderate – large sailing boat | 3 (0) | 0 (0) | 0 (0) | 1 (0) | 0 (0) | 4 (0) |
| Other | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Person working on boat (boat stationary) | 1 (0) | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 2 (0) |
| Rib or similar fast small boat | 37 (3) | 0 (0) | 1 (0) | 2 (0) | 2 (0) | 42 (3) |
| Small sailing boat (e.g. Laser / dinghy) | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) |
| Windsurfer on water | 1 (0) | 0 (0) | 0 (0) | 1 (0) | 5 (0) | 7 (1) |
| Water total | 67 (5) | 3 (0) | 5 (0) | 7 (1) | 21 (2) | 103 (8) |
| **Air** | | | | | | |
| Air-borne | 2 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 3 (0) |
| Raptor | 0 (0) | 0 (0) | 0 (0) | 2 (0) | 0 (0) | 2 (0) |
| Air Total | 2 (0) | 0 (0) | 0 (0) | 2 (0) | 1 (0) | 5 (0) |
| **Total** | **836 (65)** | **75 (6)** | **105 (8)** | **95 (7)** | **180 (14)** | **1295 (100)** |

## Unusual events/observations

5.11 A wide range of different activities were observed, in different tide conditions, weather conditions and times of year. It is difficult to generalise given the wide range of different events – and combinations of activities – observed. It is useful however to consider particular events and observations in detail. While the standard watches focused on a 500m arc to record counts of birds and responses of birds in detail, we also recorded additional information for the wider area visible at each survey point and notes provide additional detail about how birds responded. A number of particular events are worth highlighting:

5.12 Often it was gaining access for particular activities that appeared to cause disturbance. For example at the Turf on the 30th January 2010, four kayaks were observed. Redshank, red-breasted merganser and avocet were all recorded as undertaking a 'major flight' with the birds actually taking flight only when the kayaks were lifted out of the water, rather than when the paddlers approached the shore. Similarly with crab tillers it often appeared that the person walking out to the tiles caused more disturbance than the actual checking under the tiles. For example notes from October 2010 recorded that there was one crab tiler present at the start of count, subsequently joined by a second, with both present at the end of count. Walking to begin lifting tiles resulted in disturbance events being recorded, but once the tiler had started lifting tiles no major flight events occurred, birds simply walked away such that a bird-free zone of around 30m around the tiler was maintained, with only herring gulls coming closer.

5.13 Some events had particularly dramatic effects. On the 5th March 2011 a hovercraft was recorded, launching at the Duck Pond. The hovercraft did a circuit of the southern half of the estuary, going as far up river as Powderham Church. All birds were flushed from the mudflats. The hovercraft was present in the area only for a few minutes.

5.14 Air-borne events were occasionally recorded and were relatively erratic but often appeared to make the birds particularly jittery. For example on the 13th January at Topsham a green and yellow helicopter was seen repeatedly, and flying quite low. It flushed birds from the general area on multiple occasions. On the 18th January a microlite crossed low over the duck pond area, flushing all the birds from the count area and a much wider radius. There was also one instance when a remote-controlled model sea-plane was observed being flown in the Duck Pond area. As with the microlite, all birds in the area were flushed. This is an example of a new and perhaps unexpected activity.

5.15 On the 12th March 2011 two kitesurfers were observed walking out from the shore at Exmouth. There was plenty of mud and sand exposed at Exmouth, and the tide was rising. The two kitesurfers set up their equipment c.700m offshore, well beyond the count area. They then proceeded to kitesurf up the length of the estuary. The event coincided with surveys being conducted simultaneously at the Duck Pond and

at Topsham, and the same two kitesurfers were observed to walk across Greenland bank and to then walk ashore at Topsham, within the count area off goat walk. It was evident that the kitesurfers pushed birds up the estuary and all birds using the mudflats at the top of the estuary were flushed. Besides the birds within the count area, this single event resulted in c.320 curlew, 40 avocet, 150 black-tailed godwit, 8 shelduck and 50 dunlin leaving the mudflats and moving onto the marshes at Exminster. The birds had not returned by the end of the count.

5.16 This latter example and the hovercraft highlight how single events can, in the space of a few minutes, push birds entirely off large parts of the estuary.

### Variation between sites

5.17 There was some variation between sites in the number of potential disturbance events recorded and the proportion of these that resulted in a major flight.

5.18 Exmouth Channel recorded the highest proportion of major flight events, but the sample size of potential disturbance events at this location is so small it is difficult to draw any firm conclusions. The proportion of major flight events was also particularly high at the Duck Pond.

**Table 9: Number and (%) of different types of response to potential disturbance events by location**

| Location | Number of Surveys | No Response | Alert | Walk/ Swim | Short Flight | Major Flight | Total |
|---|---|---|---|---|---|---|---|
| Exmouth Channel | 9 | 1 (25) | 0 (0) | 1 (25) | 0 (0) | 2 (50) | 4 (100) |
| Exmouth Duck Pond | 50 | 36 (22) | 10 (6) | 21 (13) | 28 (17) | 71 (43) | 166 (100) |
| Exmouth Maer | 9 | 26 (46) | 10 (18) | 6 (11) | 7 (13) | 7 (13) | 56 (100) |
| Lympstone | 28 | 87 (64) | 5 (4) | 12 (9) | 13 (10) | 19 (14) | 136 (100) |
| Powderham | 23 | 130 (68) | 22 (12) | 20 (11) | 10 (5) | 8 (4) | 190 (100) |
| Starcross North | 21 | 25 (33) | 5 (7) | 13 (17) | 6 (8) | 27 (36) | 76 (100) |
| Starcross South | 25 | 50 (56) | 4 (4) | 12 (13) | 7 (8) | 16 (18) | 89 (100) |
| Topsham | 34 | 446 (85) | 18 (3) | 17 (3) | 20 (4) | 21 (4) | 522 (100) |
| Turf | 21 | 40 (67) | 1 (2) | 3 (5) | 7 (12) | 9 (15) | 60 (100) |
| **Total** | **220** | **841 (65)** | **75 (6)** | **105 (8)** | **98 (8)** | **180 (14)** | **1299 (100)** |

5.19 Figure 13 shows a plot of the number of major flights at each location in relation to the mean number of diary events recorded per survey at that location. There is no significant correlation (Pearson Correlation Coefficient = -0.29; $p>0.05$), indicating that the sites where birds are being flushed the most are not necessarily those with the highest number of people visiting. A similar plot is shown in Figure 14, this time showing the number of major flights in relation to the number of potential disturbance events per survey at each location. Potential disturbance events are those where birds were present within the focal area and the event was within 200m of the birds (see methods). Again there is no apparent pattern (Pearson Correlation Coefficient = -0.08; $p>0.05$), adding further weight to the suggestion that the number of times birds are flushed is not related to levels of access per se.

5.20 Looking at Figure 15 however, there does appear to be a negative correlation between the percentage of events that resulted in major flights and the number of

times people were present and close to the birds (Pearson Correlation Coefficient = -0.711; p = 0.032). In other words, at those locations where there were relatively few potential disturbance events, a greater proportion of those events resulted in major flights. The sites with the highest percentage of major flights are Exmouth Channel and Exmouth Duck Pond. At Exmouth Channel access levels were very high, with lots of people recorded walking along the beach in particular. Here there were very few occasions when any birds were present and therefore few potential disturbance events (just four), of which two (50%) involved major flight. At the Duck Pond, by contrast, the levels of access were lower, but birds were often present and the access involved much activity on the intertidal, hence a high proportion of major flights. At the other end of the scale, at Powderham and Topsham levels of access were high, birds were often present and there appears to be a low incidence of major flight.

5.21 The actual number of birds flushed per location is illustrated by Map 35 It can be seen that the highest numbers of birds flushed were at the Duck Pond and also at Topsham. At Topsham the actual number of major flight events was relatively small, given the high levels of access. However, there were a few occasions where single events resulted in lots of birds being flushed.

5.22 The behaviour responses per location are shown in Map 36 which also illustrates the highest number of potential disturbance events occurred at Topsham (the most northerly location), with lots of people counted here close to the birds and that for the majority of these events there was no response from the birds (Table 9). Few birds were recorded at the Exmouth Channel and Exmouth Maer survey locations and as map 5 is graduated (the bigger the sample size, the bigger the pie chart) details of these locations are barely visible.

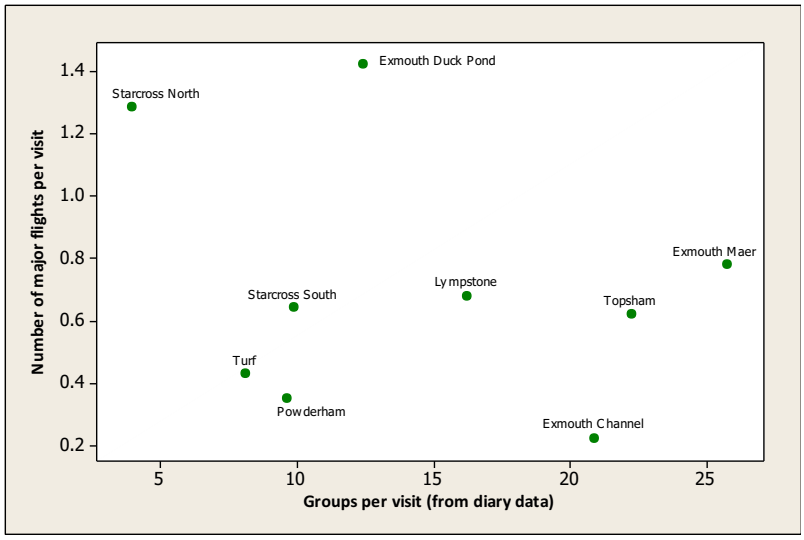


**Figure 13: Number of major flight events at each location in relation to disturbance levels (mean number of people recorded per location per survey, from the diary data).**

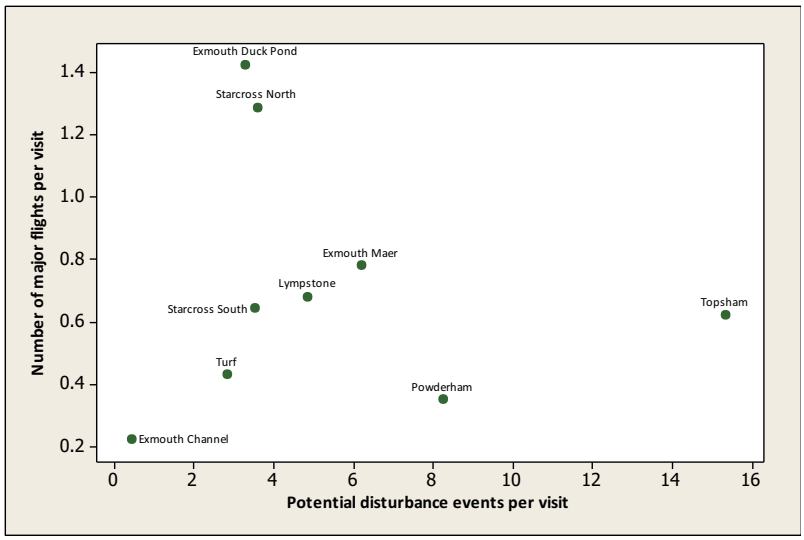


**Figure 14: Number of major flight events at each location in relation to the number of potential disturbance events.**

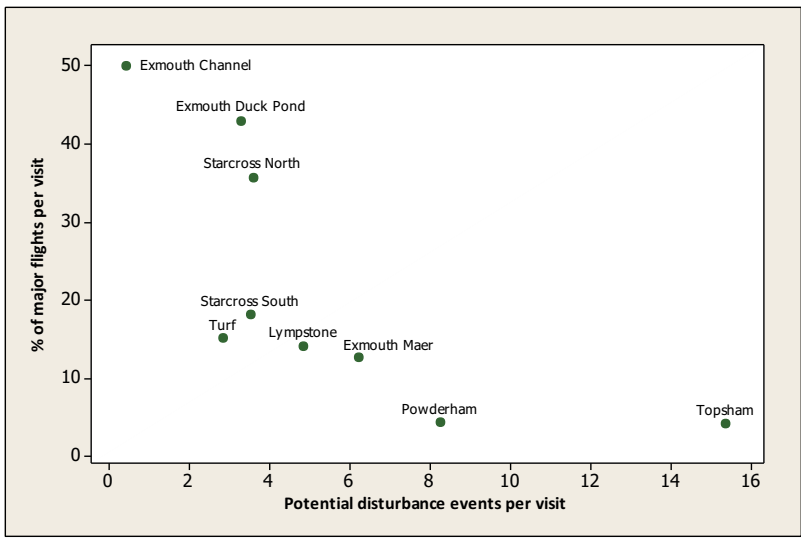


**Figure 15: Percentage of major flight events at each location in relation to the number of potential disturbance events**

## Distance at which birds responded

5.23 Birds typically flew when the source of the disturbance was close. Across all species and all potential disturbance events there were significant differences in the distances at which different types of response occurred. The median distance at which birds were recorded not responding was 70m; when birds became alert the median distance was 50m; for walk/swim it was 30m; for short flight it was 40m and for major flight it was 50m (Kruskall-Wallis H (adjusted for ties) = 171.04, 4df, $p<0.001$). These data are summarised in Figure 16.

5.24 Data are summarised by species in Table 10. Nearly three quarters of all the major flight events can be attributed to just five species: oystercatcher (59 observations of major flight), redshank (35 observations of major flight), black-tailed godwit (16 observations of major flights), dark-bellied brent goose (16 observations of major flights) and curlew (13 observations of major flights). The data for these species are summarised in Figure 17.

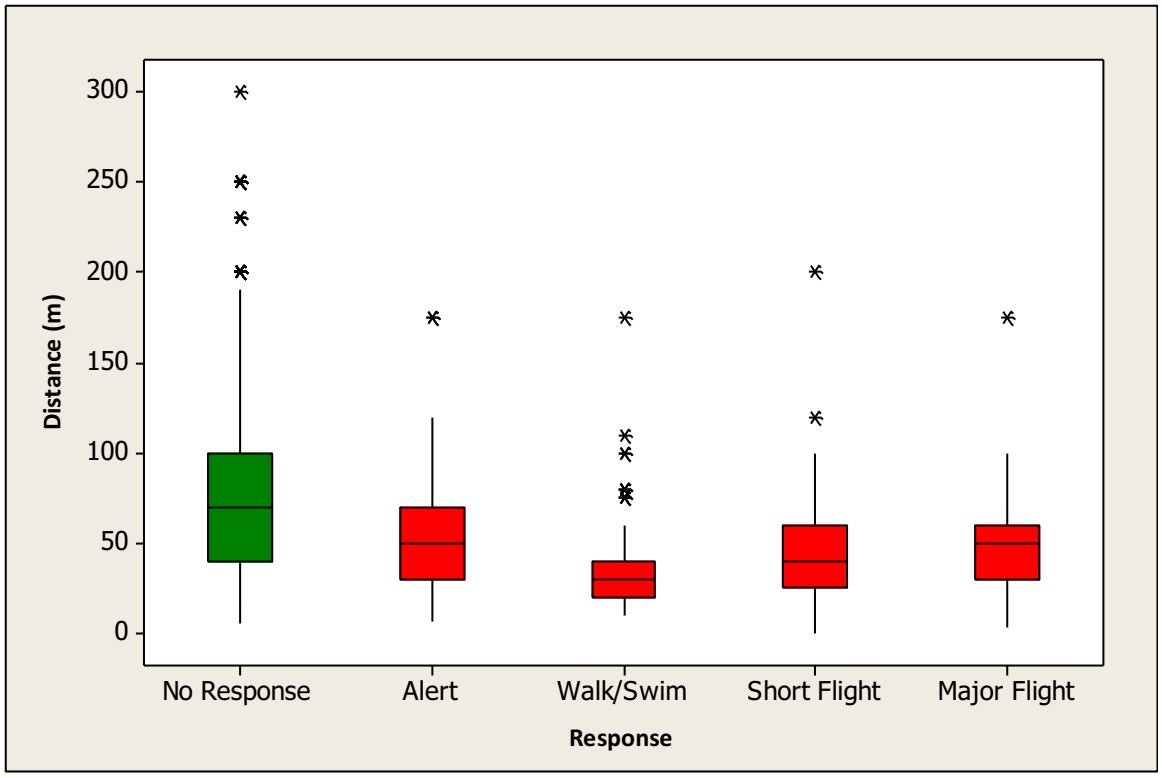


**Figure 16: Distance at which birds (across all species) showed no response or responded to the source of disturbance**

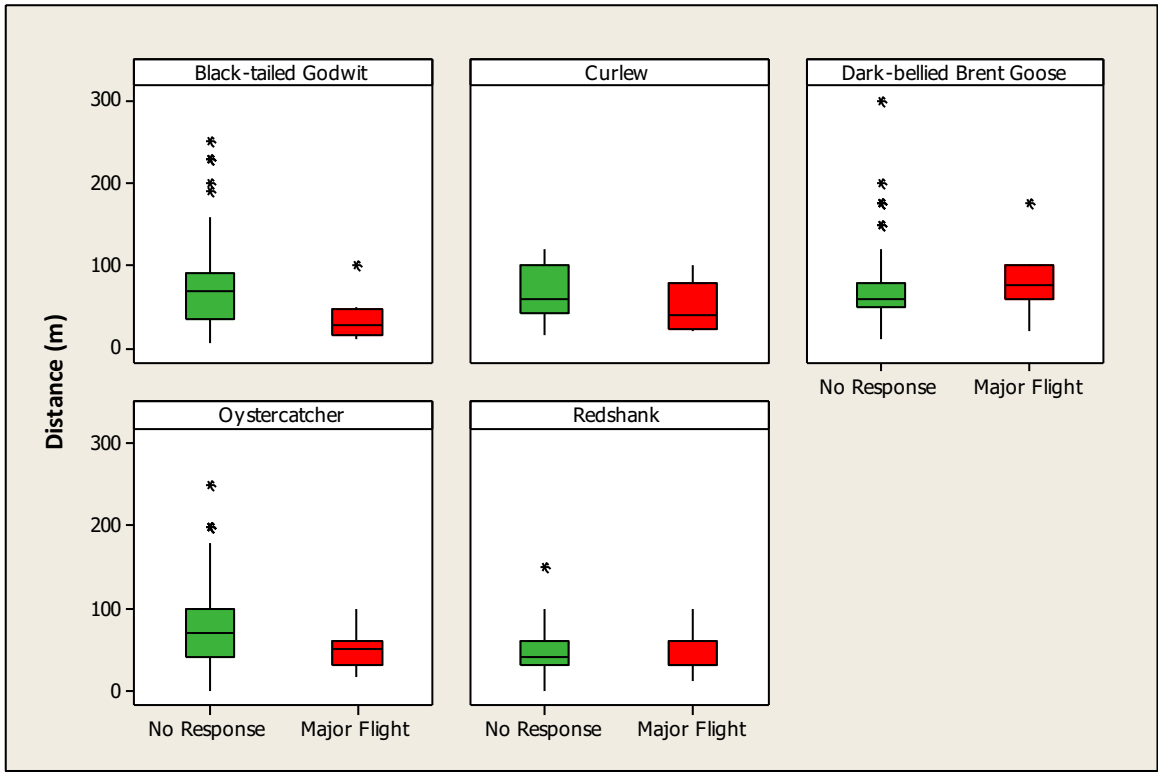


**Figure 17: Distance at which major flight occurred compared to no major flight, for five selected species**

**Table 10: Summary of response distances by species and by type of response**

| Species | No Response | | | Alert | | | Walk/Swim | | | Short Flight | | | Major Flight | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Median | Range | Count | Median | Range | Count | Median | Range | Count | Median | Range | Count | Median | Range | Count |
| Avocet | 40 | 20-160 | 86 | 30 | 30-30 | 1 | 20 | 18-75 | 7 | 45 | 20-90 | 4 | 60 | 60-100 | 3 |
| Bar-tailed Godwit | 42.5 | 30-190 | 4 | 30 | 30-30 | 1 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 25 | 25-25 | 1 |
| Black-tailed Godwit | 75 | 8-250 | 211 | 27.5 | 6-70 | 12 | 20 | 10-50 | 18 | 35 | 10-80 | 6 | 27.5 | 10-100 | 16 |
| Curlew | 80 | 20-120 | 37 | 0 | 0-0 | 0 | 22.5 | 15-40 | 4 | 50 | 15-80 | 5 | 40 | 20-100 | 13 |
| Dark-bellied Brent Goose | 60 | 30-300 | 41 | 70 | 30-175 | 17 | 30 | 10-175 | 20 | 90 | 30-120 | 6 | 77.5 | 20-175 | 16 |
| Dunlin | 150 | 8-250 | 109 | 8 | 8-8 | 1 | 35 | 30-40 | 2 | 30 | 8-100 | 15 | 55 | 35-100 | 6 |
| Greenshank | 45 | 8-75 | 4 | 0 | 0-0 | 0 | 30 | 30-30 | 1 | 35 | 20-50 | 2 | 30 | 30-60 | 6 |
| Mallard | 37.5 | 25-50 | 2 | 0 | 0-0 | 0 | 40 | 30-50 | 2 | 0 | 0-0 | 0 | 30 | 30-30 | 1 |
| Mute Swan | 37.5 | 20-60 | 4 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 30 | 30-30 | 1 | 0 | 0-0 | 0 |
| Oystercatcher | 75 | 25-250 | 154 | 40 | 20-80 | 19 | 32.5 | 20-110 | 32 | 40 | 0-200 | 27 | 50 | 15-100 | 59 |
| Red-breasted Merganser | 30 | 30-150 | 3 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 50 | 50-50 | 1 |
| Redshank | 40 | 15-150 | 85 | 60 | 15-100 | 15 | 30 | 10-60 | 15 | 27.5 | 0-75 | 20 | 70 | 42-130 | 35 |
| Ringed plover | 35 | 30-40 | 2 | 0 | 0-0 | 0 | 30 | 30-30 | 1 | 40 | 40-40 | 1 | 100 | 100-100 | 1 |
| Sanderling | 40 | 40-40 | 1 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 40 | 40-40 | 1 | 70 | 70-70 | 1 |
| Shelduck | 70 | 30-160 | 18 | 50 | 50-70 | 3 | 40 | 40-40 | 1 | 55 | 25-100 | 4 | 62.5 | 50-75 | 2 |
| Slavonian Grebe | 75 | 30-75 | 3 | 50 | 50-50 | 2 | 30 | 30-30 | 1 | 0 | 0-0 | 0 | 0 | 0-0 | 0 |
| Teal | 50 | 30-60 | 13 | 50 | 20-50 | 3 | 0 | 0-0 | 0 | 70 | 70-70 | 1 | 3 | 3-3 | 1 |
| Turnstone | 25 | 5-110 | 24 | 12 | 12-12 | 1 | 20 | 20-20 | 1 | 15 | 5-40 | 3 | 30 | 10-60 | 8 |
| Wigeon | 75 | 75-75 | 1 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 0 | 0-0 | 0 | 60 | 50-100 | 6 |

## Identifying which factors determine the response of birds

5.25 Univariate logistic regression results are summarised in Table 11. The analysis was conducted using data for five species only (oystercatcher, redshank, black-tailed godwit, dark-bellied brent goose and curlew). Distance was highly significant, confirming that birds are more likely to take flight when the source of disturbance is closer. The effect of distance (across all five species included in the analysis) was such that at 20m the probability of major flight taking place was 0.25, i.e. one in four observations are predicted to involve a major flight at this distance. The probability drops with distance (Figure 18), such that at 150m the probability is around 0.05 (i.e. 1 in 20 observations predicted to involve a major flight).

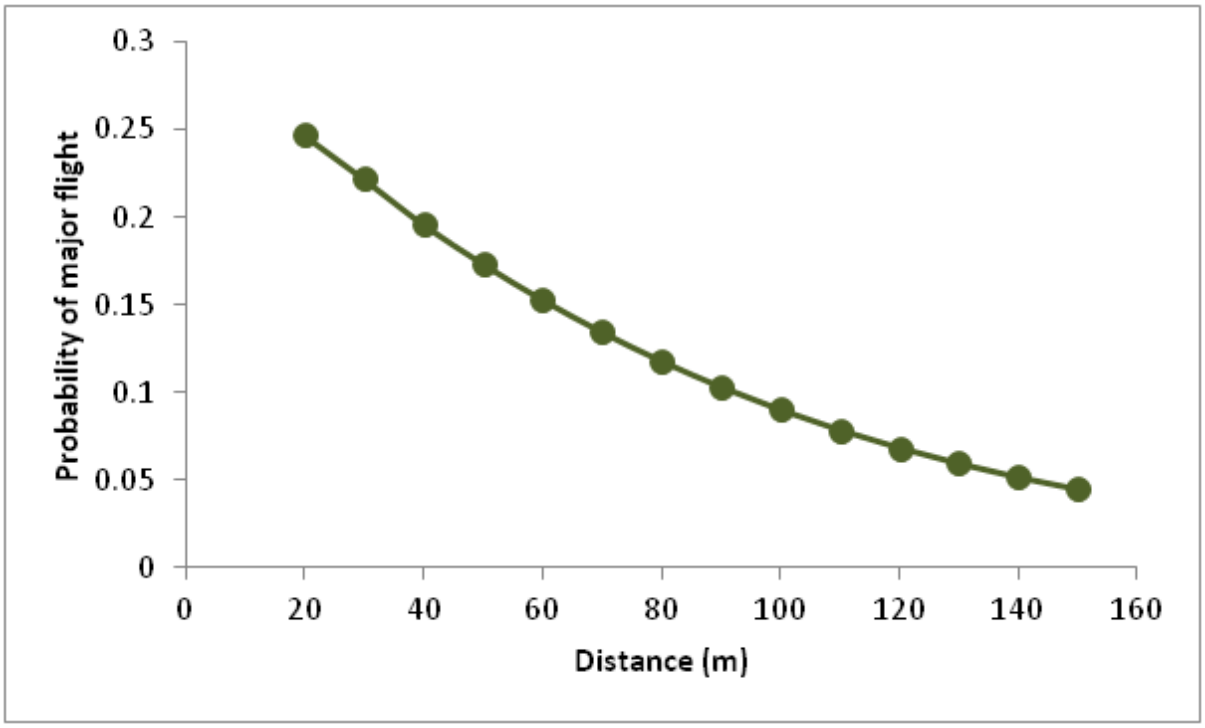


**Figure 18: Probability of major flight occurring in relation to distance. Plot generated from the logistic regression equation in Table 11. Data for all five species combined and all activities.**

5.26 The number of birds present was also significant, with (on average) the probability of major flight occurring being less for larger groups of birds. The probability of major flight taking place is approximately halved when 100 birds are present (probability of major flight = 0.081) compared to when ten birds are present (probability of major flight = 0.1665). When one bird is present the probability of a major flight event increases to 0.11.

5.27 The results for the number of dogs present in a group (regardless of whether on a lead or off a lead) showed that when dogs were present the probability of major flight occurring was greater, however the difference was not quite significant. The number of dogs off leads did show a significant effect. Regardless of species, distance, type of activity etc., the presence of a dog off a lead increased the probability that a major flight would occur, such that with no dogs the probability was 0.139, with one dog off a lead it rose to 0.183 and with 2 dogs off a lead the probability was 0.238. The number

of people in a group was not significant, suggesting that a group of one, two or three people was equally likely to result in major flight. Temperature was significant. Major flight events were more likely to take place when the temperature was warmer.

5.28 With the categorical variables in Table 11, one category (the first when listed in alphabetical order) is used as a reference to which the others are compared. Comparing between locations, two locations appear to be different, with the coefficients much lower at Powderham and at Topsham, suggesting that the probability of a major flight occurring at these two locations is much lower than the other locations surveyed. The simple variable dog present/not was not quite significant, but in line with the other dog variables, the positive coefficient points towards dogs resulting in a higher probability of major flight. The 'zone' in which the activity was taking place was also significant – the probability of major flight occurring was significantly higher if people were on the intertidal compared to people on the shore, but there was no significant difference between activities taking place on the water or on the intertidal.

5.29 There were some differences between activity types. We simplified activities into five broad category types – 'intertidal' (bait digging, accessing boats etc.), dog walking (whether on intertidal or shore and whether dog on lead or not), shore based (walking, fishing, cycling, jogging, horse riding etc), water-based (i.e. all sailing, watersports, boats etc) and all others. Using intertidal as the reference category, water-based activities and 'others' were not significantly different. Dog walkers (all grouped together in a single category) were less likely to cause major flight compared to intertidal and water-based activities, and the group least likely to cause a major flight were shore based activities without a dog.

5.30 Comparing between species, black-tailed godwit was the reference species and all other species were significantly more likely to undertake major flight. Curlew had the highest probability of major flight, followed by oystercatcher, redshank and brent goose.

5.31 The state of the tide was also significant, compared to a falling tide, birds were more likely to take flight at low tide or a rising tide.

**Table 11: Univariate logistic regression results. Table gives the coefficients, standard error ("SE"), z score, significance ("p") and the odd ratio ("OR"). Ten species included (see table).**

| Variable | Regression Coefficient | SE | Z | p | OR |
|---|---|---|---|---|---|
| **CONTINUOUS VARIABLES** | | | | | |
| *Distance of birds from disturbance (m)* | | | | | |
| Intercept | -0.811 | 0.186 | -6.72 | <0.001 | |
| Distance | -0.015 | 0.003 | -5.54 | <0.001 | 0.98 |
| *Number of birds* | | | | | |
| Intercept | -1.521 | 0.100 | -15.17 | <0.001 | |
| Count of number of individuals | -0.009 | 0.003 | -3.05 | 0.002 | 0.99 |
| *Number of dogs present* | | | | | |
| Intercept | -1.7881 | 0.107 | -16.70 | <0.001 | |
| No. dogs | 0.200 | 0.113 | 1.77 | 0.078 | 1.22 |
| *No. of dogs off lead* | | | | | |

| Variable | Regression Coefficient | SE | Z | p | OR |
|---|---|---|---|---|---|
| Intercept | -1.821 | 0.105 | -17.32 | <0.001 | |
| No. dogs | 0.328 | 0.121 | 2.71 | 0.007 | 1.39 |
| *Group Size (No. People)* | | | | | |
| Intercept | -1.477 | 0.147 | -10.01 | <0.001 | |
| Number of People in group | -0.157 | 0.087 | -1.81 | 0.070 | 0.85 |
| *Temperature (deg. C)* | | | | | |
| Intercept | -1.948 | 0.131 | -14.88 | <0.001 | |
| Temperature | 0.039 | 0.014 | 2.91 | 0.004 | 1.04 |
| **CATEGORICAL VARIABLES** | | | | | |
| *Location (reference category=Exmouth Channel)* | | | | | |
| Intercept | 0 | 1 | 0 | 1 | |
| Exmouth Duck Pond | -0.444 | 1.014 | -0.44 | 0.661 | 0.64 |
| Exmouth Maer | -1.946 | 1.078 | -1.80 | 0.071 | 0.14 |
| Lympstone | -1.554 | 1.040 | -1.50 | 0.135 | 0.21 |
| Powderham | -3.148 | 1.072 | -2.94 | 0.003 | 0.04 |
| Starcross North | -0.546 | 1.035 | -0.53 | 0.598 | 0.58 |
| Starcross South | -1.421 | 1.043 | -1.36 | 0.173 | 0.24 |
| Topsham | -3.416 | 1.056 | -3.24 | 0.001 | 0.03 |
| Turf | -1.386 | 1.100 | -1.26 | 0.207 | 0.25 |
| *Presence of a Dog*: 2 categories (reference category=no dog) | | | | | |
| Intercept | -1.806 | 0.114 | -15.88 | <0.001 | |
| yes | 0.331 | 0.192 | 1.72 | 0.085 | 1.39 |
| *Zone*: 3 categories (reference category = intertidal) | | | | | |
| Intercept | -0.976 | 0.117 | -8.36 | <0.001 | |
| shore | -2.263 | -0.280 | -8.07 | <0.001 | 0.10 |
| water | -0.315 | 0.360 | -0.88 | 0.381 | 0.36 |
| *Activity Type*: 5 categories (reference category=intertidal) | | | | | |
| Intercept | -0.829 | 0.245 | -3.39 | 0.001 | |
| Other | -0.721 | 0.483 | -1.49 | 0.135 | 0.49 |
| Shore based, no dog | -1.544 | 0.297 | -5.19 | <0.001 | 0.21 |
| Dog walker | -0.608 | 0.288 | -2.11 | 0.035 | 0.54 |
| Watersport/boat | -0.178 | 0.362 | -0.49 | 0.625 | 0.84 |
| *Species*: 5 categories (reference category = Black-tailed Godwit) | | | | | |
| Intercept | -2.727 | 0.250 | -10.90 | 0.001 | |
| Curlew | 1.421 | 0.400 | 3.55 | <0.001 | 4.14 |
| Brent Goose | 1.046 | 0.370 | 2.83 | 0.005 | 2.85 |
| Oystercatcher | 1.333 | 0.289 | 4.61 | <0.001 | 3.79 |
| Redshank | 1.377 | 0.314 | 4.39 | <0.001 | 3.97 |
| *State of Tide*: 4 categories (reference category= falling) | | | | | |
| Intercept | -1.207 | 0.149 | -8.07 | <0.001 | |
| high | -0.952 | 0.628 | -1.52 | 0.129 | 0.39 |
| low | -1.072 | 0.289 | -3.71 | <0.001 | 0.34 |
| rising | -0.592 | 0.202 | -2.92 | 0.004 | 0.55 |

5.32 We then tested variables including distance in all models, as the distance between the activity and the birds is likely to be fundamental in affecting how birds respond. At this stage we did not test whether there were interactions with distance and other variables, just whether the addition of an extra variable resulted in an improved model or changed the significance of any of the variables when considered on their own. Results are summarised in Table 12.

5.33 It can be seen that:

- Temperature is not significant after distance is accounting for distance.

- There is relatively little change with the other variables, indicating that once distance is accounted for, the number of birds present; dogs (both presence of and the number of dogs); zone; activity type; species and state of the tide all influence the probability of major flight.

**Table 12: Logistic regression results for model runs involving distance and a single additional variable.**

| Variable | Regression coefficient | SE | Z | p | OR |
|---|---|---|---|---|---|
| **Distance alone:** 139 major flight events; Log-likelihood=-370.081; G=29.032, 1 df, p<0.001 | | | | | |
| Intercept | -0.811 | 0.187 | -4.36 | <0.001 | |
| Distance | -0.015 | 0.003 | -4.83 | <0.001 | 0.98 |
| **Distance and Number of Birds** 139 major flight events; Log-likelihood=-363.784; G=41.284, 2 df, p<0.001; | | | | | |
| Intercept | --0.706 | 0.187 | -3.78 | <0.001 | |
| Distance | -0.014 | 0.003 | -4.57 | <0.001 | 0.98 |
| Count of number of individuals | -0.008 | 0.003 | -2.81 | 0.005 | 0.99 |
| **Distance and Number Dogs Present** 139 major flight events; Log-likelihood=-368.302; G=32.590, 2 df, p<0.001 | | | | | |
| Intercept | -0.895 | 0.193 | -4.64 | <0.001 | |
| Distance | -0.016 | 0.003 | -4.87 | <0.001 | 0.98 |
| No. Dogs | 0.226 | 0.116 | 1.94 | 0.052 | 1.25 |
| **Distance and Dogs off leads** 139 major flight events; Log-likelihood=-366.504; G=36.186, 2 df, p<0.001 | | | | | |
| Intercept | -0.925 | 0.193 | -4.79 | <0.001 | |
| Distance | -0.016 | 0.003 | -4.85 | <0.001 | 0.98 |
| No. Dogs off leads | 0.342 | 0.124 | 2.76 | 0.006 | 1.41 |
| **Distance and Group size (number of people)** 139 major flight events; Log-likelihood=--368.809; G=31.577, 2 df, p<0.001 | | | | | |
| Intercept | -0.652 | 0.213 | -3.06 | 0.002 | |
| Distance | -0.015 | 0.003 | -4.70 | <0.001 | 0.98 |
| Group Size | -0.130 | 0.088 | 0.142 | 0.142 | 0.74 |
| **Distance and Temperature** 139 major flight events; Log-likelihood=--369.659; G29.877, 2 df, p<0.001 | | | | | |
| Intercept | -0.946 | 0.238 | -3.98 | <0.001 | |
| Distance | -0.014 | 0.003 | -4.38 | <0.001 | 0.99 |
| Temperature | 0.013 | 0.015 | 0.92 | 0.355 | 1.01 |
| **Distance and dog present** 139 major flight events; Log-likelihood=-368.204; G=32.786, 2 df, p<0.001 | | | | | |
| Intercept | -0.918 | 0.196 | -4.68 | <0.001 | |
| Distance | -0.015 | 0.003 | -4.88 | <0.001 | 0.98 |
| Dogs present: Yes | 0.386 | 0.197 | 1.96 | 0.050 | 1.47 |
| **Distance and Location** 139 major flight events; Log-likelihood=-302.555; G=164.085, 9 df, p<0.001 | | | | | |
| Intercept | 1.005 | 1.131 | 0.89 | 0.374 | |
| Distance | -0.015 | 0.004 | -4.09 | <0.001 | 0.99 |
| Exmouth Duck Pond | -0.546 | 1.126 | -0.48 | 0.628 | 0.58 |
| Exmouth Maer | -2.183 | 1.185 | -1.84 | 0.065 | 0.11 |
| Lympstone | -1.580 | 1.150 | -1.37 | 0.170 | 0.21 |
| Powderham | -3.520 | 1.189 | -2.96 | 0.003 | 0.03 |
| Starcross North | -1.003 | 1.148 | -0.87 | 0.382 | 0.37 |
| Starcross South | -1.530 | 1.154 | -1.33 | 0.185 | 0.22 |
| Topsham | -3.519 | 1.164 | -3.02 | 0.003 | 0.03 |
| Turf | -1.013 | 1.225 | -0.83 | 0.408 | 0.36 |
| **Distance and Zone** 126 major flight events; Log-likelihood=-295.190; G=112.851, 3 df, p<0.001 | | | | | |
| Intercept | -0.286 | 0.211 | -1.36 | 0.175 | |
| Distance | -0.012 | 0.003 | -3.64 | <0.001 | 0.99 |
| Zone: shore | -2.211 | 0.282 | -7.84 | <0.001 | 0.11 |

| Variable | Regression coefficient | SE | Z | p | OR |
|---|---|---|---|---|---|
| Zone: water | -0.121 | 0.399 | 0.30 | 0.762 | 1.13 |
| **Distance and Activity** | | | | | |
| 139 major flight events; Log-likelihood=-349.795; G=69.605, 5 df, p<0.001 | | | | | |
| Intercept | -0.214 | 0.275 | -0.78 | 0.436 | |
| Distance | -0.016 | 0.003 | -4.68 | <0.001 | 0.98 |
| Other | -0.592 | 0.522 | -1.13 | 0.257 | 0.55 |
| Shore based, no dog | -1.257 | 0.307 | -4.10 | <0.001 | 0.28 |
| Dog walker | -0.289 | 0.300 | -0.96 | 0.335 | 0.75 |
| Watersport/boat | 0.600 | 0.404 | 1.48 | 0.138 | 1.82 |
| **Distance and Species** | | | | | |
| 139 major flight events; Log-likelihood=-355.310; G=58.573, 5 df, p<0.001 | | | | | |
| Intercept | -1.805 | 0.308 | -5.87 | <0.001 | |
| Distance | -0.016 | 0.003 | -4.69 | <0.001 | 0.98 |
| Curlew | 1.457 | 0.413 | 3.53 | <0.001 | 1.91 |
| Brent Goose | 1.170 | 0.382 | 3.06 | 0.002 | 1.52 |
| Oystercatcher | 1.417 | 0.301 | 4.71 | <0.001 | 2.29 |
| Redshank | 1.159 | 0.324 | 3.57 | <0.001 | 1.69 |
| **Distance and Tide** | | | | | |
| 139 major flight events; Log-likelihood=-364.188; G=40.818, 4 df, p<0.001 | | | | | |
| Intercept | -0.489 | 0.213 | -2.30 | 0.021 | |
| Distance | -0.014 | 0.003 | -4.30 | <0.001 | 0.99 |
| Tide: high | -0.653 | 0.637 | -1.03 | 0.305 | 0.52 |
| Tide: low | -0.927 | 0.301 | -3.09 | 0.002 | 0.40 |
| Tide: rising | -0.505 | 0.207 | -2.44 | 0.015 | 0.60 |

5.34 Variables were combined further in order to assess potential interactions between variables and combinations. We built preliminary multivariate models containing all variables and biologically significant interactions, and reduced the number of variables and combinations manually. Following the results of the previous logistic regression analyses we created additional, simplified variables as follows:

- We simplified zone into two categories – shore based activities and all others (i.e. combining activities on the intertidal and on the water)

- We simplified location to give just two different categories: we grouped Topsham and Powderham together as one category and grouped all other locations in the second category

- We simplified tide into two categories: low tide as one category and rising/falling/high tide grouped

5.35 The best model is summarised in Table 13. This fits the data well (Hosmer-Lemeshow statistic=9.229, p=0.237) and is reasonably accurate (concordant pairs = 79.3%). It includes distance and the three simplified variables described above. During early stages of model building it was found that temperature was not significant as a single independent variable when included with distance, but there was a significant interaction (p=0.025 for the interaction term when distance, temperature and the interaction term only are used in the model). This suggests that the probability of major flight varies differently with distance according to temperature. The interaction term was not included in the final model as it resulted

in a higher AIC. Models containing species as a variable were similar to those containing the simplified location variable, but when both variables were included species was no longer significant. This suggests that the significant effect included when separating Topsham and Powderham from the other locations is not due to features of the site that mean that birds respond differently, more it is that these sites (at the top of the estuary) hold a different species grouping to other locations. The difference can potentially instead be explained in that black-tailed godwit (which show the lowest probability of major flight) are more abundant here.

5.36 The results indicate that distance from the bird(s) to the source of disturbance, tide and the zone where the access takes place are significant together in explaining the probability of a major flight event taking place. These variables are summarised in Figure 19. The analysis shows that:

- After controlling for distance, tide and location, the probability of a major flight occurring was lower when the activity is on the shore compared to activities on the intertidal or on the water.

- The probability of major flight events was lower at Topsham and Powderham compared to other sites

- The state of the tide in which the activity or event was taking place was also significant and effectively added to the ability of the model to explain the variation in response. The probability of a major flight event occurring was lower at low tide.

**Table 13: Reduced logistic regression model estimating probability of major flight**

| Variable | Regression coefficient | SE | Z | p | OR |
|---|---|---|---|---|---|
| **Distance, Simple Zone, Simple Location, Simple Tide:** 139 major flight events; Log-likelihood=-307.628; G=153.94, 4 df, p<0.001; AIC=-143.93 | | | | | |
| Intercept | -0.691 | 0.338 | -2.04 | 0.041 | |
| Distance | -0.012 | 0.003 | -3.83 | <0.001 | 0.99 |
| Simplified Zone (shore based or intertidal/water) | | | | | |
| Shore based | -0.838 | 0.329 | -2.54 | 0.011 | 0.43 |
| Simplified Location (Topsham/Powderham or all others) | | | | | |
| Topsham/Powderham | -1.801 | 0.374 | -4.81 | <0.001 | 0.17 |
| Simplified Tide (low tide or high/falling/rising) | | | | | |
| High/falling/rising | 0.721 | 0.290 | 2.48 | 0.013 | 2.06 |

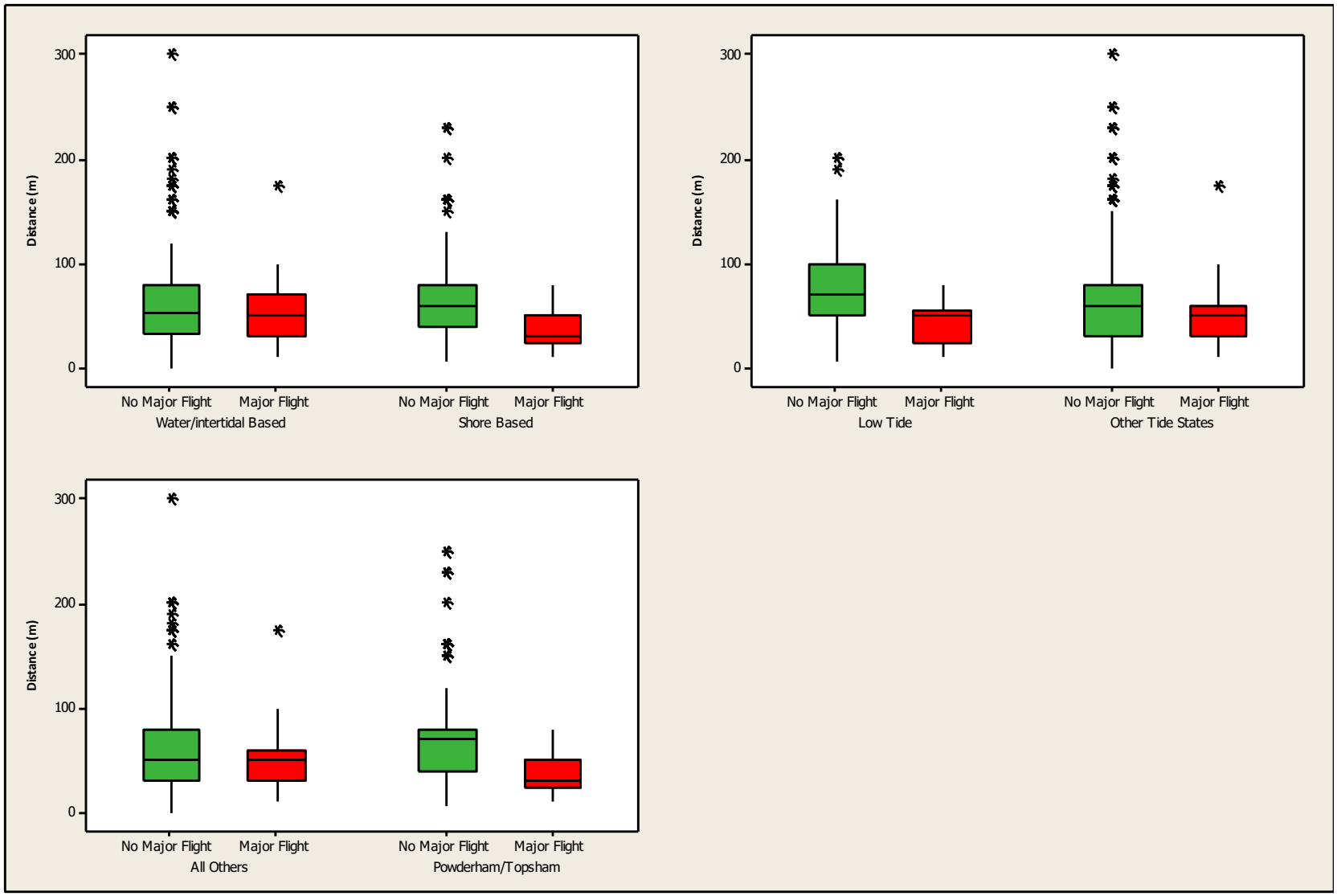


**Figure 19: Summary graphs showing distance at which birds (all five species included in the analysis) responded with a major flight compared to no major flight, by location, zone in which activity took place and tide states**

## Determining lost feeding area

5.37 Using the model equations in Table 13 it is possible to compare different activities in different circumstances and calculate a comparative figure for the amount of habitat lost as a result of the disturbance. In order to determine this figure we calculated a 'disturbance radius'. This was calculated using 10m distance bands and, taking the predicted probability of a major flight occurring for the mid-point in each distance band, we multiplied the probability by the width of the band (i.e. 10m). This essentially gave us a value (for each band) of the effective distance disturbed. By summing these distances across all bands (up to 150m) we calculated a single value, which is essentially a radius figure, allowing us to calculate the area of intertidal habitat 'lost' as a result of the given activity in a given location. These radii are summarised in Table 14. It s important to recognise that these distances are different to the flush distances (e.g. Table 10) and should not be interpreted as the distances at which birds respond, or not. Rather these radii allow us to calculate an area. For example if the probability of major flight for a 10m distance band is 0.5, this would imply that within that band half the observations of activities would result in birds undertaking major flight. The disturbance radius would be 5m (i.e. half the area is lost to the birds), whereas the data might well show birds being flushed at greater distances than 5m.

**Table 14: Effective disturbance distances for different types of disturbance events**

| Location | Zone | Tide | Disturbance Radius (m) |
|---|---|---|---|
| Powderham or Topsham | Intertidal/Water | Rising/High/Falling | 10.30 |
| Rest of Estuary | Intertidal/Water | Rising/High/Falling | 44.15 |
| Powderham or Topsham | Shore | Rising/High/Falling | 4.68 |
| Rest of Estuary | Shore | Rising/High/Falling | 23.73 |
| Powderham or Topsham | Intertidal/Water | Low | 5.24 |
| Rest of Estuary | Intertidal/Water | Low | 26.07 |
| Powderham or Topsham | Shore | Low | 2.32 |
| Rest of Estuary | Shore | Low | 12.81 |

5.38 The total area of intertidal habitats within the Exe Estuary is around 1084ha, a figure extracted using GIS data on the extent of mudflats provided by Natural England, with the addition of Pole Sands, Great Bull Hill and Little Bull Hill Sand, digitised using OS VectorMap. We took route data from the GPS units and face-face visitor work and by buffering each route with the radii (Table 14) it is possible to calculate the effective area of intertidal habitats lost through disturbance from each activity. This approach does not take into account the relative value of the habitats (some areas of intertidal habitat will hold higher invertebrate densities for example), but provides a simple means to compare between activities – taking into account how birds respond to different activities and using real information on where people go.

5.39 In order to consider different tide states we used mean low water to represent low tide and intermediate tide states were represented by simply reducing the area of mudflats by a set width of 100m, set back from mean low water. Route data was

checked and all routes were assumed to take place at intermediate tide states unless at least 80% of the route length was entirely below mean low water.

5.40 Results are summarised in Table 15. The table gives typical areas of intertidal habitat lost to disturbance. The results indicate:

- Most activities result in the loss of less than 1% of intertidal habitats present within the estuary (i.e. 1ha per group)
- Kitesurfing and windsurfing in the area around the Duck Pond result in the highest areas lost – around 8ha per trip.
- Water based activities result in greater areas lost than land-based activities
- Dog walking routes at low tide across the intertidal habitats in the Duck Pond area result in habitat loss of an average of 3ha (maximum 6.8ha). The area lost here is much higher than the area lost at Lympstone or Topsham from dog walkers walking along the shore.
- The results indicate that the impacts of different activities vary with the tide. For example the four jet ski routes were all largely well below mean low water mark and are mainly in the channel area off Exmouth. The area of habitat lost is greater at low tide. For kite surfing there were three routes which were also mostly above mean low water and were recorded from the seafront. These routes appear to also have a greater impact when compared to the routes plotted for intermediate tide heights.

5.41 We caveat the area figures and above bullets in that the dog walker routes used are those of the walker, and not the dog, and we know from observation that the dogs will often be well away from the owner. The area figures are therefore likely to very largely underestimate the effect of dogs. If we assume that the impact is a large underestimate then a single dog walking event on the intertidal at the Duck Pond may have as big an impact as watersport users in the same general area.

5.42 We have not included time in our calculations, the area figures represent the a value for the area disturbed – lost to the birds – but the time over which this disturbance will occur will vary. Users may well linger in particular areas, for example people following a seawall may stop at a bench; a kite surfer may well spend some time on a sandbar adjusting equipment. We have avoided incorporating time as we only have data on the duration of each visit and time in particular areas from the GPS tracks. We therefore highlight that the variation in duration of each type of event should be recognised when comparing activities.

5.43 A further important caveat is that sample sizes are often quite low. We express the area lost as a mean, but given the low sample sizes we have refrained from any statistical tests.

**Table 15: Area of intertidal habitat lost from different activities occurring in different parts of the estuary. Areas derived largely from actual route data (either GPS routes or from face-face survey results) and disturbance radii derived from the logistic regression equations. Intermediate tide state is the intertidal habitat remaining removing the areas within 100m of MHWM. The percentages are calculated using 1084ha as the area of intertidal habitats (within the whole estuary) at low tide and 752ha as the area at intermediate tide states. Percentages are rounded to one decimal place. Activities are listed in ascending order, sorted by the mean area lost.**

| Activity | Tide | Location | Radius | No. of routes | Area lost (ha) | | | % loss | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Mean | min | max | | |
| Kitesurfing | intermediate | Duck Pond | 44.15 | 11 | 8.6 | 1.9 | 14.3 | 1.1 | Derived from GPS routes |
| Windsurfing | intermediate | Duck Pond | 44.15 | 8 | 7.5 | 3 | 13.4 | 1 | Derived from GPS routes |
| Kitesurfing | low | Exmouth sea front | 26.07 | 3 | 5.1 | 0.4 | 8.1 | 0.5 | Derived from GPS routes |
| Sailing | intermediate | Inside estuary | 44.15 | 7 | 4.6 | 0 | 13.2 | 0.6 | Derived from GPS routes |
| Kitesurfing | intermediate | Exmouth sea front | 44.15 | 17 | 3.7 | 0.6 | 10.8 | 0.5 | Derived from GPS routes |
| Windsurfing | low | Duck Pond | 26.07 | 1 | 3.4 | 3.4 | 3.4 | 0.3 | Derived from GPS routes |
| Sailing | low | Inside estuary | 26.07 | 4 | 3.3 | 0.8 | 8 | 0.3 | Derived from GPS routes |
| Jet skiing | low | Exmouth sea front | 26.07 | 4 | 2.7 | 0.7 | 7.9 | 0.2 | Derived from GPS routes, same 4 routes used twice for jet skiing |
| Dog walking | low | Duck Pond | 26.07 | 16 | 2.7 | 0.03 | 6.8 | 0.2 | Derived from face-face routes |
| Canoe | intermediate | Inside estuary | 44.15 | 4 | 1.73 | 0 | 5.1 | 0.2 | Derived from GPS routes |
| Jet ski | intermediate | Exmouth sea front | 44.15 | 4 | 1.7 | 0.5 | 4.9 | 0.2 | Derived from GPS routes, same 4 routes used twice for jet skiing |
| Canoe | low | Inside estuary | 26.07 | 4 | 0.9 | 0.2 | 1.9 | 0.1 | Derived from GPS routes |
| Dog walking | low | Lympstone | 26.07 | 19 | 0.5 | 0.1 | 0.9 | 0 | Derived from face-face routes |
| Walking/cycling/dog walking | low | along shore, Powderham-Turf | 2.32 | | 0.4 | | | 0 | Route used a single line along top of sea wall |
| Walking/cycling/dog walking | intermediate | Topsham, goat walk | 4.68 | | 0.1 | | | 0 | Route used is the length of goat walk |
| Walking/cycling/dog walking | low | Topsham, goat walk | 2.32 | | 0.1 | | | 0 | Route used is the length of goat walk |
| Walking/cycling/dog walking | intermediate | Along shore, Powderham-Turf | 4.68 | | 0.1 | | | 0 | Route used a single line along top of sea wall |

## Distances displaced and time lost

5.45 The distance displaced was estimated where possible. It was not always possible to see where the birds landed as sometimes they would fly out of sight. In total there were 115 major flight observations where birds were the distance was estimated. Across all species and all 115 observations, the mean distance displaced was 117.3m (standard error = 12.6m) and the median distance 100m. Given that there were 180 different major flight events observed, it is possible to estimate the median distance for all events, if we assume that the 65 observations where no distance was recorded were all high values. After ranking all 115 observations we took the 90th observation (i.e. the mid-point if there had been 180 observations); this was 150m.

5.46 Distances (medians not adjusted for missing data) are summarised by species in Figure 20. Median distances were comparatively low for black-tailed godwit 32.5m, n=6) and were highest for wigeon (120m, n=4).

5.47 As with the distances displaced, the time taken for birds to return and resume feeding/roosting was difficult to estimate. In many cases the birds did not return and recognising individuals is of course impossible, so it was not always possible to ascertain when a particular group of individuals had returned. In fact for only 66 major flight observations was it possible to estimate the time and it ranged from 1 minute through to 15 minutes. Most observations (58) were of less than 2 minutes.

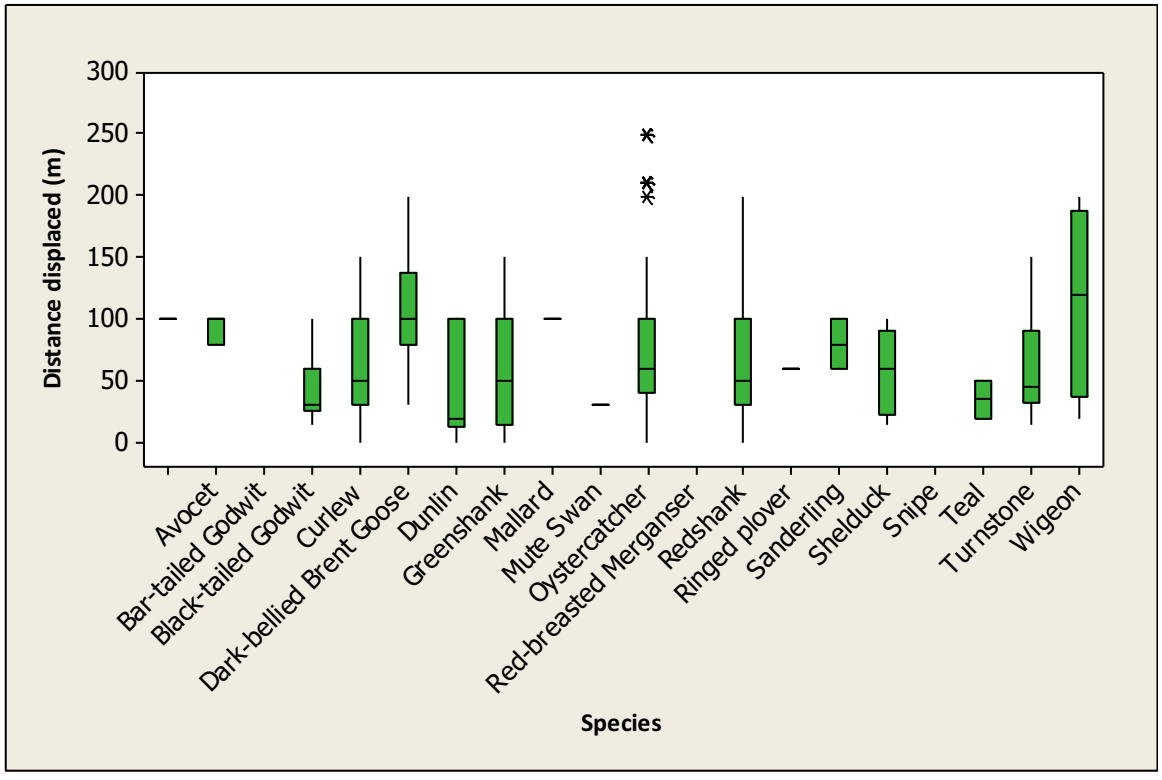


**Figure 20: Distance displaced, by species. Only major flight and short flight events included. Note that the y axis is truncated and not all outliers are shown.**

# 6. Effect of disturbance on the roost at Dawlish Warren

## Overview

Dawlish Warren is one of the key roost sites on the estuary. During the winter a warden is present to reduce disturbance to the birds, which can move between the northern-side of the spit, the tip and the southern side depending on the tide height, weather conditions and availability of roost sites. The warden is present when the tide is sufficient to push the birds close to the spit.

We briefly summarise data collected by the wardens and also during August 2010, when no warden was present. The data reveal that during the winter, when a warden is present the birds are still flushed occasionally, but at a very low rate compared to the August observations, when the birds were flushed around five times per hour. There is merit in considering extending wardening coverage through August.

## Data from August 2010

6.1 A total of 13hours and 40 minutes were spent observing roosting birds at Dawlish Warren on five different dates between 30th July and 30th August 2010. The visits were timed to coincide with times of day when people were expected to be present and also when the tide was high, such that roosting birds would be present.

6.2 A total of 66 different events were observed when the birds were flushed. This equates to a flush rate of 4.8 events per hour. In not all cases was it possible to attribute the flights to disturbance events. The data are summarised in Table 16. It can be seen that walkers were by far the most common cause of disturbance, however a range of other activities caused disturbance. These other activities included birdwatchers, joggers and golfers. The latter were observed on two occasions leaving the golf course to strike a ball that had ended up on the sand/intertidal areas.

**Table 16: Number of times birds were flushed at the Dawlish Warren roost; data from 13hours and 40minutes observation, predominantly in August 2010.**

| Activity/cause of disturbance | Number | Minimum Distance at which birds took flight | Maximum Distance at which birds took flight | Minimum time spent in flight | Maximum time spent in flight |
|---|---|---|---|---|---|
| Birdwatching | 3 | 20 | 30 | 5 | 45 |
| Fishing | 2 | 17 | 20 | 10 | 30 |
| Golfer | 2 | | | 15 | 85 |
| Jogging | 2 | 30 | 40 | 40 | 60 |
| Motor boat | 1 | 50 | 50 | 60 | 60 |
| Unknown | 7 | | | 25 | 90 |
| Walking | 49 | 15 | 50 | 5 | 240 |
| **Total** | **66** | | | | |

6.3 The time the birds spent in flight was recorded using a stopwatch. In not all cases was it possible to record the total time in flight, but from the data gathered (n=60), the time spent in flight ranged from 5 seconds to 240 seconds; in total birds spent 40 minutes in flight, roughly 5% of the total time when surveyors were present. Birds responded to people at a maximum of 50m.

## Data collected by wardens at Dawlish Warren

6.4 During the period September-March, a warden presence is maintained to minimise disturbance to the roosting waders. The wardens maintain a record of the number of disturbance events while they are on the site. The wardens are clearly visible and they actively stop people from causing disturbance and enforce the restrictions on dogs past the ninth groyne on the beach. The wardens are present for over 100 tides each year. Their data are summarised in Table 17. The totals from Table 16 are also included for comparison. While it is of course likely that the site is much busier in August, the number of times the birds were flushed in just 5 visits in August 2010 (when the roost is not wardened) is higher than over all the four winters (over 1000 hours of wardening presence).

**Table 17: Summary of data collected by wardening staff at Dawlish Warren for period Sept-March and for years from 2006, giving the number of disturbance events recorded while a warden was present. The totals are compared with the data from August 2010 (when not wardened) in the final column. Data provided by Teignbridge District Council staff.**

| Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 | Total | Aug 2010 |
|---|---|---|---|---|---|---|
| Number of tides | 112 | 118 | 114 | 111 | | 5 |
| Number of hours observation (rounded) | 307 | 250 | 286 | 310 | | 14 |
| Walker | 4 | 1 | 2 | 2 | 9 | 49 |
| Dog walker | | 2 | | 1 | 3 | 0 |
| Water based activity (boating) | 13 | 2 | 10 | 7 | 32 | 1 |
| Jogger | 1 | 2 | 1 | 1 | 5 | 2 |
| Fisherman | 3 | | | 1 | 4 | 2 |
| Natural | | 1 | 5 | | 6 | |
| Other | 3 | 1 | 1 | 5 | 10 | |
| Total | 24 | 9 | 19 | 17 | 59 | 66 |

## Implications

6.5 The survey work at Dawlish Warren was undertaken to compliment the other fieldwork that mainly focuses on foraging birds. Dawlish Warren is the main roost site on the estuary, and is particularly important for certain species such as oystercatcher. The results would tend to suggest that wardening is effective in reducing disturbance and also that, when no wardens are present, the roost is disturbed and birds repeatedly flushed. Additional wardening during the late summer period would therefore seem worthwhile.

6.6 Discerning whether the repeated flushing does have an impact on the ability of the estuary to support the key species is not straightforward. During the late summer/early autumn period birds have potentially recently finished breeding, completed a long migration and have undertaken or are undertaking moult. There are therefore

particular energetic consequences for the birds at this time of year. Also at this time of year the warm temperatures and potentially high levels of prey will mean that there is less stress for the birds. Modelling of winter survival of oystercatchers on the Exe (West et al. 2002) does indicate that it is the late winter period when birds are particularly stressed.

# 7. Conclusions and Context

7.1 A wide range of different activities occur around the Exe and overlap in time and space. Water based activities involve a wide range of craft, and include both commercial and recreational use. A range of shore-based activities also take place and people were also regularly recorded on the intertidal. We have summarised the distribution and compared the intensity of use for different activities. GPS tracks and count data provides additional resolution on how people behave and where they go. Taking an overview of access, the estuary is clearly very busy and it is only a small proportion of the perimeter of the estuary where access is limited or difficult. The highest levels of access occur around the lower stretches of the estuary, at Exmouth and also at the very top of the estuary, around Topsham.

7.2 There is evidence that bird distributions are related to access. In general terms the numbers of birds appear low at the Duck Pond and at Topsham in relation to adjacent count sectors. The parts of the estuary with the lowest levels of access (the Bight to the north of Dawlish Warren and at Powderham) are also the parts of the estuary with the highest bird counts.

7.3 At the Duck Pond, Lympstone, Starcross South and Powderham the number of birds present was correlated to the level of access during the previous 45 minutes.

7.4 Around 14% of groups/recreational events observed across the survey locations flushed birds and caused a major flight event (more than 50m). Just under two-thirds (62%) of events evoked no response at all from the birds.

7.5 Bait digging on the intertidal, dog walking with dogs off leads on the intertidal, walking on the shore and intertidal and kitesurfing are the activities which account for the majority of major flight events. It is dog walkers with their dogs off lead on the intertidal that caused the highest percentage of major flights from all the observed potential disturbance events.

7.6 After controlling for distance, tide and location, birds were more likely to take flight when the activity took place on the intertidal or on the water compared to the shore. The probability of major flight events was lower at Topsham and Powderham compared to other sites and the probability of a major flight event occurring was lower at low tide.

7.7 Based on the distance at which birds take flight and the actual patterns of use by different activities, a kitesurfer or windsurfer can result in around 8ha of intertidal habitat being ‘unavailable’ to the birds. By comparison a jet skier can result in around 3.5ha being lost and a dog walker on the mudflats at the Duck Pond around 3ha.

7.8 Specific watches at the roost at Dawlish Warren during August found that the roost was flushed around five times per hour.

### Comparison with other sites

7.9 Footprint Ecology has used a similar approach to the work on the Exe at a number of other European sites. In these other studies the survey area has involved a very large

area, encompassing multiple estuaries and hundreds of kilometres of shoreline. In these other studies we have therefore used more survey locations, and at each survey visit the period of observation used was longer. Some caution is required drawing direct comparisons, however if the number of people observed and the levels of disturbance are compared, it would appear that the Exe is busier that the other survey areas and there are a higher proportion of disturbance events per hour (Table 18).

**Table 18: Comparison of key values from the bird disturbance work on the Exe with other sites, where a similar method has been used. The North Kent work encompasses the Swale, Medway and the Outer Thames (Liley & Fearnley 2011) and Solent work includes the Solent, Southampton Water, the north shore of the Isle of Wight, Portsmouth, Langstone and Chichester Harbours (Liley, Stillman, & Fearnley 2010).**

| | N Kent | Solent | Exe |
|---|---|---|---|
| Survey Locations | 22 | 20 | 9 |
| Total number of survey visits across all locations | 257 | 240 | 220 |
| Survey period | 1.75hrs | 1.75hrs | 0.75hrs |
| Hours of survey | 449.75 | 420 | 165 |
| **Diary Events** | | | |
| Number | 1879 | 5405 | 2977 |
| Rate (number of events per hour) | 4.18 | 12.87 | 18.04 |
| **Species Specific Observations** | | | |
| Number | 3248 | 4064 | 1295 |
| Rate (observations per hour) | 7.22 | 9.68 | 7.85 |
| **Observations where no response from birds** | | | |
| n | 2415 | 3350 | 836 |
| % | 74 | 82 | 65 |
| **Major Flight** | | | |
| n | 410 | 341 | 180 |
| % | 13 | 8 | 14 |
| Rate (number of major flights per hour) | 0.91 | 0.81 | 1.09 |

## Our approach

7.10 Our approach has been to look closely at the recreational and other uses of the estuary and to also look at the behavioural responses of birds. By linking visitor data and access data we have expressed the effects of disturbance in terms of habitat loss; for a range of different activities we have calculated the area of intertidal habitat lost within the estuary from a typical visit or route on the estuary. The results clearly show that a range of activities result in areas of intertidal habitat being 'unavailable' to the birds.

7.11 Of course, as recreational use increases the area of habitat 'lost' will not necessarily increase in proportion. If birds are not using an area because it is disturbed it makes little difference if the level of recreational use increases, as birds will continue to avoid the area. As levels of access increase disturbance is minimised if access increases in already busy areas. It is likely however that recreational users will 'spread out' as access increases. We deliberately avoid making any conclusions of how the area of

'lost' habitat might change with different intensities of use, as it is difficult to predict how the distribution of access changes with different intensities of use.

7.12 We also avoid drawing conclusions on the effect of the 'lost' habitat. By reducing the area available for the birds to feed disturbance is likely to result in a reduction in the ability of the SPA to support the bird populations of interest. However intertidal habitat will vary in 'quality'. The distribution of birds within an estuary is likely to be governed by a range of factors, in particular the abundance and distribution of their food. Many studies illustrate that the distribution of birds is related to the distribution of prey (Sutherland 1983; Kennedy & Gray 1993; Farnsworth & Beecham 1997). In addition other factors such as the availability/accessibility of the prey (Stillman *et al.* 2000; Goss-Custard *et al.* 2002; Stillman *et al.* 2005; West *et al.* 2007), weather (Dugan 1982) or proximity to roost sites (Rehfisch, Insley, & Swann 2003) can be important. In order to understand the impact of disturbance on the distribution of birds it is therefore necessary to consider the disturbance in relation to the distribution of resources that are important to the birds (see for example Gill 1996; Gill, Sutherland, & Watkinson 1996). We recognise that the area of intertidal habitat 'lost' may be a relatively simple measure of resource use for the birds.

7.13 The behavioural response of birds is not necessarily a good indication of the impact of disturbance (Gill, Norris, & Sutherland 2001; Beale & Monaghan 2004). Birds are perhaps more likely to take flight when they have alternative sites at which to feed/roost or when there is little to lose from taking flight (e.g. if full and therefore not needing to feed intensively). Showing that birds are flushed is not necessarily indicative that there are impacts from disturbance. The interpretation of the results relating to the birds taking flight is therefore not straightforward. For example, the probability of major flight was higher at falling/rising/high tide. This could be because the birds have fed through the low tide period, are full, and can easily switch between roost sites. By contrast, when the tide is not high and the birds need to feed and they may be more reluctant to fly. An alternative explanation could be that major flight is simply more likely at high tide because the options for short flight or walking/swimming away are limited due to more habitat being covered by water.

7.14 To fully understand the consequences of disturbance at a population scale it is therefore necessary to consider the energetic consequences of disturbance in terms of lost feeding time, reduced intake rate etc. and therefore determine how disturbance at a given location will affect survival. Such modelling is beyond the scope of this report.

### The need for additional management or measures to reduce disturbance

7.15 The work presented in previous sections shows that disturbance is reducing the habitat available to the birds and that the numbers of birds in certain parts of the estuary are related to the levels of access. Disturbance is currently therefore influencing the distribution and behaviour of birds on the Exe. These impacts may be sufficiently widespread and frequent to result in the estuary being less able to support the designated bird populations, however this study is not able to go as far as considering the impacts of disturbance on survival or fitness.

7.16 The Exe is a particularly small estuary, meaning there is potentially relatively little space for people and birds. The estuary lacks the extensive and very wide areas of intertidal habitats of sites such as the Wash, Thames and Humber. Single disturbance events, such as the kitesurfers observed in March 2011 (see para 5.13) can affect virtually the entire estuary. As the maps with the access scores show, most of the estuary has access and there are few 'undisturbed' areas.

7.17 The UK population is increasing[11] and is set to reach 67 million by 2020 and new housing in settlements such as Exmouth, Exeter and other sites adjacent to the estuary will potentially result in more people living close to the estuary. Access levels to the UK countryside are also increasing (TNS Research International 2011) and changing. The provision of enhanced cycle access and the appearance of new types of watersports – such as kite surfing – have meant marked changes in access around the Exe Estuary in the past 10-15 years. Given the context of an increasing population living in the area and the clear draw of the Exe Estuary, it is important to maintain a strategic perspective in relation to management of access on the site. As access levels increase the estuary will become busier and busier and additional management of access is likely to become more and more important, not only to reduce disturbance, but also to ensure safe and enjoyable use for the different users and types of visitors. It is important that measures are appropriate to the scale of impact and issues of concern, and are implemented in advance of a problem occurring.

7.18 For those involved or responsible for ensuring the continued ecological viability of the interest features of the SPA, in accordance with Article 6(2) of the Habitats Directive (92/43/EEC), there are implications. Article 6(2) applies to SPA and SAC designations and requires: "*Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive*."

7.19 In order to consider future recreational pressure local planning authorities will need to consider the potential impacts of development in terms of the additional recreational pressure that an increase in population will bring. In accordance with Regulations 61 and 102 of the Conservation and Habitats Regulations 2010, any plan or project likely to have a significant effect upon a European site must be the subject of an assessment to determine the implications of that plan or project for the conservation objectives of the European site in question. There is a need to consider management of access and recreational use of the estuary.

[11] http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/stb-2010-based-npp-principal-and-key-variants.html

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**Appendix 1:** Field Codes used for categorising activities.

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

**Appendix 2:** Summary of Bird Count Data from Standard Watches. Table gives the mean (range) [number of counts in which species present], for all species and all locations. The total number of counts undertaken at each location are given in the first row.

| Species | Exmouth Channel | Exmouth Duck Pond | Exmouth Maer | Lympstone | Powderham | Starcross North | Starcross South | Topsham | Turf |
|---|---|---|---|---|---|---|---|---|---|
| Number of counts | 16 | 93 | 15 | 51 | 40 | 39 | 42 | 62 | 37 |
| Avocet | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 3.75 (0-119) [3] | 0.7 (0-20) [3] | 0 (0-0) [0] | 0.05 (0-1) [2] | 11.47 (0-123) [25] | 7.14 (0-102) [12] |
| Bar-tailed Godwit | 0 (0-0) [0] | 0.09 (0-3) [6] | 0 (0-0) [0] | 0.67 (0-16) [6] | 0.58 (0-8) [5] | 0.1 (0-2) [2] | 2.05 (0-30) [7] | 0 (0-0) [0] | 0.22 (0-4) [2] |
| Black-necked Grebe | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.05 (0-1) [2] | 0 (0-0) [0] | 0 (0-0) [0] |
| Black-tailed Godwit | 0 (0-0) [0] | 0.06 (0-3) [3] | 0 (0-0) [0] | 2.49 (0-32) [13] | 11.35 (0-85) [18] | 5.44 (0-22) [21] | 4.05 (0-56) [13] | 78.84 (0-360) [42] | 5.68 (0-50) [15] |
| Canada Goose | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.17 (0-7) [1] | 0 (0-0) [0] | 0 (0-0) [0] |
| Common Scoter | 2.44 (0-12) [5] | 0 (0-0) [0] | 1.33 (0-8) [3] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] |
| Curlew | 0 (0-0) [0] | 1.81 (0-34) [36] | 0 (0-0) [0] | 3.65 (0-35) [21] | 1.25 (0-20) [11] | 1.59 (0-7) [25] | 5.67 (0-69) [18] | 10.9 (0-160) [30] | 16.89 (0-120) [19] |
| Dark-bellied Brent Goose | 0 (0-0) [0] | 28.56 (0-509) [58] | 0.87 (0-13) [1] | 2.76 (0-80) [6] | 23.35 (0-300) [17] | 1.41 (0-26) [6] | 28.17 (0-225) [16] | 0 (0-0) [0] | 0.32 (0-7) [5] |
| Dunlin | 0 (0-0) [0] | 3.23 (0-110) [9] | 0 (0-0) [0] | 21.76 (0-500) [10] | 14.73 (0-440) [10] | 0.36 (0-10) [2] | 10.33 (0-200) [8] | 20.16 (0-300) [18] | 56.62 (0-340) [16] |
| Gadwall | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.05 (0-2) [1] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] |
| Goldeneye | 0 (0-0) [0] | 0.1 (0-5) [3] | 0 (0-0) [0] | 0.29 (0-8) [3] | 0 (0-0) [0] | 0 (0-0) [0] | 0.6 (0-4) [9] | 0 (0-0) [0] | 0 (0-0) [0] |
| Great Northern Diver | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.03 (0-1) [1] | 0.12 (0-3) [3] | 0 (0-0) [0] | 0 (0-0) [0] |
| Great-crested Grebe | 0 (0-0) [0] | 0 (0-0) [0] | 0.07 (0-1) [1] | 0.08 (0-4) [1] | 0.05 (0-1) [2] | 0 (0-0) [0] | 0 (0-0) [0] | 0.02 (0-1) [1] | 0 (0-0) [0] |
| Greenshank | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.12 (0-2) [4] | 0.05 (0-1) [2] | 1.26 (0-14) [15] | 0.19 (0-4) [5] | 0.06 (0-2) [2] | 0.11 (0-4) [1] |
| Grey Plover | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.06 (0-4) [1] | 0 (0-0) [0] |
| Knot | 0 (0-0) [0] | 0.01 (0-1) [1] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.12 (0-3) [2] | 0 (0-0) [0] | 0 (0-0) [0] |
| Little Grebe | 0 (0-0) [0] | 0.05 (0-3) [2] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.21 (0-4) [2] | 0.02 (0-1) [1] | 0 (0-0) [0] | 0 (0-0) [0] |
| Long-tailed Duck | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.05 (0-1) [2] | 0 (0-0) [0] | 0 (0-0) [0] |
| Mallard | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 4.69 (0-90) [8] | 0.6 (0-7) [6] | 0.1 (0-2) [2] | 0 (0-0) [0] | 1.5 (0-39) [12] | 0.38 (0-4) [5] |
| Mute Swan | 0 (0-0) [0] | 0.83 (0-27) [3] | 0 (0-0) [0] | 0.55 (0-13) [5] | 0 (0-0) [0] | 0 (0-0) [0] | 5.33 (0-33) [17] | 0.95 (0-24) [5] | 0.08 (0-3) [1] |
| Oystercatcher | 1.5 (0-10) [4] | 68.89 (0-400) [67] | 3.07 (0-15) [7] | 36.29 (0-198) [35] | 8.38 (0-80) [13] | 5.9 (0-26) [27] | 22.71 (0-158) [24] | 0.21 (0-6) [4] | 0.84 (0-10) [6] |
| Pintail | 0 (0-0) [0] | 0.31 (0-22) [2] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] |
| Red-breasted Merganser | 0.13 (0-2) [1] | 0.53 (0-12) [8] | 0 (0-0) [0] | 0.98 (0-28) [4] | 0.3 (0-7) [4] | 0.59 (0-8) [6] | 5.1 (0-35) [16] | 0.11 (0-3) [3] | 0.16 (0-3) [3] |
| Redshank | 0 (0-0) [0] | 1.19 (0-11) [27] | 0 (0-0) [0] | 3.76 (0-55) [17] | 0.63 (0-5) [8] | 2.21 (0-14) [20] | 6.67 (0-152) [13] | 2.16 (0-30) [21] | 2.97 (0-34) [15] |
| Ringed Plover | 0 (0-0) [0] | 1.31 (0-36) [8] | 0 (0-0) [0] | 0.16 (0-4) [2] | 1.83 (0-25) [6] | 0.56 (0-14) [2] | 0 (0-0) [0] | 0.32 (0-20) [1] | 0.35 (0-13) [1] |
| Sanderling | 0 (0-0) [0] | 0.01 (0-1) [1] | 0 (0-0) [0] | 0 (0-0) [0] | 0.05 (0-2) [1] | 0 (0-0) [0] | 0.38 (0-8) [2] | 0 (0-0) [0] | 0 (0-0) [0] |
| Shelduck | 0 (0-0) [0] | 2.1 (0-33) [11] | 0 (0-0) [0] | 1.12 (0-16) [8] | 0.43 (0-5) [5] | 0 (0-0) [0] | 1.38 (0-16) [6] | 3.13 (0-40) [11] | 18.43 (0-98) [13] |
| Slavonian Grebe | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.62 (0-3) [24] | 0 (0-0) [0] | 0.08 (0-1) [3] |
| Spotted Redshank | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.03 (0-1) [2] | 0 (0-0) [0] |
| Teal | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.44 (0-8) [6] | 0 (0-0) [0] |
| Turnstone | 0 (0-0) [0] | 0.22 (0-7) [7] | 0 (0-0) [0] | 3.51 (0-45) [7] | 0 (0-0) [0] | 3.79 (0-42) [20] | 0.07 (0-1) [3] | 0.18 (0-4) [4] | 0 (0-0) [0] |

| Species | Exmouth Channel | Exmouth Duck Pond | Exmouth Maer | Lympstone | Powderham | Starcross North | Starcross South | Topsham | Turf |
|---|---|---|---|---|---|---|---|---|---|
| Whimbrel | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.18 (0-3) [6] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0 (0-0) [0] | 0.11 (0-2) [2] |
| Wigeon | 0 (0-0) [0] | 13.75 (0-500) [6] | 0 (0-0) [0] | 0.08 (0-4) [1] | 4.83 (0-110) [3] | 0.08 (0-3) [1] | 4.76 (0-200) [1] | 0 (0-0) [0] | 0 (0-0) [0] |