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Marine Institute Bird Studies

Dungarvan Harbour SPA: Monitoring of waterbird distribution across the tidal cycle.

2017-2018

Lead Agency: Marine Institute

Authors: ATKINS:

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An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

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Foras na Mara
Marine Institute

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Dungarvan Harbour SPA: Monitoring of waterbird distribution across the tidal cycle, 2017/18

August 2018

Notice

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1. Introduction

Brief

1.1 Atkins (Ecology) was commissioned by the Marine Institute to carry out tidal cycle monitoring of waterbird numbers and distribution at Dungarvan Harbour, Co. Waterford.

1.2 The brief for this work was as follows:

1. This programme will focus on systematic monitoring of bird distribution on Whitehouse Bank (Dungarvan Harbour), specifically in response to a management action to create a single 400m buffer zone among oyster trestle culture sites which was created as a consequence of mitigation recommendations following appropriate assessment of aquaculture in Dungarvan Harbour, Co. Waterford. The programme requires contractors to conduct a series of tidal cycle monitoring focusing specifically on Grey Plover and Dunlin use of the tidal break/corridor. Incidental use of the 'break/corridor' by other bird species should also be documented. The monitoring regime should target two monitoring days per month, during neap and spring low tide. Each monitoring event should cover the full duration of exposure of Whitehouse Bank.

2. Monitoring to include the period September 2017 to March 2018, inclusive.

3. Prepare a report identifying site-use by the aforementioned species providing a commentary on the effectiveness of the management measure specifically as it relates to species distribution at the site.

1.3 Due to the seasonal and diurnal pattern of the tidal cycle, and weather constraints, there were limitations to the range of tidal variation that could be covered in this survey.

Context

1.4 This study builds on the monitoring work carried out as part of the oyster trestle study (Gittings and O'Donoghue, 2012) in 2011, the assessment, based on that work, carried out for the Dungarvan Harbour SPA Appropriate Assessment (Gittings and O'Donoghue, 2014) and subsequent monitoring of the distribution of selected waterbird species across the tidal cycle in the winters of 2014/15 (Gittings and O'Donoghue, 2015) and 2016/17 (Gittings and O'Donoghue, 2018).

1.5 The Appropriate Assessment found that intertidal oyster cultivation is potentially having significant negative displacement impacts on four of the Special Conservation Interests (SCIs) of the Dungarvan Harbour SPA: namely, Grey Plover (*Pluvialis squatarola*)[1], Knot (*Calidris canutus)*, Dunlin (*Calidris alpina*) and Bar-tailed Godwit (*Limosa lapponica*). These species are referred to, hereafter as the target species. In the case of Grey Plover, Knot and Dunlin, the main displacement impact appeared to be exclusion of most, or all, birds from Whitehouse Bank during the low tide period when the tideline is within the zone occupied by the oyster trestles; the evidence for this was the occurrence of large flocks of these species in the upper shore zone of Whitehouse Bank on the rising/falling tide, before/after the tideline reached the trestles. In the case of Bar-tailed Godwit, the density of birds on Whitehouse Bank is much lower than the density on the Ballyrandle Sandflats, despite the two areas being broadly similar intertidal biotopes (however, there is some evidence that there may be differences in food resources between the two areas).

[1] Referred to by the common name Black-bellied Plover in North American literature.

1.6 The monitoring study carried out in 2014/15 (Gittings and O'Donoghue, 2015) found evidence that indicated that the timing of movements of the target species was related to the exposure of mudflats in the Inner Harbour, rather than the tideline reaching the trestles on Whitehouse Bank. However, the study also found evidence of a marked decrease in the utilisation of Whitehouse Bank by Grey Plover at low tide over recent winters and this may have been linked to changes in the configuration of the trestles that eliminated the trestle-free corridors that had been present on Whitehouse Bank. Arising from the results of this study, a reorganisation of aquaculture licences was carried out, as part of the process of approving licence renewals and new applications. This reorganisation was designed to create a trestle-free corridor (the *Bird Corridor*) approximately 400 m wide in a section of Whitehouse Bank where Grey Plover had been recorded at low tide in the 2011 trestle study.

1.7 The monitoring study carried out in 2016/17 (Gittings and O'Donoghue, 2018) included ten tidal cycle counts between October 2016 and February 2018, which used the same methodology as the 2014/15 monitoring. In addition, the Bird Corridor was continuously monitored throughout the low tide period on four days in March 2017 to provide more detailed data on bird usage of the Bird Corridor, and disturbance impacts from husbandry activities, throughout the low tide period (Bird Corridor monitoring). The target species showed similar broad patterns of tidal cycle movements, low tide distribution and association with oyster trestles to those recorded in previous winters. However, in contrast to previous winters, Dunlin distribution in the Outer Sandflats zone appeared to show a neutral/positive association with oyster trestles. The target species occurred infrequently and in low numbers in the Bird Corridor during the tidal cycle low tide counts. However, this may have been due to disturbance from tractor movements and husbandry activities. On three of the four Bird Corridor monitoring count days, significant numbers of one or more of three of the target species (Grey Plover, Knot and Dunlin) were recorded in the Bird Corridor during the low tide period. Patterns of tractor activity in relation to waterbird numbers, and direct observations of disturbance incidents, indicated that tractor movements and husbandry activities were limiting the usage of the Bird Corridor, and may also be having larger-scale effects on waterbird utilisation of Whitehouse Bank at low tide.

1.8 Building on the results of the previous monitoring work, the 2017/18 monitoring included three components. The tidal cycle counts were continued to provide comparable data to previous winters, but with reduced intensity (six counts compared to ten in 2016/17). Greater emphasis was placed on the Bird Corridor monitoring, with counts completed on fifteen dates, as the results from 2016/17 indicated that this monitoring was more informative than the tidal cycle counts about waterbird utilisation of the Bird Corridor. In addition, flock distribution of the target species in the Inner Harbour was monitored on two dates (Inner Harbour monitoring) to provide information about the spatial requirements of these species.

1.9 As in previous winters, data was also collected on an additional four species: Light-bellied Brent Goose (*Branta bernicla hrota*), Ringed Plover (*Charadrius hiaticula*), Golden Plover (*Pluvialis apricaria*) and Sanderling (*Calidris alba*). These species are referred to as the additional monitored species. Light-bellied Brent Goose is a SCI of the Dungarvan Harbour SPA, and while it appears to have a neutral/positive association with oyster trestles at Dungarvan Harbour, it can show an apparent negative association with oyster trestles at other sites (Gittings and O'Donoghue, 2012). Golden Plover is a SCI of the Dungarvan Harbour SPA, and there is some indication of potential displacement impacts from oyster trestles on its population in Dungarvan Harbour. Ringed Plover and Sanderling are not SCIs of the Dungarvan Harbour SPA, but occur in numbers close to national importance levels, and are species that appear to show a strong negative response to oyster trestles. Data was collected on these two species to inform potential future requirements for Environmental Impact Assessment (EIA) of any new applications for intertidal oyster licensing in Dungarvan Harbour (as EIA requirements are not restricted to SCI species). In addition, this data can be used to inform future appropriate assessments of other coastal SPAs where these species are SCIs.

1.10 The data collected on the additional monitored species is included in Appendix A of this report, but is not analysed or discussed here.

Limitations

1.11 The decisions of waders to utilise areas for feeding, and the timings of movements between areas, will usually be based on the availability of suitable food resources and the density of potential competitors. Therefore, detailed information on benthic invertebrates would be required to fully analyse wader distribution patterns, and the potential displacement impacts of intertidal oyster cultivation, in Dungarvan Harbour.

1.12 The configuration of the oyster trestle blocks on Whitehouse Bank is subject to ongoing change. The accuracy of mapping available to the contract also impacts on the accuracy of the recording of the tideline position at low tide on Whitehouse Bank.

Personnel

1.13 The survey design, analysis and report writing was carried out by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. The fieldwork was carried out by Tom Gittings, Lesley Lewis, John Meade and Pat Smiddy. Data entry was carried out by Siobhán Gallagher.

2. Methods

Study area and count sectors

2.1 Dungarvan Harbour was divided into three broad zones by Gittings and O'Donoghue (2014a) for the purposes of broad-scale analyses of waterbird distribution: the Inner Harbour, the Outer Sandflats and the Outer Bay (Figure 2.1). The Outer Sandflats were also divided into two sub-zones: the Ballyrandle Sandflats and Whitehouse Bank. For the present monitoring work, the Inner Harbour zone was divided into two sub-zones: the Inner Harbour (main) and the Inner Harbour (upper). This division reflects the distribution patterns of the target species, which rarely occur in the Inner Harbour (upper).

2.2 The Bird Corridor is a 400 m wide corridor extending from the upper to the lower edges of the oyster trestle zone in the northern part of sector OY2 (Figure 2.2).

2.3 The study area for the tidal cycle counts was: Whitehouse Bank and the eastern section of the Inner Harbour (main) for the ebb and flood tide counts; and the Outer Sandflats and the Inner Harbour for the low tide counts. The Bird Corridor monitoring was carried out within Whitehouse Bank and covered the Bird Corridor, as well as sectors CS1 and CS2 on the ebb and flood tide. The Inner Harbour monitoring covered most of the Inner Harbour (main) (Figure 2.3).

2.4 The count sectors used in this study are shown in Figure 2.1. In the Ballyrandle Sandflats and Whitehouse Bank, the counts used the sectors defined for the trestle study (Gittings and O'Donoghue, 2012). However, sector OY2 was subdivided between the Bird Corridor and the remaining area of the sector. In the Inner Harbour, the counts used the NPWS Waterbird Survey Programme subsites.

2.5 The oyster trestles occur within the lower part of Whitehouse Bank (sectors OY1-OY4; Figure 2.1). The most recent mapping available of the trestles across the whole of Whitehouse Bank is from the summer of 2014, which was provided by the Department of Agriculture, Fisheries and the Marine. However, the trestles in, and around, the Bird Corridor were mapped by GPS by Tom Gittings in October 2017.

Survey design

Tidal cycle counts

2.6 The survey included three components:

- Ebb tide counts: a series of four counts at 30 minute intervals across the ebb tide period, focussing on Whitehouse Bank and the adjacent area of the Inner Harbour (main).
- Low tide count: a single low tide count covering the Inner Harbour, Ballyrandle Sandflats and Whitehouse Bank.
- Flood tide counts: a series of four counts at 30 minute intervals across the flood tide period, focussing on Whitehouse Bank and the adjacent area of the Inner Harbour (main).

2.7 On the ebb and flood tide counts, the objective was to achieve complete coverage of Whitehouse Bank. The counts of the adjacent area of the Inner Harbour (main) covered (approximately) the sections of 0M419 and 427 to the east of the main tidal channel. However, the objective of these

latter counts was to record positions that birds moving to/from Whitehouse Bank came from, or moved to, and the counts were not intended to provide accurate data on the bird numbers in the Inner Harbour (main).

2.8 The count periods are shown in Table 2.1. The ebb and flood tide counts covered the periods when the tideline was above the trestle zone but below the top of the beach. The low tide count covered the main period when the tideline was within, or below, the trestle zone. The 30 minute gaps between the end of the ebb counts and start of the low tide count, and between the end of the low tide count and the start of the flood tide counts, allowed time for the counters covering the Inner Harbour and Ballyrandle Sandflats to travel between these areas and Whitehouse Bank.

2.9 Note that the numbering of the ebb tide counts in this report follows that used for the 2016/17 survey (Gittings and O'Donoghue, 2018), which differs from that used for the 2014/15 survey (Gittings and O'Donoghue, 2015). The counts numbered EBB0-EBB3 in Gittings and O'Donoghue (2015) are now numbered EBB1-EBB4. The count numbered EBB4 in Gittings and O'Donoghue (2015) corresponds to the 30 minute interval between the count numbered EBB4 in this report and the start of the low tide period.

Table 2.1 - Count periods used for the tidal cycle counts.

Period	Count	Start time	Finish time
Ebb tide	EBB1	-04:00	-03:30
	EBB2	-03:30	-03:00
	EBB3	-03:00	-02:30
	EBB4	-02:30	-02:00
Low tide	LT	-01:30	+01:30
Flood tide	FLOOD1	+02:00	+02:30
	FLOOD2	+02:30	+03:00
	FLOOD3	+03:00	+03:30
	FLOOD4	+03:30	+04:00

All times are relative to low tide.

Bird corridor monitoring

2.10 The main objective of the Bird Corridor monitoring was to continuously monitor the Bird Corridor throughout its period of tidal exposure. In addition, monitoring of the adjacent areas of the upper shore was carried out on the ebb and flood tides to help understand movement patterns of birds onto/off the Bird Corridor.

2.11 Counts were generally carried out at 30 minute intervals from four hours before low tide to four hours after low tide (Table 2.2), apart from on three dates, when the EBB1-EBB4, or FLOOD1-FLOOD4 counts were not carried out.

2.12 During the period when the Bird Corridor was exposed (usually EBB5-FLOOD0 counts), all waterbirds within the Bird Corridor were counted. The ebb and flood tide counts outside that period only covered the target species and the additional monitored species within sectors CS1 and CS2 (and OY1-OY3 for Light-bellied Brent Goose).

Table 2.2 - Count periods used for the Bird Corridor monitoring.

Period	Count	Start time	Finish time
Ebb tide	EBB1	-04:00	-03:30
	EBB2	-03:30	-03:00
	EBB3	-03:00	-02:30
	EBB4	-02:30	-02:00
	EBB5	-02:00	-01:30
Low tide	LT1	-01:30	-01:00
	LT2	-01:00	-00:30
	LT3	-00:30	00:00
	LT4	00:00	+00:30
	LT5	+00:30	+01:00
	LT6	+01:00	+01:30
Flood tide	FLOOD0	+01:30	+02:00
	FLOOD1	+02:00	+02:30
	FLOOD2	+02:30	+03:00
	FLOOD3	+03:00	+03:30
	FLOOD4	+03:30	+04:00

All times are relative to low tide.

Inner Harbour monitoring

2.13 The objective of the Inner Harbour monitoring was to map the distribution and movements of Grey Plover, Knot and Dunlin flocks within the survey area at low tide. Bar-tailed Godwit was not included because it is generally absent, or only present in very low numbers, in the Inner Harbour at low tide.

2.14 The monitoring started on the EBB1 or EBB2 tides as intertidal habitat became exposed in the Inner Harbour (main). On 20th February, it continued until the end of the low tide period, at which point all the Grey Plover, Knot and Dunlin had left the Inner Harbour (main). On 6th March, it continued until the FLOOD3 period, at which point the intertidal habitat was fully covered.

2.15 The count periods used for the Inner Harbour monitoring were the same as those used for the Bird Corridor monitoring. The position of all Grey Plover, Knot and Dunlin flocks within the survey area was mapped at the start of each count period and any significant movements of the flocks observed within the count period were also mapped.

Count dates and timings

2.16 The tidal cycle counts were carried out on six dates between October 2017 and February 2018 (Table 2.3). The selection of count dates to allow full tidal cycle counts was constrained by the need to have a low tide in the middle of the day. In midwinter, with the short day length, this meant that there were only a few suitable dates each month. As the timing of the low tide is broadly linked to the spring-neap cycle, this further constrained the range of tidal conditions that could be sampled. The counts were carried out on days with low tides of 0.2-0.7 m (Table 2.3), representing spring-mean low tides (mean low water spring = 0.4 m; mean low tide = 0.75 m).

Table 2.3 - Count dates and timings for the tidal cycle counts.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
06/10/2017	12:49	0.4 m	08:50-10:50	11:20-14:20	14:50-16:50
07/11/2017	13:42	0.4 m	09:40-11:40	12:10-14:44	15:40-17:20
05/12/2017	12:46	0.3 m	08:45-10:45	11:15-13:30	14:45-16:45
19/01/2018	13:05	0.7 m	09:05-11:05	11:35-14:15	15:05-17:05
02/02/2018	13:11	0.2 m	09:10-11:10	11:30-14:30	15:10-17:10
19/02/2018	13:56	0.6 m	09:55-11:55	12:25-14:59	15:55-17:55

Low tide data source: Admiralty tidal predictions for Dungarvan (www.ukho.gov.uk/easytide).

2.17 The Bird Corridor monitoring counts were carried out on fifteen dates between September 2017 and March 2018 days with low tides of 0.3-1.0 m (Table 2.4).

Table 2.4 - Count dates and timings for the Bird Corridor counts.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
07/09/2017	13:14	0.4 m	09:30-11:45	11:45-14:45	14:45-16:55
21/09/2017	13:24	0.3 m	09:30-11:55	11:55-14:55	14:55-17:05
09/10/2017	14:54	0.4 m	11:05-13:20	13:20-16:20	16:20-18:30
23/10/2017	14:33	0.7 m	10:42-12:30	12:30-16:00	16:00-18:10
06/11/2017	12:55	0.4 m	09:02-11:25	11:25-14:22	14:25-16:30
23/11/2017	14:17	1.0 m	10:23-12:45	12:45-15:45	15:45-16:30
04/12/2017	11:59	0.4 m	08:20-10:30	10:30-13:30	13:30-16:00
08/12/2017	15:18	0.6 m	11:20-13:45	13:45-16:45	no counts
19/12/2017	12:16	0.8 m	08:25-10:45	10:45-13:45	13:45-16:00
18/01/2018	12:32	0.7 m	08:40-11:00	11:00-14:00	14:00-16:30
03/02/2018	13:56	0.3 m	10:14-12:30	12:30-15:30	15:30-16:00
16/02/2018	12:13	0.6 m	08:50-10:45	10:45-13:45	13:45-15:25
05/03/2018	14:13	0.3 m	10:25-12:45	12:45-15:45	15:45-17:30
15/03/2018	10:40	0.6 m	08:40-09:10	09:10-12:10	12:10-14:03
20/03/2018	13:32	0.4 m	09:30-11:09	12:00-15:00	15:00-17:35

Low tide data source: Admiralty tidal predictions for Dungarvan (www.ukho.gov.uk/easytide).

EBB1 count not carried out on 16/02/2018 and EBB1-EBB4 counts not carried out on 15/03/2018. Counts only continued until the FLOOD1 count period on 23/11/2017, until the FLOOD0 period on 03/02/2018 and until the FLOOD3 period on 16/02/2018, 05/03/2018 and 15/03/2018.

2.18 The Inner Harbour monitoring was carried out on two dates in February and March 2018 (Table 2.5).

Table 2.5 - Count dates and timings for the Inner Harbour monitoring.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
20/02/2018	14:34	0.7 m	10:25-12:55	12:55-15:55	no counts
06/03/2018	14:52	0.5 m	11:20-12:50	13:20-16:20	16:20-18:20

Low tide data source: Admiralty tidal predictions for Dungarvan (www.ukho.gov.uk/easytide).

EBB5 count not carried out on 20/02/2018. EBB1 and FLOOD4 counts not carried out on 06/03/2018.

Counter organisation

2.19 All the tidal cycle counts were carried out with three counters. The areas covered by each counter on each count are shown in Table 2.6. All the Bird Corridor monitoring counts were carried out by a single counter (Tom Gittings).

Table 2.6 – Coverage of the tidal cycle counts.

Period	Counter	Coverage
Ebb and flood tide	Lesley Lewis	Whitehouse Bank (CS1)
	Tom Gittings	Whitehouse Bank (CS3) and eastern side of Inner Harbour (main)
	Pat Smiddy	Whitehouse Bank (CS2) and eastern side of Inner Harbour (main)
Low tide	Lesley Lewis	Ballyrandle Sandflats and sectors 0M423-424 in Inner Harbour (upper)
	Tom Gittings	Whitehouse Bank
	Pat Smiddy	Inner Harbour (main) and sectors 0M412-414 in Inner Harbour (upper)

John Meade counted the sections normally covered by Pat Smiddy on 06/10/2017 and the sections normally covered by Lesley Lewis on 02/02/2018.

Count methodology

2.20 The tidal cycle counts were mainly carried out from shoreline vantage points, apart from the low tide count on Whitehouse Bank. In the latter case, the trestle blocks obscured the detection of birds from shoreline vantage points. Instead, these counts were carried out by walking a transect roughly parallel to, and a few 100 m above, the tideline, and carefully scanning along each row of trestles. As most birds occur on, or close to the tideline, and the birds are habituated to the presence of humans through husbandry activity, it was possible to carry out counts in this way without causing significant disturbance.

2.21 The Bird Corridor counts were mainly carried out from shoreline vantage points. The counts of the Bird Corridor during its period of exposure (EBB5-FLOOD0 counts) were usually carried out from the Whitehouse Bank car park (Figure 2.2), which provides a viewline approximately down the middle of the Bird Corridor. However, during the counts in March, large accumulations of seaweed on the sandflats within the Bird Corridor made detection of birds difficult at low tide from the Whitehouse Bank car park, so the counts during the middle of the low tide period were carried out from a vantage point just above the top of the Bird Corridor. On the EBB1-EBB4 and FLOOD1-FLOOD4 counts, the counts were carried out from the shoreline to the east of the car park at a position that provided views of the upper shore on both sides of the Bird Corridor (Figure 2.2).

2.22 The Inner Harbour monitoring was carried out from shoreline vantage points on the Cunnigar. Low tide monitoring was carried out from the highest point of the dunes, which provided an elevated position from which waterbird distribution within most of count sectors 0M419, 0M427 and 0M428 could be mapped. On the ebb/flood tides, monitoring was carried out from vantage points along the northern section of the Cunnigar as the birds moved out of/into the intertidal habitat adjacent to this area.

2.23 On each tidal cycle count, all the target species, and additional monitored species, present were counted. Birds were counted separately in each count sector and in the two sub-divisions of sector OY2. In addition, on the low tide count, all waterbird species in the Bird Corridor were counted.

2.24 During the Bird Corridor monitoring counts, all waterbird species in the Bird Corridor were counted on counts when the Bird Corridor was exposed (EBB5-FLOOD0 counts). The counts took place at the start of each count period and normally took 5-10 minutes to complete. For the remainder of each count period, the Bird Corridor was monitored and any arrivals or departures of the target and additional monitored species (excluding Light-bellied Brent Goose) were recorded. The EBB1-EBB4 and FLOOD1-FLOOD4 counts covered the target and additional monitored species within sectors CS1 and CS2 (and OY1-OY3 for Light-bellied Brent Goose). Some of the counts for CS2 were of low accuracy due to the distances involved.

2.25 During the tidal cycle and Bird Corridor monitoring counts counters also recorded the behaviour of the birds (feeding or roosting/other), whether birds were in subtidal habitat, on the tideline, or in intertidal habitat away from the tideline, and whether birds were within, or outside, trestle blocks. The counters also mapped the main flock locations during each count, and recorded details of any observations of bird movements between sectors.

2.26 During the Inner Harbour monitoring, the distribution and movements of flocks of Grey Plover, Knot and Dunlin within count sectors 0M419, 0M427 and 0M428 was mapped and the numbers of birds within each flock was counted, and their behaviour was categorised as feeding or roosting/other. The configuration of the tidal channels and the shoreline and bearing lines to various landmarks were used to help map the flock positions.

2.27 The counters mapped the tideline positions during each ebb/flood tide count, and (on Whitehouse Bank) during the low tide counts. On the ebb/flood tide counts the red buoys on Whitehouse Bank were used to guide the mapping of the tideline positions. On the low tide counts, the percentage of the tideline within the trestle blocks in each count sector was estimated (by recording the distances of trestle blocks and/or trestle-free areas along the transect route).

2.28 On each count day, the number of tractors in each count sector on Whitehouse Bank was counted at 30 minute intervals centred on low tide throughout their period of occurrence. The tractors were classified as working (parked or active within the trestles), travelling (moving between trestle blocks), arriving (arriving on the beach), or leaving (leaving the beach). During the Bird Corridor monitoring counts, the tractor counts only covered part of sector OY2 and did not cover sector OY1, due to the position of the vantage point used during the low tide period. Also, during these counts, the number of tractors within 250 m of either side of the Bird Corridor was also counted. These latter counts did not include tractors that had been parked within these zones but had no associated husbandry activity.

2.29 The counters also recorded the nature and location of any human activity within the intertidal zone, and recorded the weather conditions during the counts.

2.30 Detailed recording instructions were provided to the counters and the count data was recorded on standard recording forms and maps.

Data processing

2.31 All count data was entered into Excel spreadsheets and the Whitehouse Bank tideline positions were digitised in QuantumGis shapefiles. In line with internal quality assurance, we double-checked the spreadsheet and shapefile data against the original count forms to pick up any errors in data entry.

2.32 The notes on bird movements, and the timings of counts, were reviewed to identify potential double-counts. Where double-counts were identified, these were excluded from calculations of count totals.

Data analysis

2.33 The patterns of husbandry activity on Whitehouse Bank were assessed by calculating tractor minutes, where each tractor on each tractor count represent 15 tractor minutes (tractors arriving or leaving), or 30 tractor minutes (tractors travelling or working)

2.34 The patterns of bird numbers on Whitehouse Bank, and bird movements onto/off Whitehouse Bank, during the ebb and flood tide periods was compared to the movement of the tideline on Whitehouse Bank, and in the adjacent section of the Inner Harbour, to identify whether birds occurrence on Whitehouse Bank was related to either the tideline reaching the trestle zone, or the exposure of intertidal habitat in the Inner Harbour.

2.35 The distribution of birds at low tide in relation to the presence of oyster trestles was analysed by comparing the observed numbers within oyster trestle blocks with the numbers that would be predicted if the birds were distributed evenly throughout suitable habitat, and were not affected by the presence of oyster trestles. These analyses were restricted to Bar-tailed Godwit, as Dunlin distribution patterns in 2017/18 violated the assumptions required for this analysis, and Grey Plover and Knot never occurred within the trestle blocks during the tidal cycle counts.

2.36 These analyses were based on the methodology used in the trestle study (Gittings and O'Donoghue, 2012). However, because up to date mapping of the trestle configuration on Whitehouse Bank was not available, the methodology was modified to use data on the proportion of tideline within oyster trestles only. In the Outer Sandflats zone, Bar-tailed Godwit mainly occurred on, or close to the tideline: on the six tidal cycle counts, 92-100% (mean 98%) of the Bar-tailed Godwits were on the tideline. Therefore, we considered that the tideline length provided a reasonable representation of the availability of suitable habitat, and calculated the expected number of birds in areas of oyster trestles using the following formula:

Expected number = total number * proportion of tideline within oyster trestles

2.37 We only included counts with totals of ten or more birds in these analyses. We carried out two analyses: one using all the relevant sectors within the Outer Sandflats zone (all sectors analysis) and the other using only the relevant sectors on Whitehouse Bank (close sectors analysis). The relevant sectors were CN1-CN5 in Ballyrandle Sandflats, and OY1-OY4 on Whitehouse Bank. CN6 in Ballyrandle Sandflats was excluded as this sector is largely occupied by mixed sediment habitat (and was not included in the trestle study). CS1-CS4 on Whitehouse Bank were excluded because these sectors are usually not used by Bar-tailed Godwit at low tide: CS1-CS3 are upper shore areas which are largely empty of birds at low tide, while CS4 is an area of sandflat adjacent to the main tidal channel which is little used by waterbirds.

2.38 The tideline lengths within, and outside, the trestle blocks in the relevant areas on Whitehouse Bank were calculated from the tidelines mapped during the low tide counts and the estimated proportions of the tidelines that were within the trestle blocks. In calculations of tideline length we also excluded the narrow sandbanks that are exposed below the main tideline in sector OY1: these sandbanks have steeply shelving shorelines, and, therefore, do not provide much tideline habitat.

2.39 The tideline lengths within the relevant areas on Ballyrandle Sandflats were derived from the mapping of tidelines carried out for the AA report (see Appendix D in Gittings and O'Donoghue, 2014). This mapping provides tideline alignments and lengths for representative low tides from extreme neap to spring tide conditions. For each count day, we selected the tideline length for the appropriate tidal condition.

2.40 We then compared the observed number with the expected number. We used scatter graphs to assess the relationship between observed and expected numbers.

2.41 We also used an adapted version of Jacobs Index (Jacobs, 1974) to compare the predicted and observed occurrence of birds within trestle blocks on each count. The index is defined as:

$$D = r - p / (r + p - 2rp)$$

2.42 D can vary from -1 (indicating complete avoidance) to +1 (strong preference). We defined r as the proportion of the total count recorded within the trestle blocks and p as the predicted number within the trestle blocks divided by the total count. We calculated index values for each count with predicted numbers of ten or more. To examine the overall pattern of association we calculated the mean index value across all counts (with expected numbers < 10) in each dataset (all sectors and close controls in the extensive study and the intensive study). We examined the correlations between index values and total numbers in case the pattern of association was affected by the numbers present

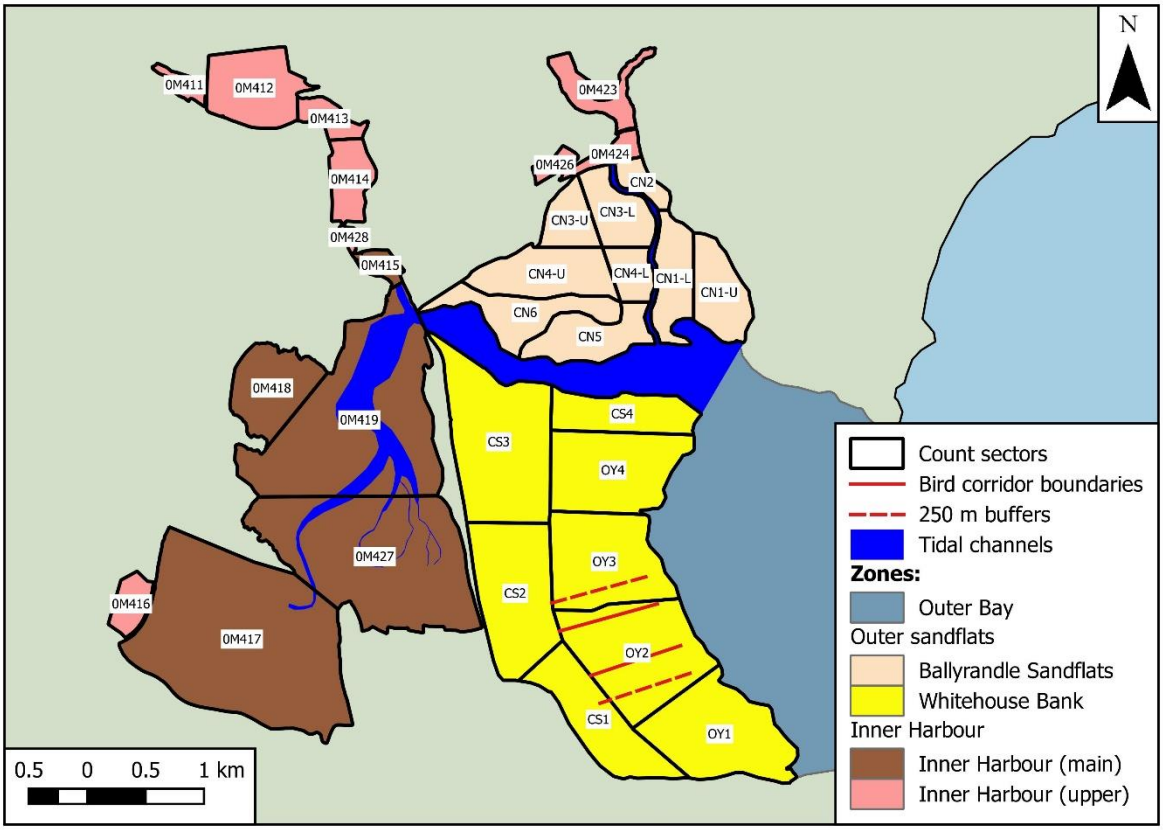


Figure 2.1 – Zones and count sectors.

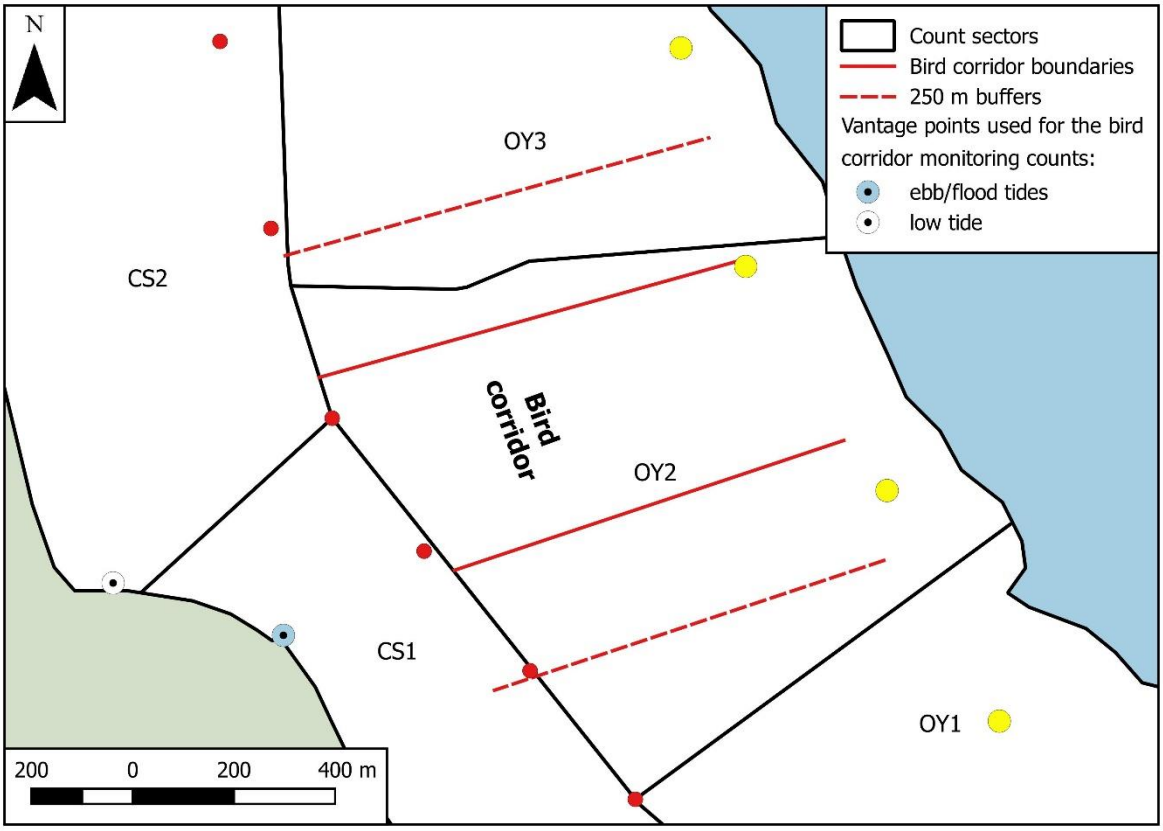


Figure 2.2 – Bird corridor.

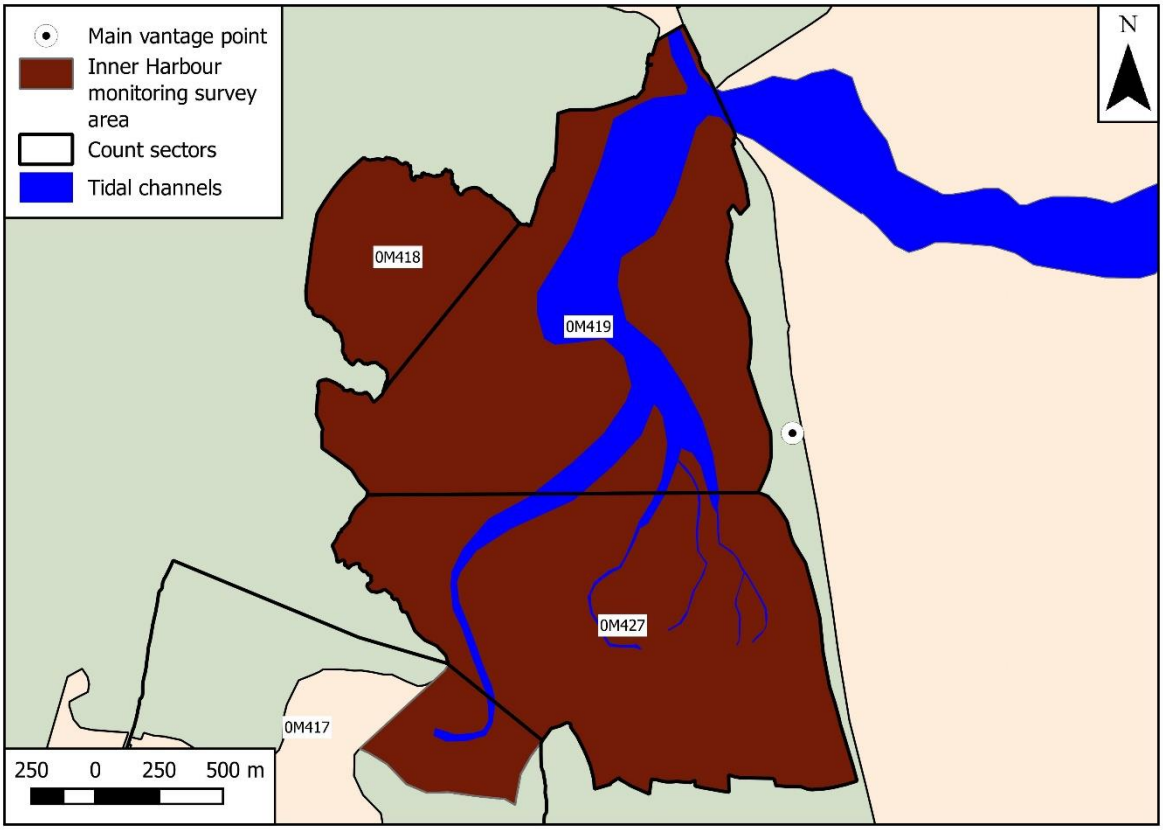


Figure 2.3 – Inner Harbour monitoring survey area.

3. Results: Tidal cycle counts

Introduction

3.1 This chapter presents the results of the 2017/18 tidal cycle counts for the target species, excluding the data on their occurrence in the Bird Corridor which is included in Chapter 4. Where relevant, comparisons are made with similar data from previous winters.

3.2 The results of the tidal cycle counts for the additional monitored species are included in Appendix A.

Oyster cultivation activity

3.3 Up to date trestle mapping was not available for the winter of 2017/18, apart from the area around the Bird Corridor (see Chapter 4). The most recent trestle mapping available for the rest of Whitehouse Bank was from the summer of 2014 (Figure 3.1). Apart from the changes around the Bird Corridor, other differences between the trestle configuration in the winter of 2017/18 and the configuration shown by this mapping included expansion of trestles in the lower section in sector OY1, filling in of gaps in the northern section of sector OY3 and expansion of trestles into the new area licensed at the northern end of sector OY4.

3.4 There was a mean of 2,182 (range 1,920-2,745) tractor minutes per count day in the winter of 2017/18, compared to 2,060 (range 1,455-2,625) in the winter of 2016/17 and 1,584 (range 900-2,400) in the winter of 2014/15. Tractor minutes per count day were negatively correlated with the low tide height (Spearman's r = -0.479, one-sided p = 0.007, n = 26. Therefore, as the mean low tide height per count day was lower in 2017/18 and 2016/17 compared to 2014/15 (0.43 m in 2017/18 and 0.46 m in 2016/17, compared to 0.59 in 2014/15), a higher mean level of tractor activity would have been expected in 2017/18 and 2016/17, compared to 2014/15.

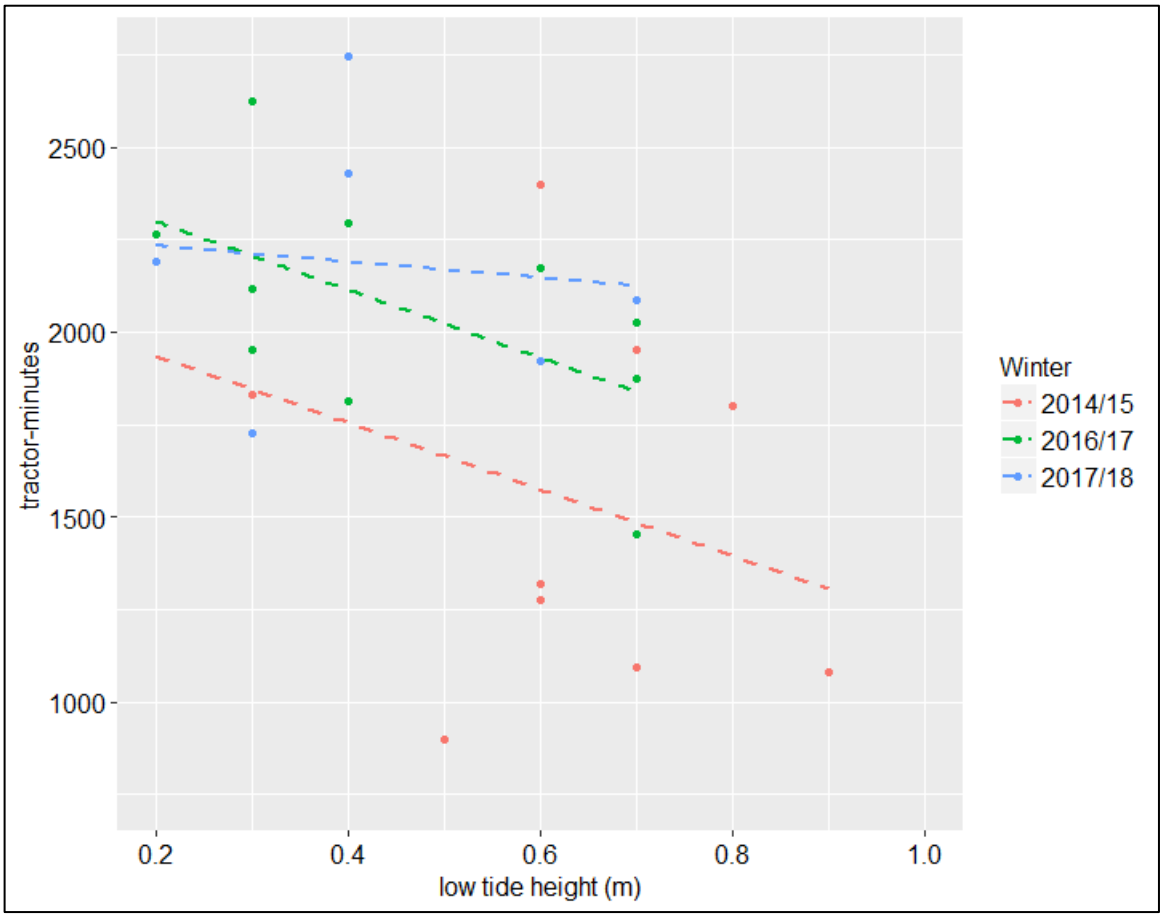
3.5 Text Figure 3.1 shows the relationship between tide height and tractor minutes in each of the three winters. The trendlines fitted to the 2014/15 and 2016/17 datasets had similar slopes but the y intercept was lower in 2014/15 compared to 2016/17 (Text Figure 3.1). Therefore, while the data is limited, it indicates a similar pattern, but a higher overall level, of husbandry activity in 2016/17 compared to 2014/15. However, the 2017/18 dataset does not show a clear relationship between tide height and tractor minutes, perhaps reflecting the smaller sample size in that dataset.

3.6 Tractor activity usually occurred from 150-120 minutes before low tide to 90-120 minutes after low tide, with the highest levels of activity between around 75 minutes before low tide and 45 minutes after low tide, and with similar activity patterns in 2016/17 compared to 2014/15 (Table 3.1). Overall, across the three winters, there was more tractor activity before low tide (mean percentage of total activity = 51%, range = 39-73%) compared to after low tide (mean percentage of total activity = 33%, range = 10-45%), and there were only three count days on which more tractor activity occurred after low tide.

Table 3.1 – Distribution of tractor activity across the tidal cycle, shown as the mean percentage of tractor minutes per count day at 30 minute intervals.

Winter	Minutes before/after low tide								
	≤ -120	-90	-60	-30	0	+30	+60	+90	≥ +120
2014/15	6%	10%	17%	19%	19%	14%	9%	5%	1%
2016/17	6%	11%	16%	17%	16%	14%	11%	6%	4%
2017/18	11%	11%	15%	15%	14%	14%	10%	6%	4%
Overall	8%	11%	16%	17%	16%	14%	10%	6%	4%

Each data column in this table, apart from the end columns, represent a 30 minute period centred on the time given; e.g., -90 minutes before low tide represents the period from -115 to -75 minutes before low tide.



Text Figure 3.1 – Relationship between tractor activity and low tide height.

Waterbird numbers

3.7 The total numbers of the target species recorded across the ebb, low tide and flood tide periods on each count day are shown in Table 3.2. The low tide counts covered a larger area than the ebb and flood tide counts and would, therefore, be expected to record the highest numbers. However, this was not always the case.

Tidal cycle distribution

3.8 The counts of the target species across the tidal cycle on Whitehouse Bank are shown in Table 3.3. On the ebb tide, Grey Plover mainly occurred on the EBB1 and EBB2 counts. On some days, the Grey Plover remained on the EBB3 count, but birds only stayed until the EBB4 period on one of the six counts. Bar-tailed Godwit and Dunlin also tended to occur in larger numbers during the EBB1 and EBB2 periods, but the pattern was less marked and significant numbers remained on Whitehouse Bank throughout the ebb tide period and into the low tide period on several dates. On the two days when significant numbers of Knot occurred on Whitehouse Bank, counts, they remained until the EBB4 counts. The occurrence of all the target species on Whitehouse Bank during the flood tide period was more erratic, but significant numbers could be present early in the flood tide period.

3.9 On most of the counts, the Grey Plover, Knot, Bar-tailed Godwit and Dunlin flocks on Whitehouse Bank mainly consisted of feeding birds (Table 3.4).

Table 3.2 - Maximum counts of the four target species recorded during ebb, low and flood tide periods on each count day.

Species	Date	Maximum count		
		Ebb	LT	Flood
Grey Plover	06/10/2017	40	0	0
	07/11/2017	68	25	24
	05/12/2017	99	80	104
	19/01/2018	172	159	162
	02/02/2018	200	101	218
	19/02/2018	157	123	170
Bar-tailed Godwit	06/10/2017	13	301	81
	07/11/2017	68	22	4
	05/12/2017	25	416	222
	19/01/2018	368	422	507
	02/02/2018	127	345	1069
	19/02/2018	399	382	570
Knot	06/10/2017	0	0	0
	07/11/2017	19	0	7
	05/12/2017	7	104	111
	19/01/2018	1	256	95
	02/02/2018	202	118	368
	19/02/2018	259	117	292
Dunlin	06/10/2017	424	414	129
	07/11/2017	612	487	206
	05/12/2017	2639	2763	1910
	19/01/2018	3056	2129	1955
	02/02/2018	1911	2475	808
	19/02/2018	2847	2264	2678

Data are the maxima across four ebb tide counts, one low tide count, and four flood tide counts. The areas covered varied between counts (see text for details).

Table 3.3 - Counts of the target species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Grey Plover	06/10/2017	40	0	0	0	0	0	0	0	0
	07/11/2017	23	62	4	0	1	4	24	15	14
	05/12/2017	95	14	13	0	0	0	3	4	2
	19/01/2018	170	57	52	0	29	48	25	16	45
	02/02/2018	75	90	110	175	101	21	60	158	218
	19/02/2018	138	35	7	0	4	88	120	34	88
Bar-tailed Godwit	06/10/2017	13	0	0	0	14	3	0	80	0
	07/11/2017	68	24	2	1	15	3	4	0	0
	05/12/2017	20	16	15	4	138	35	15	23	37
	19/01/2018	362	102	81	35	59	11	22	480	440
	02/02/2018	96	71	10	8	51	21	10	907	541
	19/02/2018	344	246	117	44	83	112	530	464	2
Knot	06/10/2017	0	0	0	0	0	0	0	0	0
	07/11/2017	19	6	0	0	0	0	0	7	3
	05/12/2017	7	4	3	0	0	0	0	14	0
	19/01/2018	0	1	0	0	0	4	2	10	0
	02/02/2018	40	190	68	173	67	0	66	232	368
	19/02/2018	219	198	205	205	0	1	223	212	100
Dunlin	06/10/2017	88	424	363	272	334	52	82	70	129
	07/11/2017	247	109	38	35	19	5	101	52	23
	05/12/2017	2352	12	112	97	197	0	0	0	28
	19/01/2018	1720	465	222	6	70	82	47	19	20
	02/02/2018	112	646	180	186	212	269	525	795	448
	19/02/2018	516	257	127	139	108	181	228	330	277

Ebb tide counts were carried out from around four hours before low tide (EBB1 count) to two hours before low tide (EBB4 count), low tide counts were carried out over a three hour period centred around low tide, and flood tide counts were carried out from around two hours after low tide (FLOOD1 count) to four hours after low tide (FLOOD4 count).

Table 3.4 - Percentages of feeding birds of the target species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Grey Plover	06/10/2017	0%								
	07/11/2017	0%	0%					100%	100%	100%
	05/12/2017	0%	0%	8%						
	19/01/2018	94%	100%	100%		100%	100%	100%	100%	24%
	02/02/2018	1%	0%	29%	0%	40%	100%	100%	84%	15%
	19/02/2018	19%	69%				94%	99%	100%	0%
Bar-tailed Godwit	06/10/2017	69%				21%			63%	
	07/11/2017	75%	54%			93%				
	05/12/2017	80%	94%	100%		100%	100%	100%	100%	0%
	19/01/2018	90%	100%	98%	91%	90%	82%	100%	100%	89%
	02/02/2018	59%	77%	100%		100%	86%	80%	29%	23%
	19/02/2018	93%	100%	98%	100%	98%	69%	53%	27%	
Knot	06/10/2017									
	07/11/2017	100%								
	05/12/2017								0%	
	19/01/2018								100%	
	02/02/2018	100%	100%	100%	1%	30%		100%	100%	49%
	19/02/2018	100%	100%	100%	100%			100%	100%	0%
Dunlin	06/10/2017	56%	100%	100%	100%	99%	100%	77%	0%	98%
	07/11/2017	23%	28%	97%	100%	100%		100%	100%	100%
	05/12/2017	88%	100%	100%	99%	99%				100%
	19/01/2018	94%	100%	100%		100%	100%	100%	100%	100%
	02/02/2018	100%	100%	100%	100%	98%	100%	100%	99%	81%
	19/02/2018	100%	100%	100%	100%	95%	99%	82%	96%	34%

Percentages are only included for counts where > 9 birds were recorded. See notes to Table 3.6 for details of count timings.

3.10 The movement patterns of Grey Plover and Bar-tailed Godwit onto/off Whitehouse Bank during the ebb tide period were similar in 2017/17, compared to 2014/15 (Table 3.5 and Text Figure 3.2). Grey Plover numbers generally remained high across the EBB1 and EBB2 count periods, decreasing in the EBB3 count period and with most birds gone by the EBB4 count period (Text Figure 3.2). The apparent differences in mean percentages between the winters in Table 3.5 are due to the means from the small 2017/18 dataset not reflecting the general patterns in Text Figure 3.2. Bar-tailed Godwit numbers showed a general pattern of decrease (Table 3.5), but with a lot of variability, across the ebb tide period (Text Figure 3.2), The higher mean percentage at low tide in 2014/15 compared to 2016/17 was due to three count days in 2014/15 when large flocks of Bar-tailed Godwit were recorded moving back on to Whitehouse Bank during the second half of the low tide period. As in 2016/17, Knot and Dunlin remained longer on Whitehouse Bank on the ebb tide in 2017/18, compared to 2014/15. (Table 3.5). In 2014/15, most birds had departed by the EBB3 period, while in 2016/17 and 2017/18 numbers remained high on some count days into the EBB3 and EBB4 periods (Text Figure 3.2).

Table 3.5 – Mean percentage of the maximum ebb tide count recorded in each count period across the ebb and low tides on Whitehouse Bank.

Species	Season	EBB1	EBB2	EBB3	EBB4	LT	n
Grey Plover	2014/15	99%	84%	23%	5%	0%	11
	2016/17	80%	73%	31%	8%	2%	10
	2017/18	80%	38%	20%	17%	13%	6
Bar-tailed Godwit	2014/15	93%	78%	42%	26%	72%	10
	2016/17	73%	64%	53%	60%	24%	7
	2017/18	100%	52%	17%	8%	29%	4
Knot	2014/15	99%	73%	10%	0%	11%	6
	2016/17	60%	95%	84%	32%	0%	4
	2017/18	61%	95%	65%	92%	18%	2
Dunlin	2014/15	99%	59%	4%	0%	1%	7
	2016/17	99%	65%	47%	28%	33%	9
	2017/18	73%	54%	29%	23%	25%	4

Data is only included for count days where the maximum Whitehouse Bank ebb tide count was > 25 (Grey Plover), > 50 (Bar-tailed Godwit and Knot) or > 100 (Dunlin). Note that EBB1 counts were only carried out on five of the eleven count days in 2014/15 and no low tide count was carried out on one of the count days in 2014/15.

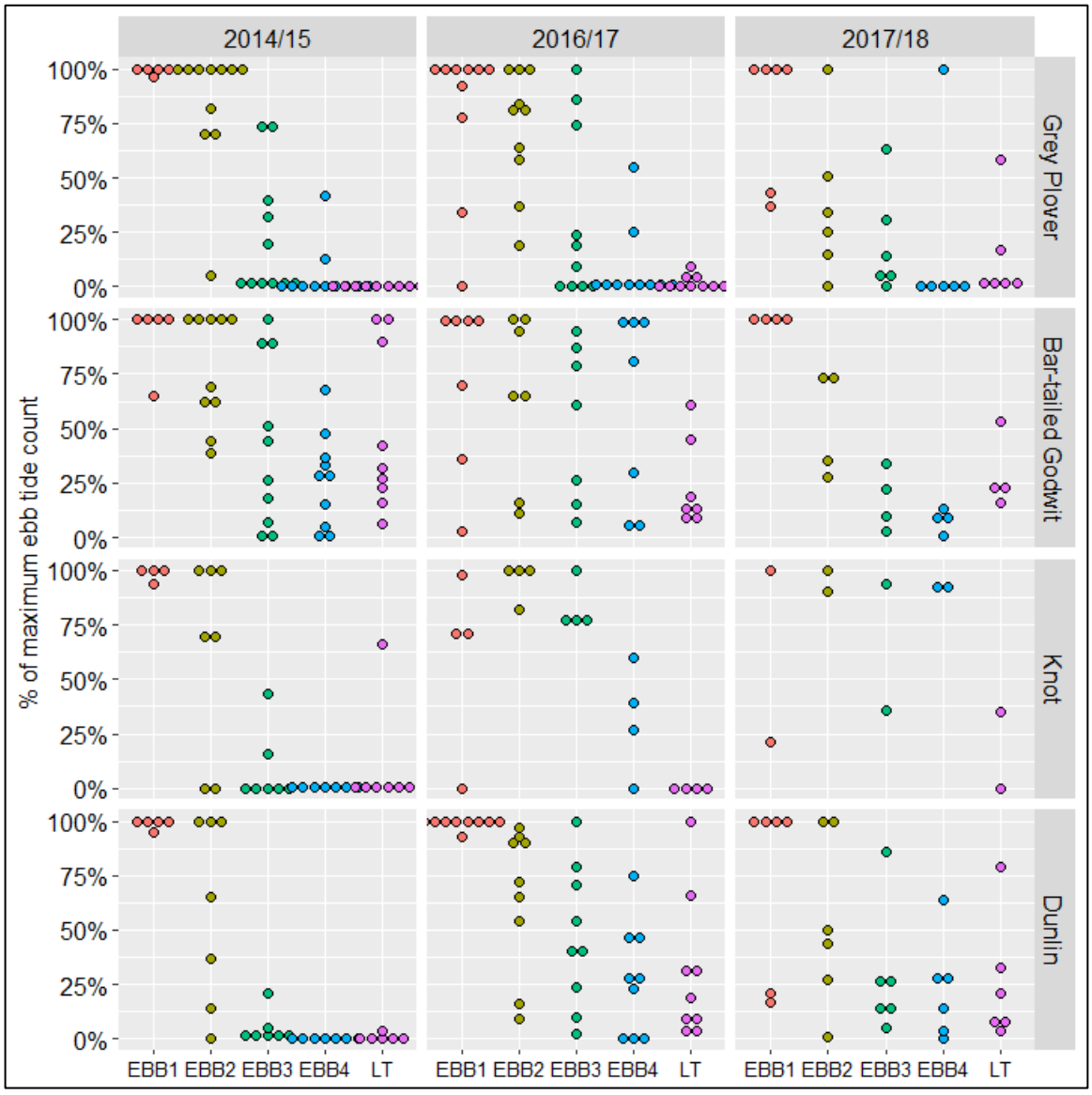
3.11 As in 2014/15 and 2016/17, most observations of Grey Plover, Knot and Dunlin movements were of birds moving between Whitehouse Bank and the Inner Harbour, while Bar-tailed Godwits on Whitehouse Bank moved to/from both the Inner Harbour and the Ballyrandle Sandflats.

Low tide distribution

Distribution across Dungarvan Harbour

3.12 During the low tide counts, Grey Plover occurred erratically, Knot occurred very rarely, and Bar-tailed Godwit and Dunlin occurred in relatively low numbers, on Whitehouse Bank (Table 3.6). Grey Plover mainly occurred in the Inner Harbour. However on all the counts the total numbers recorded at low tide were lower than the maximum ebb tide count indicating that not all the Grey Plover were located at low tide. Dunlin also mainly occurred in the Inner Harbour. Knot and Bar-tailed Godwits usually mainly occurred on the Ballyrandle Sandflats.

3.13 The overall low tide distribution patterns across Dungarvan Harbour in 2017/18 were broadly similar to those recorded in previous winters (Table 3.7). However, Knot mainly occurred on the Ballyrandle Sandflats, rather than in the Inner Harbour, as in previous winters. Within the Outer Sandflats zone, similar overall numbers of Grey Plover occurred on the the Ballyrandle Sandflats and Whitehouse Bank, while Bar-tailed Godwit and Knot mainly occurred on the Ballyrandle Sandflats and Dunlin mainly occurred on Whitehouse Bank (Table 3.8).



Text Figure 3.2 – Occurrence pattern of the target species on Whitehouse Bank across the ebb and low tide periods. The dotplots show the percentages of the maximum ebb tide count recorded on each ebb tide count and on the low tide count on each count day in 2014/15 and 2016/17. The following low tide counts that were > 100% of the maximum ebb tide count are shown as 100% in these dotplots: 2 no. counts of Bar-tailed Godwit in 2014/15 (106% and 304%); and 1 no. count of Dunlin in 2016/17 (120%). See footnote to Table 3.5 for other details.

Table 3.6 - Distribution of the target species at low tide.

Species	Date	Inner Harbour		Outer Sandflats	
		upper	main	Ballyrandle	Whitehouse
Grey Plover	06/10/2017	0	0	0	0
	07/11/2017	0	24	0	1
	05/12/2017	0	80	0	0
	19/01/2018	0	75	55	29
	02/02/2018	0	0	0	101
	19/02/2018	0	70	49	4
Bar-tailed Godwit	06/10/2017	0	0	287	14
	07/11/2017	0	0	7	15
	05/12/2017	1	3	274	138
	19/01/2018	0	11	352	59
	02/02/2018	0	0	294	51
	19/02/2018	0	2	297	83
Knot	06/10/2017	0	0	0	0
	07/11/2017	0	0	0	0
	05/12/2017	0	22	82	0
	19/01/2018	0	50	206	0
	02/02/2018	0	0	51	67
	19/02/2018	0	22	95	0
Dunlin	06/10/2017	0	80	0	334
	07/11/2017	0	468	0	19
	05/12/2017	0	2528	38	197
	19/01/2018	0	1946	113	70
	02/02/2018	0	2230	33	212
	19/02/2018	0	2151	5	108

Grey cells indicate no counts were carried out.

Table 3.7 - Mean percentage occurrence of the target species in the main zones of Dungarvan Harbour in 2009/10 and 2014/15.

Species	Season	Mean percentage of total count			n
		Inner Harbour	Ballyrandle Sandflats	Whitehouse Bank	
Grey Plover	2009/10	83%	1%	16%	4
	2014/15	74%	26%	0%	8
	2016/17	79%	21%	0%	4
	2017/18	60%	15%	25%	5
Bar-tailed Godwit	2009/10	11%	87%	2%	4
	2014/15	7%	70%	23%	10
	2016/17	11%	74%	15%	10
	2017/18	1%	82%	18%	5
Knot	2009/10	80%	15%	5%	4
	2014/15	62%	34%	4%	8
	2016/17	89%	10%	0%	8
	2017/18	15%	71%	14%	4
Dunlin	2009/10	92%	6%	2%	4
	2014/15	83%	12%	5%	9
	2016/17	92%	0%	7%	10
	2017/18	92%	2%	6%	4

Counts with low total numbers present are excluded from the analyses.

Table 3.8 - Mean percentage occurrence of the target species in the subdivisions of the Outer Sandflats zone of Dungarvan Harbour in 2009/10, 2011 and 2014/15.

Species	Season	Mean percentage of Outer Sandflats count		n
		Ballyrandle Sandflats	Whitehouse Bank	
Grey Plover	2009/10	6%	94%	2
	2011	2%	98%	5
	2014/15	99%	1%	5
	2016/17	100%	0%	2
	2017/18	53%	47%	3
Bar-tailed Godwit	2009/10	98%	2%	4
	2011	72%	28%	5
	2014/15	75%	25%	10
	2016/17	84%	16%	10
	2017/18	82%	18%	5
Knot	2009/10	83%	17%	3
	2011	87%	13%	3
	2014/15	87%	13%	8
	2016/17	95%	5%	7
	2017/18	86%	14%	4
Dunlin	2009/10	76%	24%	4
	2011	43%	57%	4
	2014/15	67%	33%	8
	2016/17	1%	99%	6
	2017/18	24%	76%	4

Counts with low total numbers present in the Outer Sandflats zone are excluded from the analyses.

Distribution within Whitehouse Bank

3.14 Only two of the target species (Bar-tailed Godwit and Dunlin) regularly occurred on Whitehouse Bank in significant numbers at low tide.

3.15 Bar-tailed Godwit occurred almost exclusively along the tideline on the lower sandflats in sectors OY2-OY4. However, on 13/02/2017, a flock of 212 was present at low tide on the upper shore in sector CS3. Their percentage occurrence within the trestle blocks (Table 3.9) varied from 8-76% (mean 29%), compared to 0-90% (mean 38%) in 2016/17 and 9-63% (mean 33%) in 2014/15.

3.16 Dunlin occurred in small numbers, either on the upper sandflats (usually in sector CS3) or within the oyster trestle blocks (mainly sector OY3) (Table 3.10). Therefore, the Dunlin distribution appears to have been concentrated in the northern section of Whitehouse Bank. This distribution pattern was similar to 2016/17, but differs from the more erratic distribution patterns recorded in previous winters, which did not show a clear pattern of concentration in one section of Whitehouse Bank (Table 3.10). Their percentage occurrence within the trestle blocks in 2017/18 (Table 3.9) reflected their relative distribution between sector CS3 and OY3, and varied from 8-100% (mean 38%), compared to 3-100% (mean 57%) in 2016/17 and 0-100% (mean 47%) in 2014/15.

Table 3.9 - Distribution of Dunlin and Bar-tailed Godwit on Whitehouse Bank at low tide in relation to the presence of oyster trestles.

Species	Date	Count		% within trestle blocks
		Within trestle blocks	Outside trestle blocks	
Bar-tailed Godwit	06/10/2017	2	12	14%
	07/11/2017	7	8	47%
	05/12/2017	17	121	12%
	19/01/2018	45	14	76%
	02/02/2018	4	47	8%
	19/02/2018	12	71	14%
Dunlin	06/10/2017	74	260	22%
	07/11/2017	19	0	100%
	05/12/2017	48	149	24%
	19/01/2018	34	36	49%
	02/02/2018	48	164	23%
	19/02/2018	9	99	8%

Table 3.10 – Distribution of Dunlin between count sectors during low tide counts of Whitehouse Bank

Season	Date	Count sector						
		CS1	CS2	CS3	OY1	OY2	OY3	OY4
2017/18	06/10/2017	0	0	250	10	28	46	0
	07/11/2017	0	0	0	0	3	16	0
	05/12/2017	0	26	122	0	9	40	26
	19/01/2018	0	0	36	0	3	31	0
	02/02/2018	0	0	135	28	9	40	0
	19/02/2018	0	0	99	0	6	3	0
2016/17	04/10/2016	0	31	318	6	1	10	23
	18/10/2016	0	0	0	0	0	81	111
	02/11/2016	0	0	7	0	0	78	101
	16/11/2016	0	0	260	0	35	52	134
	30/11/2016	0	0	4	0	6	21	15
	15/12/2016	0	1	0	0	3	1	99
	13/01/2017	0	0	0	0	1	1	23
	31/01/2017	0	0	32	0	0	3	4
	13/02/2017	0	0	71	0	2	11	1
	28/02/2017	0	0	260	0	0	2	7
2014/15	23/10/2014	0	0	0	0	0	1	60
	27/10/2014	0	0	0	1	0	0	0
	10/11/2014	0	0	14	0	0	0	0
	12/11/2014	0	0	1	0	0	0	0
	24/11/2014	0	0	2	0	0	0	17
	10/12/2014	0	0	0	0	6	0	2
	22/12/2014	0	31	10	0	0	0	0
	08/01/2015	0	0	2	0	0	0	4
2010/11	06/01/2011	48	32	142	0	65	23	37
	22/01/2011	0	1	0	0	9	6	1
	03/02/2011	0	0	0	12	1	2	0
	21/02/2011	0	135	443	0	7	9	3
	03/03/2011	0	0	7	0	282	7	2

Distribution patterns in relation to the presence of oyster trestles

3.17 Of the target species, Grey Plover and Knot were never recorded within the trestle blocks during the tidal cycle low tide counts.

3.18 Bar-tailed Godwit and Dunlin did occur within the trestle blocks.

3.19 For Bar-tailed Godwit, the observed numbers within the trestles were generally lower than the predicted numbers for both the all sectors and close sectors analyses (Text Figure 3.3). The Jacob's Index values were negative, and similar to those calculated from the 2014/15 and 2016/17 data, indicating avoidance of the oyster trestles (Table 3.11). The confidence intervals for the index values did not include zero (Table 3.11). Across the combined dataset, comparison of the observed and predicted numbers indicates that when the predicted numbers exceed a threshold value of around 200, the observed numbers show a much higher deviation from the predicted numbers, compared

to when the predicted numbers are below this threshold (Text Figure 3.3). However, the index values did not show any obvious relationship to the total numbers present (Text Figure 3.4) or the predicted numbers (Text Figure 3.5).

3.20 Using the combined dataset across all seasons, the mean Bar-tailed Godwit densities outside the trestle blocks were five times higher than the densities within the trestle blocks (Table 3.12).

3.21 The assumptions required for calculating expected values were clearly violated for Dunlin in 2016/17, as their distribution patterns indicated that some other factor, apart from the presence of oyster trestles, was influencing their distribution pattern within the Outer Sandflats zone (see paragraph 3.16). Furthermore, as they mainly occurred on the intertidal away from the tideline, tideline length did not provide a reasonable representation of the availability of suitable habitat. Therefore, we have not calculated expected numbers of Dunlin, or D index values for Dunlin. However, based on their percentage occurrence within trestle blocks, Dunlin distribution within the Outer Sandflats zone did not have an obvious negative association with oyster trestles in 2017/18.

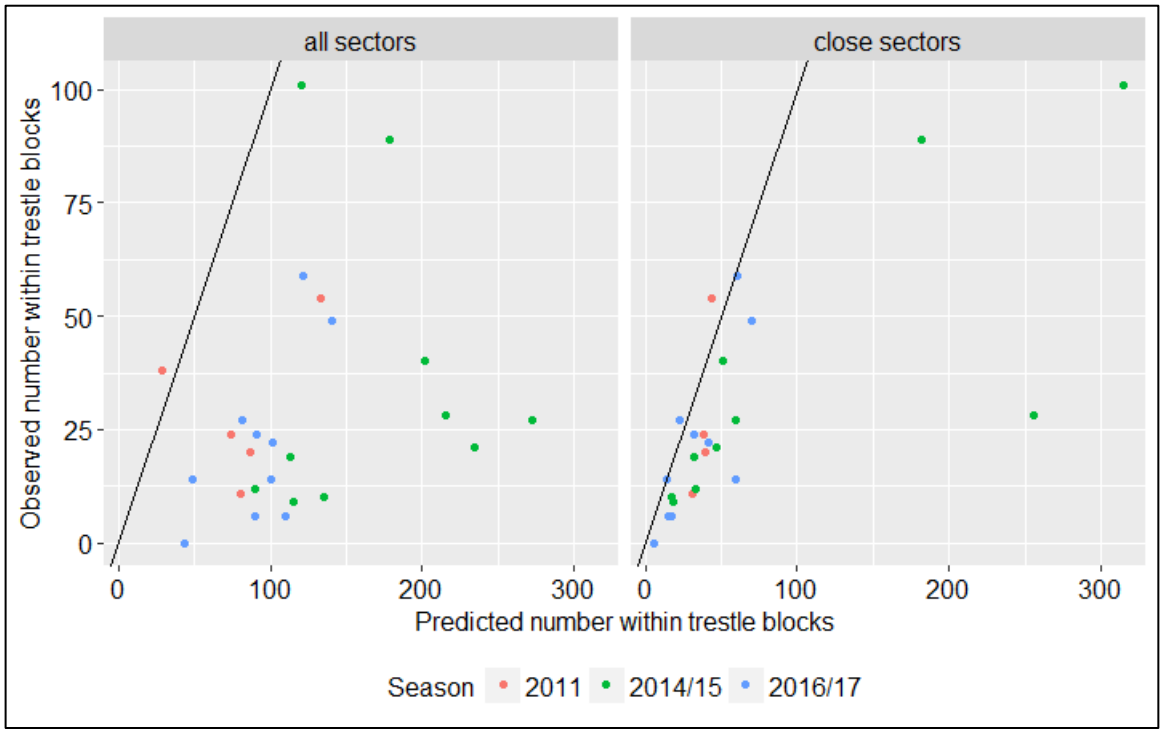
Table 3.11 - Mean Jacob's index (D) values (± 95% C.I.).

Species	Seasons	All sectors			Close sectors		
		Mean D	D > 0	n	Mean D	D > 0	n
Bar-tailed Godwit	2017/18	-0.59 (± 0.48)	1	6	-0.57 (± 0.33)	0	6
	2016/17	-0.73 (± 0.13)	0	10	-0.51 (± 0.34)	1	10
	2014/15	-0.72 (± 0.19)	0	10	-0.65 (± 0.11)	0	10
	2011	-0.47 (± 0.47)	1	5	-0.25 (± 0.72)	1	4
	all	-0.66 (± 0.11)	2	31	-0.53 (± 0.14)	2	30

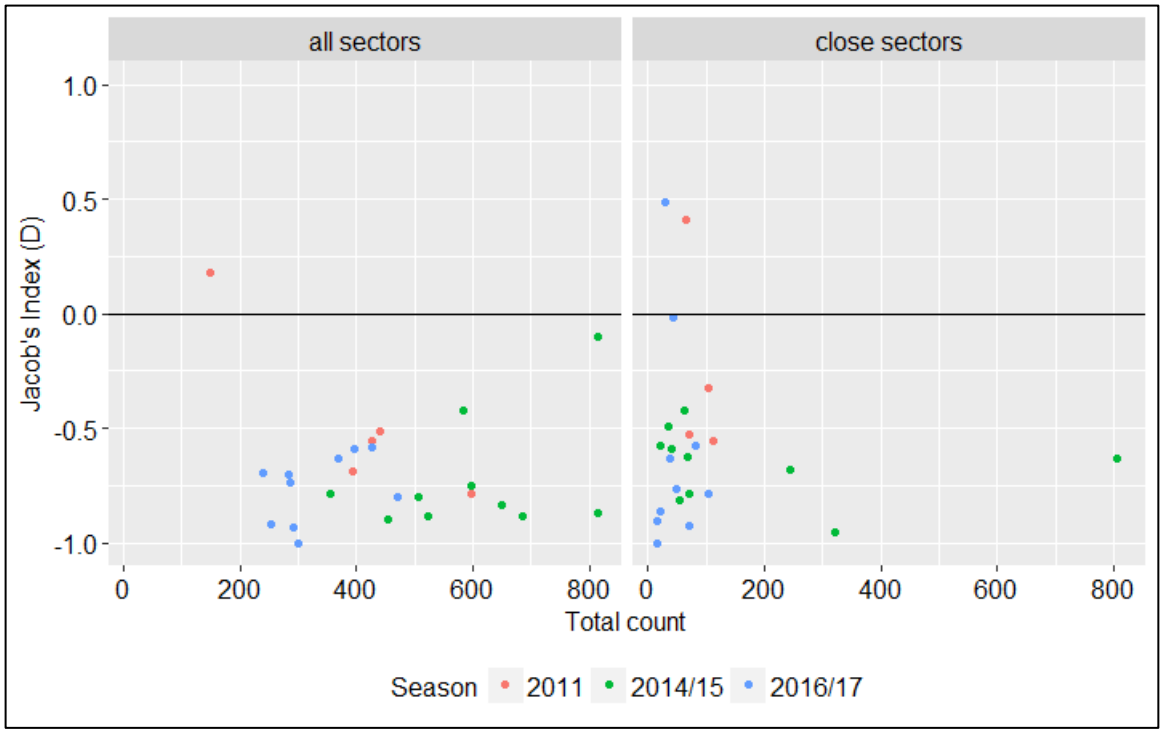
Table 3.12 - Mean densities (birds/km tideline length) within and outside trestle blocks.

Species	Analysis	Outside		Within	
		Mean	CI	Mean	CI
Bar-tailed Godwit	all sectors	65.5	14.0	14.3	6.5
	close sectors	71.7	44.8	14.3	6.5

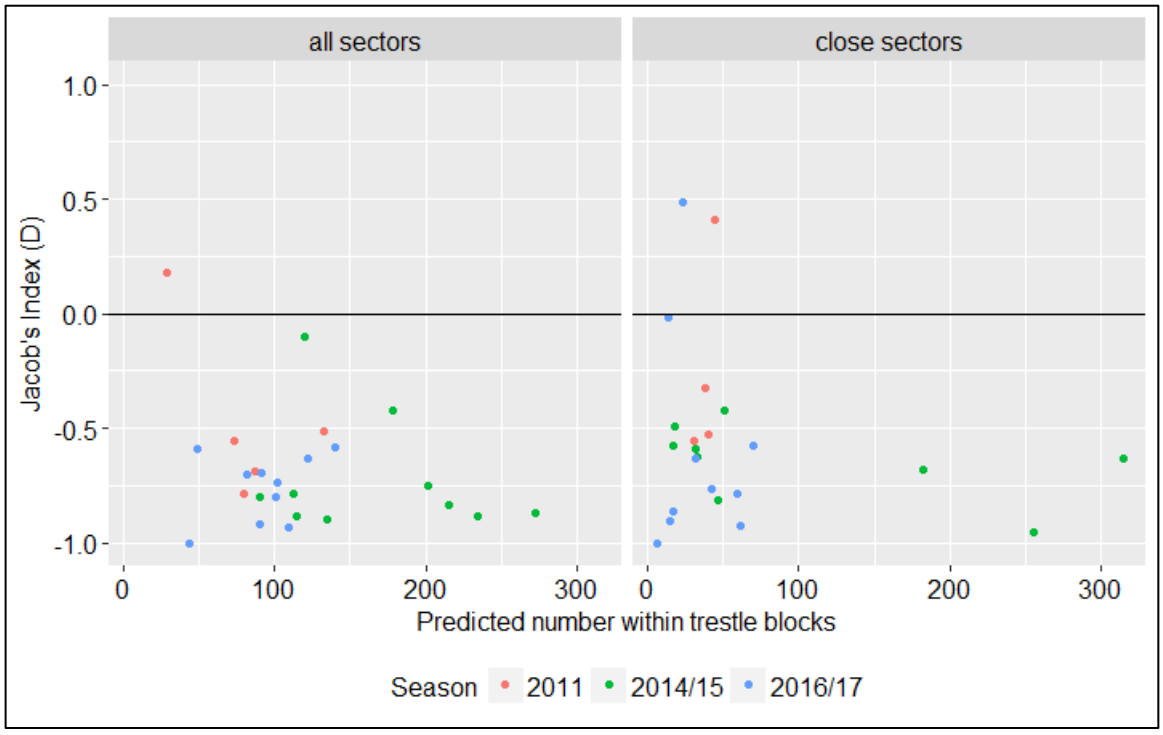
Analyses use the combined 2011, 2014/15 and 2016/17 datasets.



Text Figure 3.3 - Observed compared to predicted occurrence of Bar-tailed Godwit within oyster trestle blocks at Dungarvan Harbour.



Text Figure 3.4 - Relationship between the Jacob's Index values and the total count for Bar-tailed Godwit at Dungarvan Harbour.



Text Figure 3.5 - Relationship between the Jacob's Index values and the predicted occurrence of within oyster trestle blocks for Bar-tailed Godwit at Dungarvan Harbour.

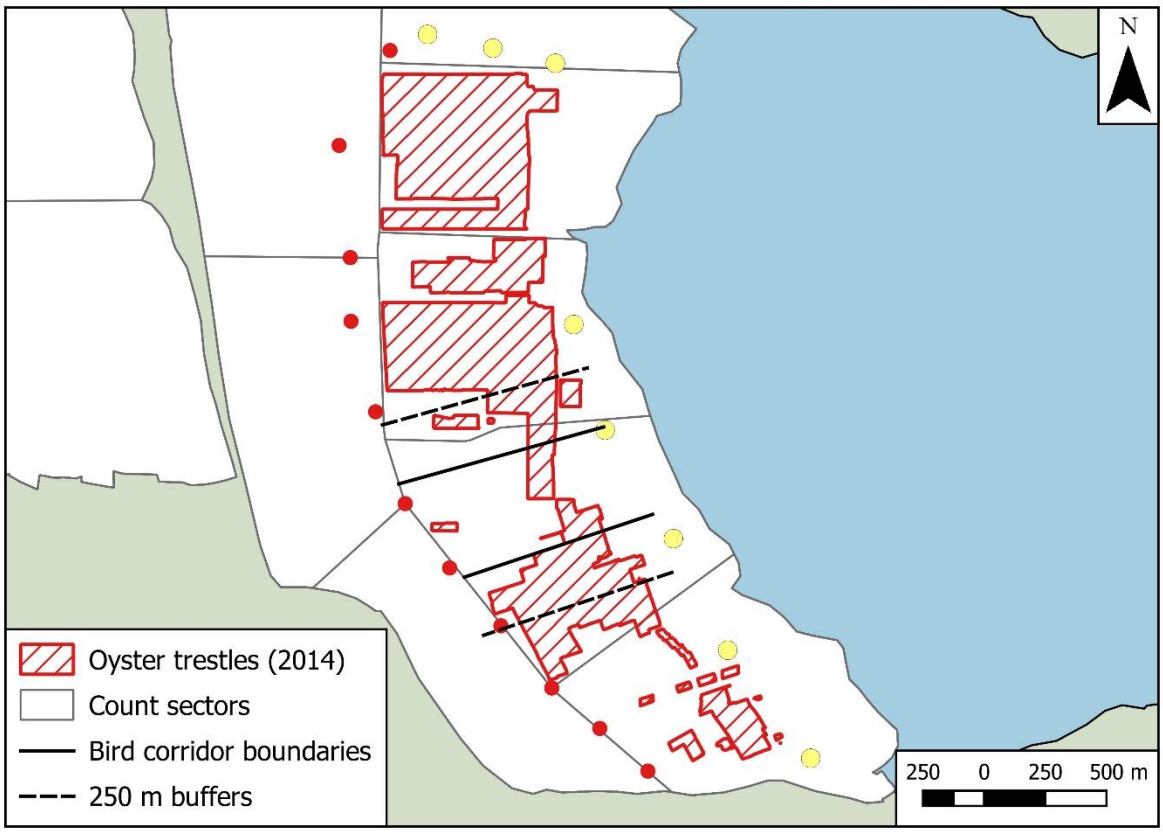


Figure 3.1 – Oyster trestle distribution on Whitehouse Bank in the summer of 2014.

4. Results: Bird corridor monitoring

Introduction

4.1 This chapter presents the results from the Bird Corridor monitoring counts on occurrence of the target species within the Bird Corridor, as well as summary data on the occurrence of other waterbird species within the Bird Corridor, and data from the tidal cycle counts on the occurrence of the target species within the Bird Corridor. The results of the Bird Corridor monitoring counts for the additional monitored species are included in Appendix A, additional count data is included for the target species in Appendix B, and the full count data for other waterbird species within the Bird Corridor are included in Appendix C.

Oyster cultivation activity

4.2 At the start of the tidal cycle counts, the Bird Corridor still had a block of trestles in the middle of the upper section of the Bird Corridor (Figure 4.1). These trestles were removed by the 23rd October (Figure 4.1). The Bird Corridor remained clear of trestles for the remainder of the winter. A large block of trestles was present adjacent to the southern edge of the Bird Corridor (Figure 4.1). At the northern end of the Bird Corridor, trestles extended up to the Bird Corridor boundary in the lower shore but there was a 150-200 m gap between the Bird Corridor boundary and the nearest trestles in the upper section (Figure 4.1).

4.3 During the tidal cycle counts, there were 2-8 tractors working within 250 m of the Bird Corridor at the time the Bird Corridor was counted (Table 4.1). Tractor movements through the Bird Corridor were only recorded on one of the six count dates (Table 4.1).

Table 4.1 – Husbandry activity around the Bird Corridor recorded during the tidal cycle counts.

Date	Tractors within 250 m	Tractor movements through Bird Corridor:			
		upper	edge	middle	lower
06/10/2017	8	0	0	0	2
07/11/2017	7	0	0	0	0
05/12/2017	2	0	0	0	0
19/01/2018	6	0	0	0	0
02/02/2018	6	0	0	0	0
19/02/2018	2	0	0	0	0

4.4 On the Bird Corridor monitoring count days, there were usually several tractors working within 250 m of the Bird Corridor for most of the period of tidal exposure of the Bird Corridor (Table 4.2). There was also a general pattern of higher levels of tractor numbers during the first half of the low tide period, compared to the second half (Table 4.2). There were 7-21 tractor movements within, and adjacent to, the Bird Corridor on the Bird Corridor monitoring count days and, again, there was a general pattern of higher levels of tractor movement during the first half of the low tide period, compared to the second half (Table 4.3). Most of the tractor movements were above the Bird Corridor, with some movements through the upper section of the Bird Corridor, but very few movements through the middle or lower sections of the Bird Corridor (Table 4.4).

Table 4.2 – Tractor numbers within 250 m of the Bird Corridor.

Date	EB4	EB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0	FL1	Totals per day
07/09/2017	0	5	6	7	6	5	5	1	1	0	36
21/09/2017	0	3	3	2	3	3	5	4	1	0	24
09/10/2017	0	2	2	3	1	3	5	5	4	0	25
23/10/2017	0	1	2	8	6	1	2	2	0	0	22
06/11/2017	4	6	5	5	4	5	5	5	5	1	45
23/11/2017	0	0	1	0	0	0	0	0	0	0	1
04/12/2017	0	4	5	0	0	0	0	0	0	0	9
08/12/2017	4	4	0	1	3	0	0	0	0	0	12
19/12/2017	3	4	1	2	2	3	4	3	1	1	24
18/01/2018	0	0	4	7	7	5	4	4	1	1	33
03/02/2018	4	5	5	6	6	9	2	4	2	0	43
16/02/2018	0	0	1	1	1	0	0	0	0	0	3
05/03/2018	0	5	3	3	3	3	3	2	0	0	22
15/03/2018	0	0	2	3	1	2	1	0	0	0	9
20/03/2018	0	2	4	5	6	6	6	1	1	0	31
Total per count period	15	41	44	53	49	45	42	31	16	3	-

Note: there was no exposure of intertidal habitat within the Bird Corridor in the EBB4-EBB5 and FLOOD0-FLOOD1 count periods on some of the count dates.

Table 4.3 – Tractor movements within, and adjacent to, the Bird Corridor during the Bird Corridor monitoring counts.

Date	EB4	EB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0	FL1	Totals per day
07/09/2017	0	3	2	1	1	0	2	5	1	0	15
21/09/2017	1	1	3	2	6	0	0	0	0	0	13
09/10/2017	0	1	2	0	3	3	1	2	1	0	13
23/10/2017	0	1	0	4	1	4	2	0	0	0	12
06/11/2017	0	0	0	1	3	1	1	0	1	0	7
23/11/2017	0	0	4	0	2	0	2	0	0	0	8
04/12/2017	0	0	6	0	1	3	0	0	0	0	10
08/12/2017	0	0	0	2	4	4	0	0	0	0	10
19/12/2017	3	0	1	4	3	2	0	0	1	2	16
18/01/2018	0	0	2	2	4	2	1	5	2	1	19
03/02/2018	3	0	0	3	0	2	0	2	0	0	10
16/02/2018	0	1	3	5	2	4	4	0	2	0	21
05/03/2018	0	0	2	1	1	1	2	1	0	0	8
15/03/2018	0	0	2	3	2	9	4	0	0	0	20
20/03/2018	0	2	5	2	1	0	0	0	0	0	10
Totals per count period	7	9	32	30	34	35	19	15	8	3	-

Note: there was no exposure of intertidal habitat within the Bird Corridor in the EBB4-EBB5 and FLOOD0-FLOOD1 count periods on some of the count dates.

Table 4.4 – Positions of the tractor movements recorded within, and adjacent to, the Bird Corridor during the Bird Corridor monitoring counts.

Date	above	edge	upper	middle	lower	Totals per day
07/09/2017	13	0	1	0	1	15
21/09/2017	4	1	8	0	0	13
09/10/2017	7	0	5	1	0	13
23/10/2017	9	1	2	0	0	12
06/11/2017	7	0	0	0	0	7
23/11/2017	7	1	0	0	0	8
04/12/2017	9	0	0	1	0	10
08/12/2017	10	0	0	0	0	10
19/12/2017	13	0	3	0	0	16
18/01/2018	18	0	1	0	0	19
03/02/2018	8	2	0	0	0	10
16/02/2018	21	0	0	0	0	21
05/03/2018	8	0	0	0	0	8
15/03/2018	18	0	2	0	0	20
20/03/2018	7	0	0	3	0	10
Totals per position	159	5	22	5	1	192

Positions: above = movements along the line of buoys that demarcate the upper edge of the oyster trestle zone; edge = movements along, or just inside, the northern and southern edge of the Bird Corridor; upper = movements through the upper third of the Bird Corridor; middle = movements through the middle third of the Bird Corridor; lower = movements through the lower third of the Bird Corridor (usually along the tideline).

Tidal cycle counts

4.5 During the tidal cycle counts, the target species were only recorded infrequently and/or in low numbers in the Bird Corridor at low tide (Table 4.5). There were also occasional records, including a few larger counts, during the EBB4 and EBB5 and FLOOD1 and FLOOD2 counts (Table 4.5). Another 12 waterbird species were also recorded within the Bird Corridor at low tide, with Light-bellied Brent Goose, Oystercatcher, Redshank, Black-headed Gull, Common Gull and Herring Gull being the most abundant of these species (Table 4.6)

Table 4.5 – Observations of target species in the Bird Corridor during the tidal cycle counts.

Species	Date	EBB4	LT	Flood 1	Flood 2
Grey Plover	07/11/2017	0	1	4	0
	02/02/2018	90	62	0	0
	19/02/2018	0	1	3	3
Bar-tailed Godwit	07/11/2017	0	3	1	0
	05/12/2017	0	8	30	0
	19/01/2018	1	0	0	0
	02/02/2018	0	2	0	0
	19/02/2018	6	0	1	115
Knot	02/02/2018	64	60	0	0
Dunlin	06/10/2017	0	10	0	0
	02/02/2018	28	28	0	0
	19/02/2018	0	0	1	0

Data only shown for days on which the species was recorded in the Bird Corridor on at least one count.

Table 4.6 – Summary of counts of other waterbird species in the Bird Corridor during the tidal cycle counts.

Species	Mean	Range	Non-zero counts
Light-bellied Brent Goose	57	4-226	6
Great Crested Grebe	< 1	0-1	1
Oystercatcher	10	0-27	4
Curlew	4	0-6	4
Greenshank	< 1	0-1	2
Redshank	6	0-20	5
Black-headed Gull	83	0-254	5
Common Gull	41	0-193	5
Herring Gull	4	0-15	5
Great Black-backed Gull	1	0-2	2

See Appendix A and Appendix C for the full count data.

Bird corridor monitoring

4.6 Grey Plover were recorded within the Bird Corridor on 10 out of the 15 Bird Corridor monitoring days (Table 4.7). On two days (9th October and 5th March) they occurred throughout the low tide period, while on the other days, they mainly occurred in the second half of the low tide period, with numbers building up towards the start of the flood tide period. The mean peak count on the days that they occurred was 27 (range 2-59)

4.7 Bar-tailed Godwit were recorded within the Bird Corridor on 12 out of the 15 Bird Corridor monitoring days (Table 4.7). Very large numbers occurred within the Bird Corridor on 7th September, but otherwise numbers were generally low with peak counts of less than 10 birds on 7 of the other 11 days.

4.8 Knot were recorded within the Bird Corridor on 7 of the 15 Bird Corridor monitoring days with peak counts of 2-50 birds (Table 4.7). Virtually all the records were towards the end of the low tide period/start of the flood tide period (LT5-FLOOD) counts).

4.9 Dunlin were recorded within the Bird Corridor on 9 of the 15 Bird Corridor monitoring days with peak daily counts of 2-1306 birds (Table 4.7). On 5th March, when the peak numbers occurred, they were present throughout the low tide period. On the other days, they mainly occurred in the second half of the low tide period, although the pattern was less clear-cut than for Grey Plover and Knot. The peak numbers on 5th March occurred at a time when large amounts of decaying seaweed were present within the Bird Corridor, and over 2000 Dunlin were also noted using the Bird Corridor on the Inner Harbour monitoring watch that was carried out on 20th February when the decaying seaweed was also present.

4.10 Another 17 waterbird species were recorded within the Bird Corridor, with Light-bellied Brent Goose, Oystercatcher, Curlew, Redshank, Black-headed Gull, Common Gull, Herring Gull and Great Black-backed Gull being the most regularly occurring/abundant species (Table 4.8).

Table 4.7 - Counts of target species in the Bird Corridor during the Bird Corridor monitoring counts.

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0
Grey Plover	07/09/2017	0	0	0	0	0	0	0	0
	21/09/2017	0	0	0	0	0	34	34	32
	09/10/2017	0	28	25	26	28	28	40	1
	23/10/2017	0	0	0	0	0	0	52	53
	06/11/2017	0	0	0	0	0	0	12	12
	23/11/2017	0	0	0	0	3	4	14	0
	04/12/2017	0	0	0	0	0	0	0	0
	08/12/2017	0	0	0	0	0	0	4	0
	19/12/2017	0	0	0	0	0	0	0	0
	18/01/2018	0	0	0	0	0	0	0	0
	03/02/2018	0	0	4	4	11	25	25	59
	16/02/2018	0	0	0	1	0	0	0	2
	05/03/2018	22	17	24	30	25	27	20	37
	15/03/2018	0	0	0	0	0	0	0	0
	20/03/2018	9	0	0	0	0	5	15	18
Bar-tailed Godwit	07/09/2017	68	1	2	0	101	302	176	0
	21/09/2017	0	0	1	0	0	0	0	0
	09/10/2017	0	0	0	0	0	0	0	3
	23/10/2017	0	0	0	0	0	0	0	0
	06/11/2017	2	0	0	0	1	0	0	0
	23/11/2017	0	0	0	0	0	0	2	0
	04/12/2017	0	0	21	13	13	11	12	12
	08/12/2017	0	0	0	1	0	0	0	0
	19/12/2017	1	1	0	4	6	2	2	0
	18/01/2018	0	0	0	0	0	1	0	0
	03/02/2018	0	0	0	0	0	0	0	0
	16/02/2018	0	0	0	0	0	0	0	0
	05/03/2018	3	0	0	0	4	0	0	42
	15/03/2018	0	0	0	0	0	5	10	0
	20/03/2018	0	0	0	0	0	2	6	15
Knot	07/09/2017	0	0	0	0	0	0	0	0
	21/09/2017	0	0	0	0	0	0	0	0
	09/10/2017	0	0	0	0	0	0	0	0
	23/10/2017	0	0	0	0	0	0	19	19
	06/11/2017	0	0	0	0	0	0	17	21
	23/11/2017	0	0	0	0	0	10	8	0
	04/12/2017	0	0	0	0	0	0	0	0
	08/12/2017	0	0	0	0	0	0	0	0
	19/12/2017	0	0	0	0	0	0	0	0
	18/01/2018	0	0	0	0	0	0	0	0
	03/02/2018	0	0	0	0	0	40	50	47
	16/02/2018	0	0	0	0	0	0	0	0
	05/03/2018	0	2	0	0	0	0	0	0
	15/03/2018	0	0	0	0	0	2	0	0

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0
Knot	20/03/2018	0	0	0	0	0	0	0	13
Dunlin	07/09/2017	0	5	0	0	0	0	0	0
	21/09/2017	0	0	0	0	0	12	28	28
	09/10/2017	0	0	0	0	0	0	0	0
	23/10/2017	0	0	0	0	0	0	2	2
	06/11/2017	0	0	0	0	0	0	0	0
	23/11/2017	0	0	0	0	0	2	40	0
	04/12/2017	0	0	0	0	0	0	0	0
	08/12/2017	0	0	0	0	0	920	80	0
	19/12/2017	0	0	0	0	0	0	0	0
	18/01/2018	0	0	0	0	0	0	0	0
	03/02/2018	0	0	356	40	40	60	210	260
	16/02/2018	0	0	0	4	0	0	0	0
	05/03/2018	240	160	402	1306	1020	1000	750	620
	15/03/2018	0	0	1	0	0	0	0	0
	20/03/2018	153	0	1	0	0	2	83	216

EBB4 counts: 2 Bar-tailed Godwit on 19/12/2017. Flood 1 counts: 32 Grey Plover on 21/09/2017; 15 Grey Plover on 20/03/2018; 12 Bar-tailed Godwit on 04/12/2017; 20 Bar-tailed Godwit on 19/12/2017; 6 Bar-tailed Godwit on 16/02/2018; 3 Bar-tailed Godwit on 20/03/2018; 216 Dunlin on 20/03/2018. Flood 2 counts: 19 Grey Plover on 20/03/2018; 130 Dunlin on 20/03/2018

Table 4.8 – Summary of counts of counts of other waterbird species in the Bird Corridor during the Bird Corridor monitoring counts.

Species	Days	Mean daily max	Maximum count	Non-zero counts
Light-bellied Brent Goose	13	42	167	69%
Teal	1	3	3	13%
Shoveler	1	5	5	50%
Little Egret	2	3	3	25%
Grey Heron	6	2	3	29%
Oystercatcher	15	14	57	80%
Golden Plover	1	1	1	13%
Curlew	12	5	13	63%
Sanderling	3	8	17	13%
Greenshank	1	1	1	13%
Redshank	12	11	50	42%
Black-headed Gull	15	86	250	80%
Common Gull	15	42	263	83%
Lesser Black-backed Gull	8	2	5	25%
Herring Gull	14	7	36	68%
Great Black-backed Gull	11	3	11	28%
Sandwich Tern	2	1	1	13%

The non-zero counts shows the mean percentage of count periods (between the EBB5 and FLOOD0 counts) per day on which the species was recorded, excluding days when the species was not recorded. See Appendix A and Appendix C for the full count data.

Disturbance

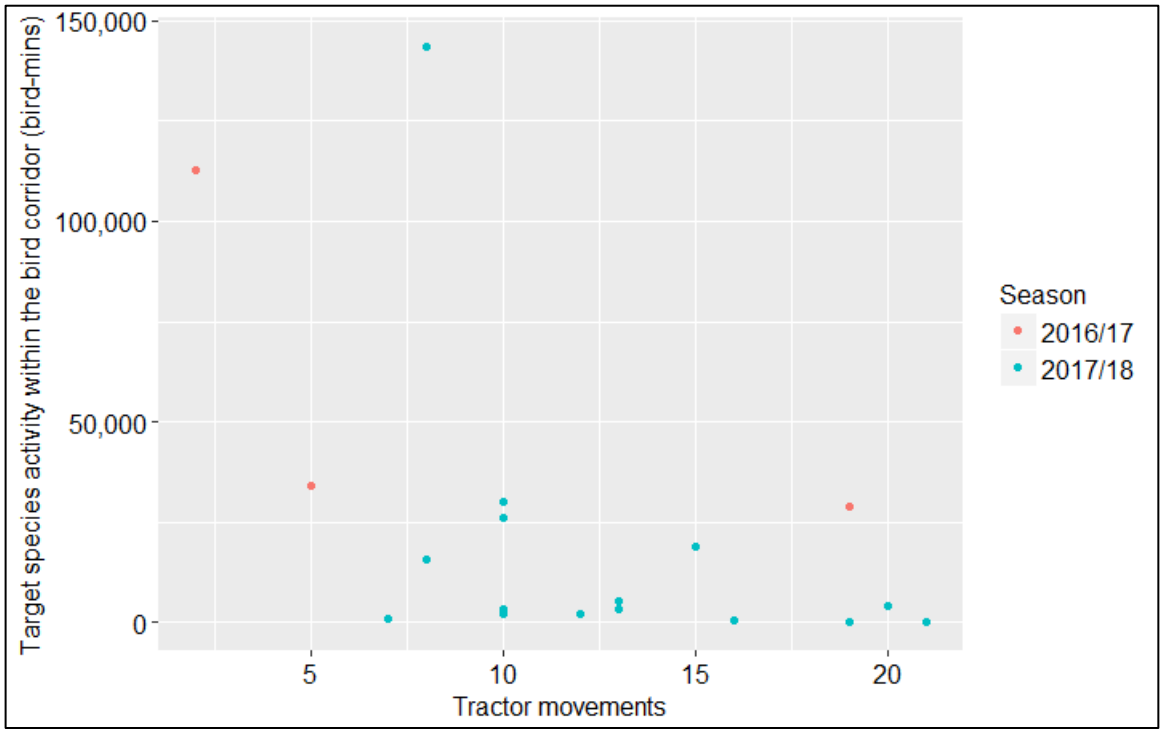
4.11 Across all the Bird Corridor monitoring days, the overall occurrence of target species in the Bird Corridor was not correlated with the numbers of tractors working within 250 m of the Bird Corridor (Spearman's r = -0.049, 1-sided p = 0.579, n = 18), but it was correlated with the number of tractor movements within and adjacent to the Bird Corridor (Spearman's r = -0.520, 1-sided p = 0.013, n = 18). However, the latter correlation is heavily influenced by two outliers (Text Figure 4.1) and when these are removed, the correlation is not significant (Spearman's r = -0.376, 1-sided p = 0.076, n = 16).

4.12 The relationship between the total numbers of target species in the Bird Corridor on each 30 minute count during the low tide period and the numbers of tractors working within 250 m of the Bird Corridor is shown in Text Figure 4.2. This indicates that, while there is a lot of variability in the data, there was a consistently negative trend on each count day. However, the overall relationship across the count days is not significant (Spearman's r = -0.1.31, 1-sided p = 0.173, n = 18)

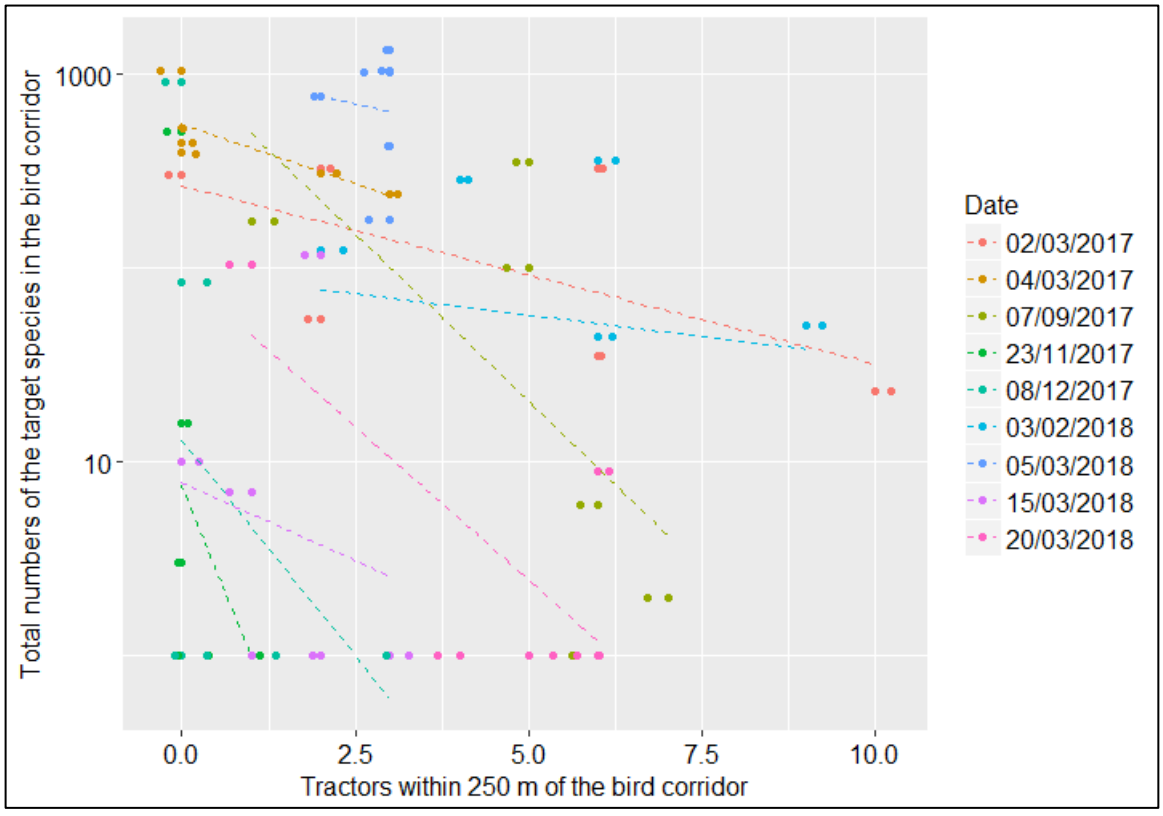
4.13 In 2017/18, three instances of target species within the Bird Corridor apparently being flushed by tractor movements or husbandry activity were observed during the Bird Corridor monitoring counts (Table 4.9). There were 61 instances where tractor movements or husbandry activity were observed to not have any detectable disturbance impact on birds within the Bird Corridor (Table 4.9). These included eight instances at distances of 100-200 m, and five instances at distances of 200-300 m. The low number of observations of close interactions between tractor activity and target species, compared to those observed in the much more limited 2016/17 Bird Corridor monitoring dataset, reflects the much lower level of tractor activity within the Bird Corridor in 2017/18.

Table 4.9 - Disturbance responses of the target species within the Bird Corridor to tractor movement and husbandry activity within and around the Bird Corridor (2017/18 data).

Species	Response	Number of observations at distances of:					
		0-100 m	100-200 m	200-300 m	300-400 m	400-500 m	> 500 m
Grey Plover	none	0	3	2	5	4	14
	flush	0	1	0	0	0	0
Bar-tailed Godwit	none	0	0	1	0	3	7
	flush	0	0	0	0	0	0
Knot	none	0	2	0	1	1	0
	flush	0	0	0	0	0	0
Dunlin	none	0	3	2	2	3	8
	flush	1	0	1	0	0	0



Text Figure 4.1 - Relationship between total daily tractor movements within/adjacent to the Bird Corridor and total daily activity of target species in the Bird Corridor during the Bird Corridor monitoring low tide counts.



Text Figure 4.2 - Relationship between tractor activity and numbers of target species in the Bird Corridor during the Bird Corridor monitoring low tide counts. Only days with peak counts of ≥ 50 birds are included. The data from the EBB and FLOOD counts is excluded because the Bird Corridor has limited or no exposure during these periods.

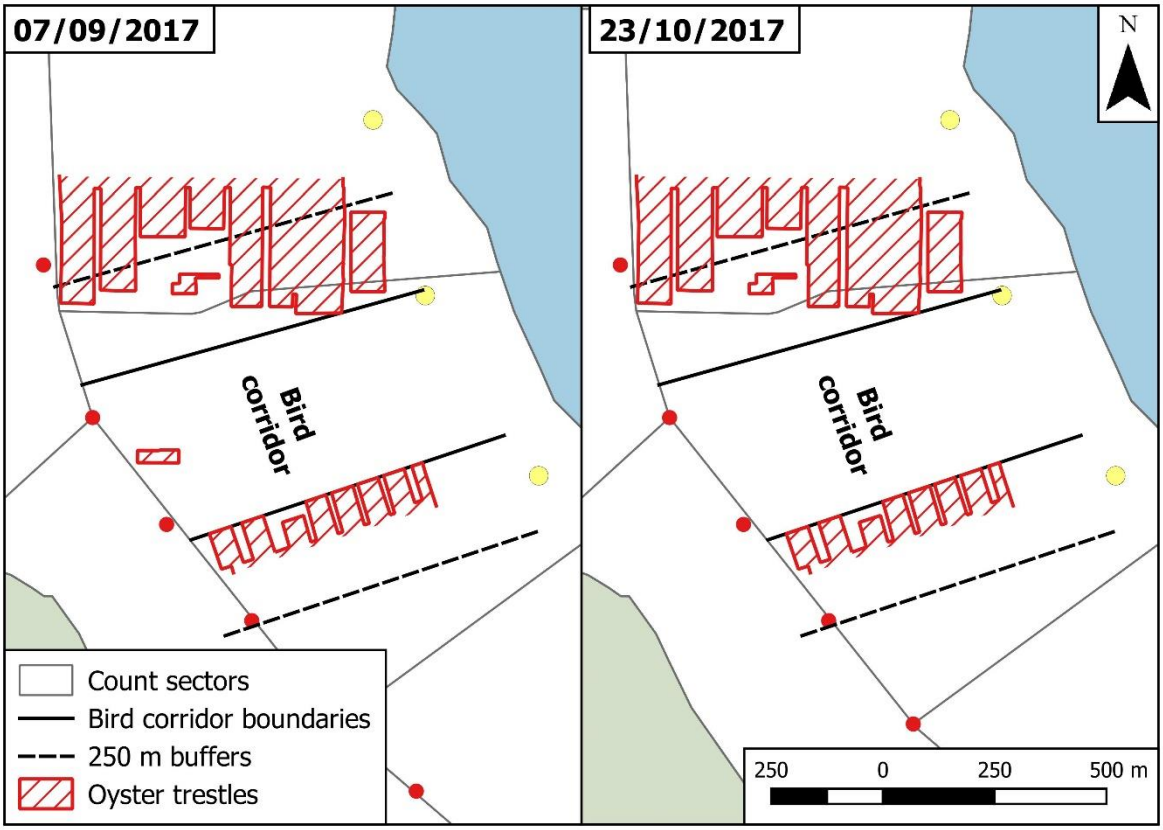


Figure 4.1 – Extent of oyster trestles within and around the Bird Corridor.

5. Results: Inner Harbour monitoring

Target species numbers

5.1 The numbers of the target species (excluding Bar-tailed Godwit) recorded in the Inner Harbour across the tidal cycle on the Inner Harbour monitoring days are shown in Table 5.1.

5.2 On 20th February, Grey Plover numbers gradually decreased across the ebb and low tide periods, with no birds present at the end of the low tide period. Most of the Grey Plover that left the Inner Harbour during the low tide period appeared to move to the Bird Corridor where a flock of around 100 Grey Plover was present by the LT3 count. Knot only occurred on the EBB3 and EBB4 counts. Dunlin numbers remained more or less constant up to the LT2 period. The flock then moved back and forth between the Inner Harbour and Whitehouse Bank until the end of the low tide period. At the end of the low tide period, the Dunlin flock settled in the upper part of the Bird Corridor and followed the tideline up into CS2 and CS3 on the flood tide.

5.3 On 6th March, Grey Plover numbers in the Inner Harbour again decreased across the low tide period, but some remained until the end of the low tide period, with a roosting flock building up towards the end of the flood tide period. Knot numbers built up across the ebb tide period, but all the Knot left the Inner Harbour after the LT1 count. Dunlin numbers also built up across the ebb tide period and numbers remained high throughout the low tide period.

5.4 On most counts, all, or nearly all, of the birds were feeding. However, around half of the Grey Plover began roosting from the LT2 count onwards on 20th February and from the LT3 count onwards on 6th March.

Table 5.1 – Tidal cycle counts of Grey Plover, Knot and Dunlin in the Inner Harbour during the Inner Harbour monitoring days.

Species	Count	20/02/2018	06/03/2018
Grey Plover	EBB1	0	6
	EBB2	121	30
	EBB3	84	7
	EBB4	65	54
	EBB5	52	no count
	LT1	59	32
	LT2	54	37
	LT3	13	56
	LT4	12	14
	LT5	0	15
	LT6	0	16
	FLOOD0	no count	11
	FLOOD1		11
	FLOOD2		11
	FLOOD3		94
Knot	EBB1	0	11
	EBB2	0	60
	EBB3	20	220
	EBB4	150	340
	LT1	0	270

Species	Count	20/02/2018	06/03/2018
Dunlin	EBB1	2000	630
	EBB2	2000	1500
	EBB3	2000	1920
	EBB4	2000	2400
	EBB5	2000	no count
	LT1	1500	2490
	LT2	1500	2000
	LT3	0	2000
	LT4	1500	2000
	LT5	0	2000
	LT6	1500	2000
	FLOOD0	no count	900
	FLOOD1		1320
	FLOOD2		2460
	FLOOD3		1000

Distribution patterns

5.5 The distribution patterns of Grey Plover, Knot and Dunlin in the Inner Harbour across the tidal cycle during the tidal cycle monitoring are shown in Appendix D, and summary maps of the overall areas occupied at low tide by Grey Plover and Dunlin are shown in Figure 5.1.

5.6 Grey Plover moved out from Whitehouse Bank on the ebb tide. At low tide, the birds split into several loose flocks. These were widely distributed, with the main areas occupied being around the minor tidal channels close to the Cunnigar, the western side of sector 0M419, and the southern section of sector 0M418 (Figure 5.1). Within these areas, the flocks moved around between counts, with the total areas occupied across the low tide period of extending across around 400-900 m of intertidal habitat (Figure 5.1). The birds within each loose flock were generally widely spaced, with flocks of 10-50 birds usually extending across several hundred metres of intertidal habitat. However, on 6th March, the flocks became more compact in the second half of the low tide period and on the flood tide, when most birds were roosting.

5.7 Knot flock maps are not shown for 20th February as they were only present on two counts on that day. On 6th March, Knot moved out from Whitehouse Bank into the middle of the intertidal area to the west of the Cunnigar, remaining in two fairly compact flocks, before leaving the Inner Harbour after the LT1 count.

5.8 Dunlin moved out from Whitehouse Bank on the ebb tide and at low tide occurred mainly in the western sections of 0M419 and 0M427 (Figure 5.1). They generally remained in a single compact flock, with 1500-2000 birds extending over a few hundred metres of intertidal habitat. However, the flocks showed a lot of movement, within and between counts, with the total area occupied across the low tide period extending across around 1300-1400 m of intertidal habitat (Figure 5.1).

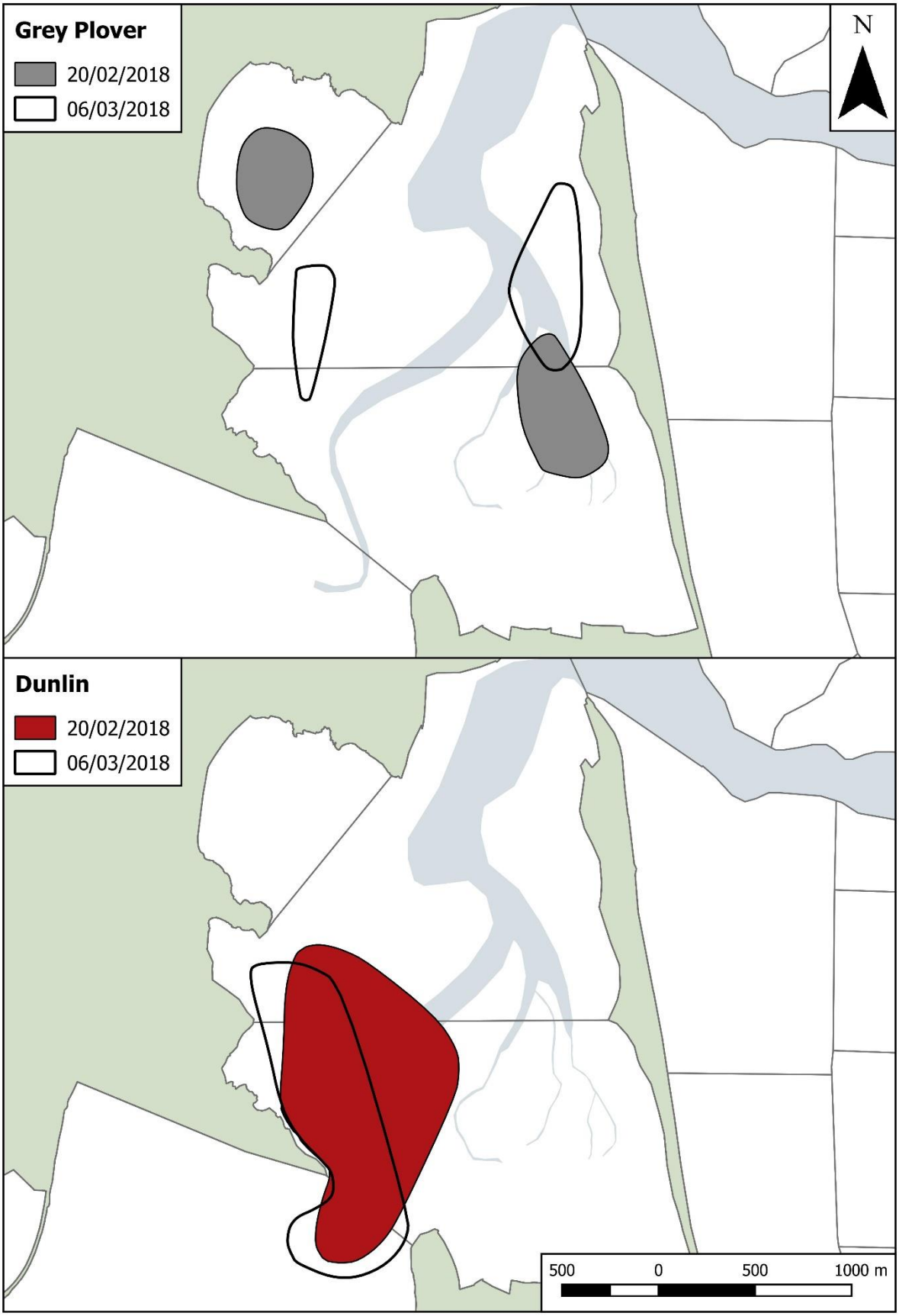


Figure 5.1 – Overall areas occupied by Grey Plover and Dunlin (excluding outlying areas only occupied during one count period) across the low tide period on the Inner Harbour monitoring days.

6. Discussion

Count accuracy

6.1 The ebb and flood tide counts followed the methodology established in 2014/15 (Gittings and O'Donoghue, 2015) and we consider that the ebb and flood tide counts on Whitehouse Bank were generally very accurate. This is reflected in the count data for target species in the ebb tide period that generally showed a consistent pattern of decrease across the ebb tide period, reflecting the movement of birds off Whitehouse Bank during this period. The count data in the flood tide period showed a less consistent pattern, but this appears to have reflected more complex movement patterns.

6.2 As in 2014/15, the fact that the maximum count on the ebb or flood tide counts often exceeded the low tide count shows that there were some issues with count accuracy during the low tide counts. As in 2016/17, Grey Plover was particularly affected by these issues, with lower numbers at low tide, compared to the maximum count ebb/flood tide count, on all of the tidal cycle count dates. There were a number of factors that probably affected the accuracy of the low tide counts (Gittings and O'Donoghue, 2015). These issues illustrate the challenges in carrying out accurate low tide counts of highly mobile species in complex intertidal sites. At Dungarvan Harbour, fully accurate low tide counts for the target species would probably require a team of at least six observers (Gittings and O'Donoghue, 2015).

Distribution patterns

6.3 The tidal cycle movements of Grey Plover and Bar-tailed Godwit in 2016/17 were similar to those observed in 2014/15. However, as in 2016/17, on the ebb tide counts, both Knot and Dunlin stayed longer on Whitehouse Bank in 2017/18 compared to 2014/15. Therefore, the pattern of the Knot and Dunlin tidal cycle counts in 2016/17 and 2017/18 could be interpreted as indicating that the tideline reaching the trestle zone was a proximal cause of Knot and Dunlin movements off Whitehouse Bank.

6.4 In contrast to 2014/15 and 2016/17, Grey Plover were present on Whitehouse Bank in significant numbers at low tide on two of the tidal cycle counts. Knot were largely absent from the Inner Harbour at low tide, unlike previous winters. The broad distribution patterns of Bar-tailed Godwit and Dunlin at low tide were similar to previous winters. As in 2016/17, the Dunlin that occurred on Whitehouse Bank at low tide were concentrated in the northern part in sectors CS3 and OY3, although numbers in OY4 were lower than in 2016/17.

6.5 Overall, the comparison of the low tide distribution patterns between the four winters for which we have data shows that, while the broad distribution patterns remain fairly constant (i.e., the concentration of Grey Plover, Knot, apart from 2017/18, and Dunlin in the Inner Harbour and Bar-tailed Godwit on the Ballyrandle Sandflats), the finer scale patterns can be quite variable (e.g., the relative distribution of Grey Plover and Dunlin between the Ballyrandle Sandflats and Whitehouse Bank, and the distribution of Dunlin within Whitehouse Bank). Without data on the availability of food resources, it is not possible to interpret the significance of these finer scale patterns.

Responses to intertidal oyster cultivation

6.6 As in previous winters, Grey Plover and Knot were more or less completely absent from the areas occupied by oyster trestles. Across the four winters that we have monitored waterbird distribution on Whitehouse Bank, there have only been two records of a total of five birds of Grey Plover within

trestle blocks during low tide counts, as well as one record of a flock of 17 Grey Plover roosting on an isolated block of trestles at the start of the flood tide period. There have been no records of Knot in the oyster trestle areas on any of the counts carried out across these four winters. While it could be argued that the apparent avoidance of the oyster trestles is an artefact of the low numbers/absence of these species from Whitehouse Bank at low tide, the occurrence of large numbers of these species in the Bird Corridor on some of the Bird Corridor monitoring days indicates that it is the presence of oyster trestles on Whitehouse Bank that is, at least in part, causing the low numbers/absence of these species from Whitehouse Bank.

6.7 The percentage occurrence of Bar-tailed Godwit in the oyster trestle areas at low tide in 2017/18, and the patterns of negative association with oyster trestles derived from analysis of the data, were similar to that recorded in previous winters. Therefore, the 2017/18 data provides further evidence of a strong negative pattern of association between Bar-tailed Godwit and oyster trestles.

6.8 While the relative numbers within the trestle blocks were lower than in 2016/17, Dunlin distribution in the Outer Sandflats zone did not have an obviously negative association with oyster trestles, in contrast to the patterns shown in 2010/11 and 2014/15. This was due to the relatively low numbers of Dunlin recorded from the Ballyrandle Sandflats, and the occurrence of relatively large numbers of Dunlin in sector OY3. The latter was part of an apparent concentration of Dunlin at low tide in the northern part of Whitehouse Bank. This suggests that food resources, rather than the presence of oyster trestles, was the main factor determining Dunlin distribution patterns at low tide in the Outer Sandflats zone in 2016/17. However, the much larger Dunlin flocks recorded at low tide in the Bird Corridor on some of the Bird Corridor monitoring days suggests that the presence of trestles on Whitehouse Bank may have limited the overall numbers in the Outer Sandflats zone.

6.9 It was also notable that the Dunlin in the oyster trestle areas occurred in scattered small groups (usually less than 20 birds), while, when large numbers of Dunlin occurred in sector CS3, or in the Bird Corridor, at low tide, they were usually in one or two large flocks.

Bird corridor

6.10 Large numbers of all four of the target species were recorded in the Bird Corridor at low tide on some counts, but their occurrence was erratic. On some days, large flocks of one or more target species remained in the Bird Corridor throughout most of the low tide period. On other days, the target species only occurred for brief periods and/or only towards the end of the low tide period, while there were also days on which all the target species were largely absent from the Bird Corridor.

6.11 The monitoring of Grey Plover and Dunlin flock distribution within the Inner Harbour indicates that large flocks of these species move across large areas of intertidal habitat over the duration of a low tide period. Based on the patterns observed on the two Inner Harbour monitoring days, the Bird Corridor is probably not wide enough to hold large numbers of these species across a full low tide period.

6.12 In contrast to 2016/17, very little tractor activity was recorded within the Bird Corridor. Most of the activity that did occur was at the start of the monitoring period when one block of trestles remained present in the upper section of the Bird Corridor generating some husbandry activity in the Bird Corridor. These trestles were removed from the Bird Corridor by mid-October.

6.13 The target species numbers recorded in the limited Bird Corridor monitoring carried out in 2016/17, showed a strong negative relationship with tractor activity within/adjacent to the Bird Corridor. The more extensive dataset that has now been compiled with the addition of the 2017/18 data does not show such clear relationships although there are still indications of tractor activity causing negative effects on target species numbers within the Bird Corridor. The weakening of this apparent effect probably reflects the fact that the 2016/17 data was collected over a short period of time when there

may have been less noise in the data caused by other factors that may vary over time (such as seasonal effects). Also, the reduction in tractor activity within the Bird Corridor may mean that birds are becoming habituated to activity adjacent to the Bird Corridor and no longer perceive it as being such a threat. However, full analysis of the effects of tractor activity on bird numbers within the Bird Corridor would require a more sophisticated mixed-modelling analytical approach.

6.14 A complicating factor in analysing the effects of tractor activity on target species numbers within the Bird Corridor is that both tractor activity and target species numbers appear to be correlated with the stage of the low tide period. This means that two potential explanatory variables (tractor activity and tidal stage) are inter-correlated, making it difficult to distinguish between the effects of the two variables. It may be that target species usage of the Bird Corridor is largely driven by tidal exposure patterns, with birds coming to the Bird Corridor in the second half of the low tide period when intertidal areas in the Inner Harbour are drying out. If this is the case, the apparent relationships with tractor activity could be artefacts.

6.15 Alternatively, as discussed before (Gittings and O'Donoghue, 2018), it could be that the apparent relationship with the tidal stage is an artefact, resulting from sensitisation to the typical patterns of husbandry activity.

Conclusions

6.16 The broad patterns of tidal cycle movements, low tide distribution and association with oyster trestles recorded in the 2017/18 waterbird monitoring of the target species at Dungarvan Harbour are largely similar to those recorded in previous winters. However, as in 2016/17, Dunlin distribution in the Outer Sandflats zone did not show an obvious negative association with oyster trestles, although the trestles may still be causing displacement at a larger scale.

6.17 Large numbers of all four of the target species were recorded in the Bird Corridor at low tide on some counts, but their occurrence was erratic.

6.18 Monitoring of Grey Plover and Dunlin flock distribution within the Inner Harbour indicated that the Bird Corridor is probably not wide enough to consistently hold large numbers of these species across a full low tide period.

6.19 There is some evidence that tractor movements and husbandry activities may be limiting the usage of the Bird Corridor, and may also be having larger-scale effects on waterbird utilisation of Whitehouse Bank at low tide. However, it is also possible that the apparent relationships with tractor activity are artefacts of a relationship between waterbird numbers and low tide stage.

7. References

Gittings, T. & O'Donoghue, P.D. (2012). *The Effects of Intertidal Oyster Culture on the Spatial Distribution of Waterbirds*. Report prepared for the Marine Institute, Atkins, Cork.

Gittings, T. & O'Donoghue, P.D. (2014). *Dungarvan Harbour SPA Appropriate Assessment*. Report prepared for the Marine Institute, Atkins, Cork.

Gittings, T. & O'Donoghue, P.D. (2015). *Dungarvan Harbour SPA Monitoring of Waterbird Distribution across the Tidal Cycle*. Report prepared for the Marine Institute, Atkins, Cork.

Gittings, T. & O'Donoghue, P.D. (2018). *Dungarvan Harbour SPA: Monitoring of waterbird distribution across the tidal cycle, 2016/17*. Report prepared for the Marine Institute, Atkins, Cork.

Laursen, K., Kahlert, J. & Frikke, J. (2005) Factors affecting escape distances of staging waterbirds. Wildlife Biology, 11, 13–19.

Appendix A
Count data for the additional monitored species

Table A.1 - Maximum counts of the additional monitored species recorded during ebb, low and flood tide periods on each count day.

Species	Date	Maximum count		
		Ebb	LT	Flood
Light-bellied Brent Goose	06/10/2017	61	177	145
	07/11/2017	1033	933	817
	05/12/2017	1162	684	921
	19/01/2018	84	648	341
	02/02/2018	205	691	139
	19/02/2018	374	769	306
Golden Plover	06/10/2017	420	1300	1
	07/11/2017	4080	0	10
	05/12/2017	0	4000	0
	19/01/2018	0	3579	0
	02/02/2018	120	932	0
	19/02/2018	0	3950	0
Ringed Plover	06/10/2017	61	47	152
	07/11/2017	83	18	82
	05/12/2017	80	117	71
	19/01/2018	135	22	86
	02/02/2018	138	95	75
	19/02/2018	48	88	62
Sanderling	06/10/2017	0	4	77
	07/11/2017	40	6	1
	05/12/2017	121	95	108
	19/01/2018	38	0	101
	02/02/2018	145	4	102
	19/02/2018	55	76	79

Data are the maxima across four ebb tide counts, one low tide count, and four flood tide counts. The areas covered varied between counts (see text for details).

Table A.1 - Counts of the additional monitored species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Light-bellied Brent Goose	06/10/2017	19	0	61	56	177	132	145	113	59
	07/11/2017	979	1033	696	486	933	668	724	586	817
	05/12/2017	1162	1113	497	666	684	551	921	505	404
	19/01/2018	56	62	84	43	648	11	10	341	25
	02/02/2018	205	176	119	106	691	139	81	15	40
	19/02/2018	165	371	374	224	769	261	306	206	268
Golden Plover	06/10/2017	0	400	420	420	1300	0	0	0	1
	07/11/2017	3008	3000	4080	0	0	10	7	7	0
	05/12/2017	0	0	0	0	4000	0	0	0	0
	19/01/2018	0	0	0	0	3579	0	0	0	0
	02/02/2018	0	120	0	0	932	0	0	0	0
	19/02/2018	0	0	0	0	3950	0	0	0	0
Ringed Plover	06/10/2017	61	47	42	54	47	98	7	31	152
	07/11/2017	81	79	57	83	18	62	80	82	50
	05/12/2017	44	53	80	74	117	32	27	71	66
	19/01/2018	73	57	85	135	22	0	0	0	86
	02/02/2018	20	79	128	138	95	37	75	69	60
	19/02/2018	42	47	48	29	88	62	56	49	38
Sanderling	06/10/2017	0	0	0	0	4	77	66	9	48
	07/11/2017	40	10	34	18	6	1	1	1	0
	05/12/2017	116	121	82	75	95	108	106	96	68
	19/01/2018	34	34	38	7	0	11	60	86	101
	02/02/2018	34	97	145	128	4	0	30	82	102
	19/02/2018	55	47	43	46	76	37	79	56	1

See notes to Table 3.6. Light-bellied Brent Goose were not counted on 04/10/2017.

Table A.1 - Percentages of feeding birds of the additional monitored species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Light-bellied Brent Goose	06/10/2017		0%	0%	0%	0%				
	07/11/2017	0%	0%	5%			0%			
	05/12/2017									
	19/01/2018									
	02/02/2018		0%							
	19/02/2018									
Golden Plover	06/10/2017	100%		11%	11%	59%	72%	0%	35%	100%
	07/11/2017	12%	24%	75%	94%	69%	69%	87%	0%	0%
	05/12/2017	7%	96%	79%	88%	82%	76%	59%	7%	33%
	19/01/2018	42%	30%	96%	79%	95%	64%			
	02/02/2018	63%	89%	74%	94%	89%	56%	60%		
	19/02/2018	30%	77%	91%	59%	77%	70%	89%	71%	12%
Ringed Plover	06/10/2017	85%	98%	93%	100%	100%	84%		0%	54%
	07/11/2017	68%	65%	91%	93%	100%	92%	100%	0%	0%
	05/12/2017	61%	83%	64%	64%	52%			33%	100%
	19/01/2018	100%	100%	100%	100%					12%
	02/02/2018	100%	100%	27%	100%	79%	51%	27%	42%	65%
	19/02/2018	100%	100%	100%	100%	36%	47%	25%	57%	79%
Sanderling	06/10/2017						96%			94%
	07/11/2017	100%	100%	100%	100%					
	05/12/2017	100%	100%	99%	100%	100%	100%	100%	100%	100%
	19/01/2018	100%	100%	100%			100%		100%	100%
	02/02/2018	100%	100%	100%	100%			100%	100%	100%
	19/02/2018	93%	100%	100%	100%	100%	100%	100%	100%	

See notes to Table 3.4.

Table A.1 - Distribution of the additional monitored species at low tide.

Species	Date	Inner Harbour		Outer Sandflats	
		upper	main	Ballyrandle	Whitehouse
Light-bellied Brent Goose	06/10/2017	0	100	18	59
	07/11/2017	130	129	186	488
	05/12/2017	0	153	203	328
	19/01/2018	46	210	330	62
	02/02/2018	22	412	147	110
	19/02/2018	20	267	245	237
Golden Plover	06/10/2017	0	800	0	500
	07/11/2017	0	0	0	0
	05/12/2017	0	4000	0	0
	19/01/2018	0	3000	579	0
	02/02/2018	232	0	700	0
	19/02/2018	0	1230	2720	0
Ringed Plover	06/10/2017	0	0	0	47
	07/11/2017	0	0	0	18
	05/12/2017	0	16	0	101
	19/01/2018	0	22	0	0
	02/02/2018	0	0	0	95
	19/02/2018	0	0	0	88
Sanderling	06/10/2017	0	0	0	4
	07/11/2017	0	0	5	1
	05/12/2017	0	0	0	95
	19/01/2018	0	0	0	0
	02/02/2018	0	0	4	0
	19/02/2018	0	0	0	76

Table A.1 - Observations of additional monitored species in the Bird Corridor during the tidal cycle counts.

Species	Date	EBB3	EBB4	LT	Flood 1	Flood 2
Light-bellied Brent Goose	02/11/2016	0	0	63	0	0
	16/11/2016	0	0	15	0	0
	30/11/2016	29	0	136	0	0
	15/12/2016	0	0	52	0	0
	13/01/2017	32	45	37	0	0
	31/01/2017	0	0	50	0	0
	13/02/2017	0	0	18	0	0
	28/02/2017	0	0	80	0	26
Sanderling	02/11/2016	0	0	0	22	0

Data only shown for days on which the species was recorded in the Bird Corridor on at least one count. Golden Plover and Ringed Plover were not recorded in the Bird Corridor on any of the tidal cycle counts.

Table A.1 - Observations of the additional monitored species in the Bird Corridor during the Bird Corridor monitoring counts.

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	Flood 0
Light-bellied Brent Goose	09/10/2017	0	0	0	0	0	2	8	7
	23/10/2017	0	11	1	10	6	0	0	0
	06/11/2017	5	14	124	167	115	96	71	36
	23/11/2017	0	1	2	9	0	0	0	1
	04/12/2017	0	6	7	2	5	4	8	0
	08/12/2017	0	2	41	56	66	40	15	0
	19/12/2017	0	7	26	30	44	53	47	44
	18/01/2018	0	10	21	11	4	2	2	4
	03/02/2018	5	19	24	18	25	0	6	7
	16/02/2018	0	2	2	7	1	13	0	0
	05/03/2018	30	35	0	57	0	39	50	12
	15/03/2018	0	0	3	0	0	0	0	0
	20/03/2018	12	26	61	78	9	49	77	108
Golden Plover	04/12/2017	0	0	0	0	0	0	0	1
Sanderling	07/09/2017	0	4	0	0	0	0	0	0
	04/12/2017	0	0	0	0	0	0	2	0
	20/03/2018	0	0	0	0	0	0	17	0

Ringed Plover not recorded in the Bird Corridor on any of the Bird Corridor monitoring counts. EBB4 counts: 5 Light-bellied Brent Goose on 06/11/2017; 5 Light-bellied Brent Goose on 20/03/2018. FLOOD1 counts: 48 Light-bellied Brent Goose on 20/03/2018; 1 Sanderling on 19/12/2017; 7 Sanderling on 20/03/2018.

Appendix B

Additional Bird Corridor count data for the target species

Table B.1 - Maximum counts of target species on Whitehouse Bank during the ebb and flood tide periods on the Bird Corridor monitoring days.

Species	Date	Maximum counts:	
		ebb tide	flood tide
Grey Plover	07/09/2017	30	28
	21/09/2017	35	32
	09/10/2017	16	36
	23/10/2017	60	53
	06/11/2017	91	12
	23/11/2017	50	3045
	04/12/2017	50	0
	08/12/2017	66	0
	19/12/2017	30	1
	18/01/2018	40	49
	03/02/2018	0	59
	16/02/2018	18	11
	05/03/2018	89	37
	15/03/2018	10	149
	20/03/2018	108	188
Bar-tailed Godwit	07/09/2017	250	56
	21/09/2017	5	350
	09/10/2017	2	3
	23/10/2017	8	18
	06/11/2017	5	41
	23/11/2017	105	23
	04/12/2017	1	22
	08/12/2017	7	0
	19/12/2017	3	28
	18/01/2018	38	129
	03/02/2018	214	0
	16/02/2018	29	72
	05/03/2018	104	144
	15/03/2018	0	610
	20/03/2018	52	463
Knot	07/09/2017	0	0
	21/09/2017	0	0
	09/10/2017	0	0
	23/10/2017	10	20
	06/11/2017	0	21
	23/11/2017	0	20
	04/12/2017	0	0
	08/12/2017	0	0
	19/12/2017	80	12
	18/01/2018	26	130
	03/02/2018	310	50
	16/02/2018	0	0

Species	Date	Maximum counts:	
		ebb tide	flood tide
Knot	05/03/2018	0	0
	15/03/2018	0	100
	20/03/2018	0	30
Dunlin	07/09/2017	0	63
	21/09/2017	10	50
	09/10/2017	3	200
	23/10/2017	300	2
	06/11/2017	150	0
	23/11/2017	300	570
	04/12/2017	1060	0
	08/12/2017	340	0
	19/12/2017	1200	80
	18/01/2018	400	250
	03/02/2018	200	260
	16/02/2018	290	0
	05/03/2018	240	620
	15/03/2018	300	930
	20/03/2018	153	630

Note: the ebb and flood tide counts only covered sectors CS1 and CS2, and counts of birds in the northern section of CS2 were of low quality (see text).

Appendix C

Bird corridor count data for other waterbird species

Table C.1 - Counts of other waterbird species in the Bird Corridor during the Bird Corridor monitoring watches.

Species	Date	EBB4	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0	FL1
Wigeon	21/09/2017	6	0	0	0	0	0	0	0	0	0
Teal	19/12/2017	0	0	0	0	3	0	0	0	0	0
Shoveler	04/12/2017	0	0	0	0	0	5	5	5	5	5
Little Egret	07/09/2017	0	0	0	0	0	1	0	0	2	0
	21/09/2017	0	0	0	0	0	0	0	3	1	0
Grey Heron	07/09/2017	0	0	0	0	0	0	0	0	2	0
	21/09/2017	0	1	0	0	0	0	0	0	0	0
	09/10/2017	0	0	1	1	0	0	0	0	1	0
	06/11/2017	0	0	0	0	0	0	0	0	3	0
	16/02/2018	0	0	0	0	0	0	0	0	1	0
	20/03/2018	0	0	1	1	2	1	3	1	1	0
Oyster-catcher	07/09/2017	0	3	3	7	11	22	12	13	4	3
	21/09/2017	2	2	1	5	19	24	17	6	9	7
	09/10/2017	9	9	8	7	12	24	33	14	18	4
	23/10/2017	0	3	5	1	3	5	1	4	3	0
	06/11/2017	19	57	31	15	19	22	16	12	21	8
	23/11/2017	0	3	3	2	0	1	2	2	0	0
	04/12/2017	15	6	8	15	22	17	13	13	4	10
	08/12/2017	1	1	2	2	5	1	0	1	0	0
	19/12/2017	9	3	1	9	6	1	2	9	3	3
	18/01/2018	0	4	4	2	1	0	1	7	3	2
	03/02/2018	0	2	2	6	6	5	3	6	2	0
	16/02/2018	0	3	0	0	0	0	0	0	1	0
	05/03/2018	0	0	0	0	0	0	1	1	0	0
	15/03/2018	0	0	0	0	6	0	0	0	0	0
	20/03/2018	5	4	6	4	3	12	9	5	6	7
Curlew	07/09/2017	0	4	4	2	5	7	4	3	1	0
	21/09/2017	0	0	1	1	4	6	1	1	2	0
	09/10/2017	2	7	6	5	3	6	7	5	3	0
	23/10/2017	0	0	0	0	1	3	1	3	3	0
	06/11/2017	1	1	4	1	6	13	10	4	0	2
	23/11/2017	0	0	0	0	1	1	0	1	0	0
	04/12/2017	3	4	1	12	7	11	9	11	2	2
	08/12/2017	0	0	0	1	1	1	0	0	0	0
	19/12/2017	0	0	0	0	2	0	0	0	0	0
	03/02/2018	3	2	1	1	0	1	0	0	0	0
	05/03/2018	0	0	0	0	0	0	0	0	1	0
	20/03/2018	0	0	6	4	7	4	4	0	0	1
Green-shank	06/11/2017	1	1	0	0	0	0	0	0	0	0

Species	Date	EBB4	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0	FL1
Red-shank	21/09/2017	6	1	0	0	0	1	0	0	0	0
	09/10/2017	25	26	19	0	0	0	8	0	0	0
	06/11/2017	4	15	2	0	16	8	4	0	0	0
	23/11/2017	0	0	0	1	0	1	1	0	0	0
	04/12/2017	0	0	2	1	16	9	1	1	0	0
	08/12/2017	0	0	0	0	2	0	0	0	0	0
	19/12/2017	7	1	5	4	2	5	0	11	4	9
	18/01/2018	0	0	1	0	1	0	0	1	1	0
	03/02/2018	0	0	0	2	0	0	0	0	0	0
	16/02/2018	0	0	1	0	0	0	0	0	0	0
	05/03/2018	0	36	42	0	50	0	3	3	3	0
	20/03/2018	7	5	0	0	0	0	0	0	0	0
Black-headed Gull	07/09/2017	0	39	21	44	38	63	46	34	26	9
	21/09/2017	69	111	128	55	155	177	19	30	3	7
	09/10/2017	2	48	33	90	45	27	37	75	9	11
	23/10/2017	0	140	86	77	77	46	30	13	1	0
	06/11/2017	6	3	7	34	33	14	6	15	4	4
	23/11/2017	0	0	0	64	31	15	16	0	0	0
	04/12/2017	22	21	29	145	16	4	50	2	0	0
	08/12/2017	0	1	5	7	25	35	60	121	0	0
	19/12/2017	8	21	10	15	50	15	13	21	21	16
	18/01/2018	0	28	0	9	2	4	4	12	3	2
	03/02/2018	0	11	30	250	3	6	14	6	0	0
	16/02/2018	0	0	1	1	8	11	3	0	1	0
	05/03/2018	0	58	81	0	63	0	16	10	2	0
	15/03/2018	0	0	0	0	0	0	30	0	0	0
	20/03/2018	0	7	2	0	1	0	0	0	0	0
Common Gull	07/09/2017	0	0	3	38	39	25	13	21	1	2
	21/09/2017	0	2	1	16	49	56	18	2	1	1
	09/10/2017	0	0	0	4	5	11	12	7	1	0
	23/10/2017	0	18	2	2	12	18	12	9	6	0
	06/11/2017	0	4	5	8	18	31	16	5	1	1
	23/11/2017	0	0	0	3	6	4	2	1	0	0
	04/12/2017	0	6	9	9	20	18	11	6	0	0
	08/12/2017	0	0	4	2	12	15	19	25	0	0
	19/12/2017	0	0	2	0	1	5	4	2	3	6
	18/01/2018	0	6	0	9	2	10	4	3	0	0
	03/02/2018	1	24	60	86	18	13	22	11	6	2
	16/02/2018	0	0	2	1	4	6	2	0	0	0
	05/03/2018	0	263	217	0	194	0	142	89	16	0
	15/03/2018	0	0	10	7	9	3	12	2	0	0
	20/03/2018	4	13	34	18	10	6	1	2	0	1

Species	Date	EBB4	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	FL0	FL1
Herring Gull	07/09/2017	0	1	1	5	2	4	1	2	3	1
	21/09/2017	0	0	0	0	2	2	2	1	0	1
	09/10/2017	1	2	0	0	1	0	1	3	1	0
	23/10/2017	0	3	1	0	0	0	0	1	1	0
	06/11/2017	2	1	1	0	4	4	2	1	0	0
	23/11/2017	0	0	0	0	3	1	0	0	0	0
	04/12/2017	4	0	0	3	5	1	5	1	0	0
	08/12/2017	0	2	2	2	4	6	0	1	0	0
	19/12/2017	1	1	3	3	1	1	0	1	1	0
	18/01/2018	0	0	1	3	1	6	0	0	0	0
	03/02/2018	0	2	9	3	2	4	2	0	8	0
	05/03/2018	0	28	21	0	36	0	21	11	3	0
	15/03/2018	0	0	0	1	3	0	1	2	0	0
	20/03/2018	2	2	12	12	8	8	11	2	1	2
Lesser Black-backed Gull	07/09/2017	0	1	1	0	0	0	0	0	0	0
	21/09/2017	0	0	0	0	1	1	0	0	0	0
	09/10/2017	0	0	1	0	0	0	0	0	3	0
	23/10/2017	0	1	0	0	0	0	2	1	0	0
	06/11/2017	0	0	0	0	1	0	0	0	1	0
	23/11/2017	0	0	0	0	0	4	5	3	0	0
	03/02/2018	0	0	0	0	0	1	0	0	0	2
	05/03/2018	0	0	0	0	1	0	0	0	0	0
Great Black-backed Gull	07/09/2017	0	0	0	0	1	0	0	0	0	0
	23/10/2017	0	0	0	1	0	0	0	0	0	0
	23/11/2017	0	0	0	0	0	0	1	0	2	0
	04/12/2017	0	0	0	0	4	1	0	4	0	0
	08/12/2017	0	0	0	0	3	2	3	11	0	0
	19/12/2017	0	0	0	1	0	0	0	0	0	0
	18/01/2018	0	0	0	1	2	1	0	0	0	0
	03/02/2018	8	1	1	4	4	2	4	4	0	0
	16/02/2018	0	0	1	0	0	0	0	0	0	0
	05/03/2018	0	0	0	0	1	0	0	0	0	0
	20/03/2018	0	0	0	0	0	0	1	0	0	0
Sandwich Tern	07/09/2017	0	1	0	0	0	0	0	0	0	0
	21/09/2017	0	1	0	0	0	0	0	0	0	0

EBB3 counts: 1 Grey Heron on 07/09/2017; 3 Oystercatcher on 07/09/2017; 12 Oystercatcher on 04/12/2017; 1 Curlew on 07/09/2017; 2 Curlew on 04/12/2017; 51 Black-headed Gull on 07/09/2017; 1 Black-headed Gull on 21/09/2017; 6 Black-headed Gull on 04/12/2017; 2 Herring Gull on 07/09/2017; 2 Herring Gull on 21/09/2017; 1 Herring Gull on 04/12/2017. FLOOD2 counts: 15 Oystercatcher on 20/03/2018.

Appendix D
Inner Harbour flock maps

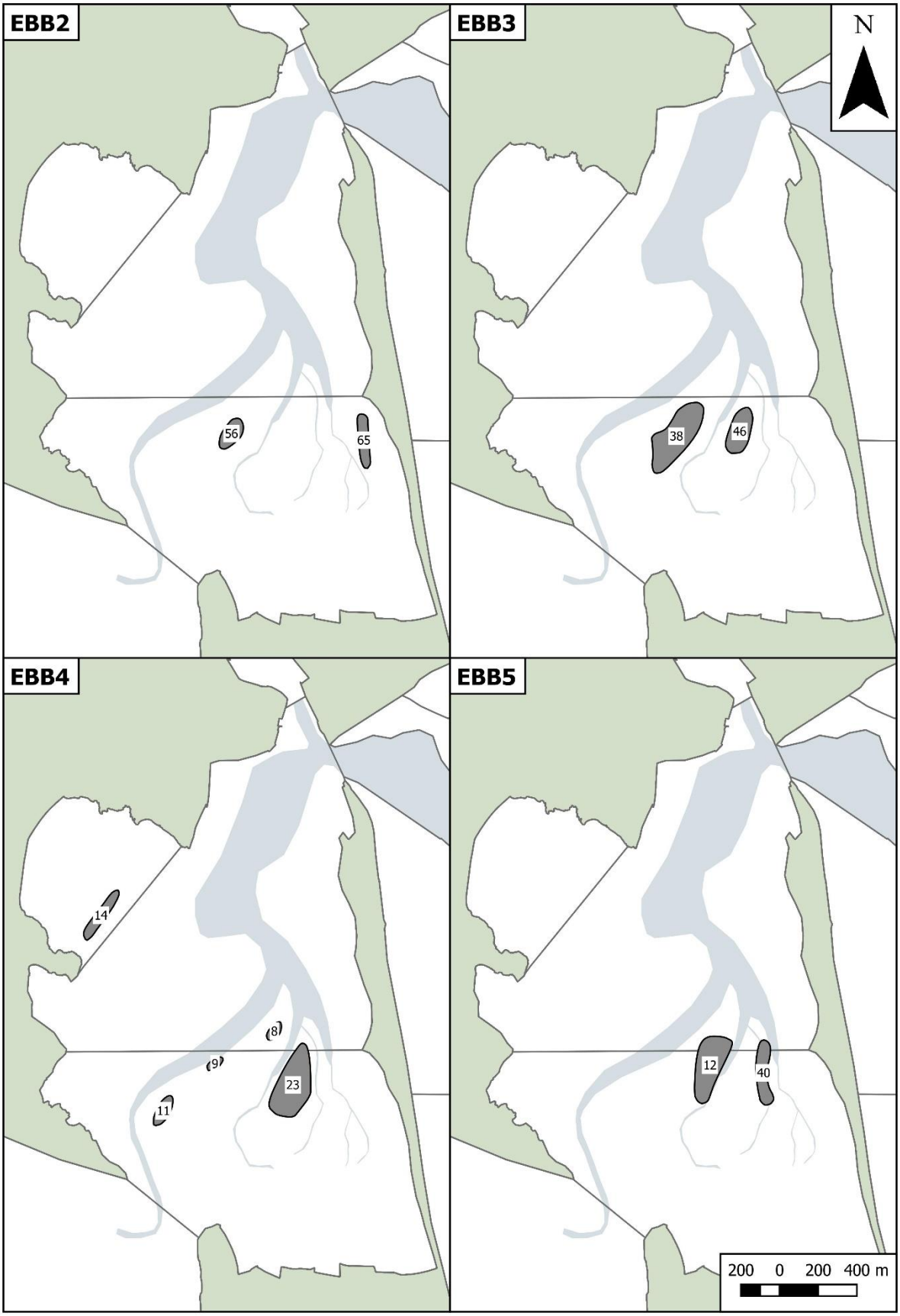


Figure D.1 – Grey Plover 20/02/2018, EBB2-EBB5

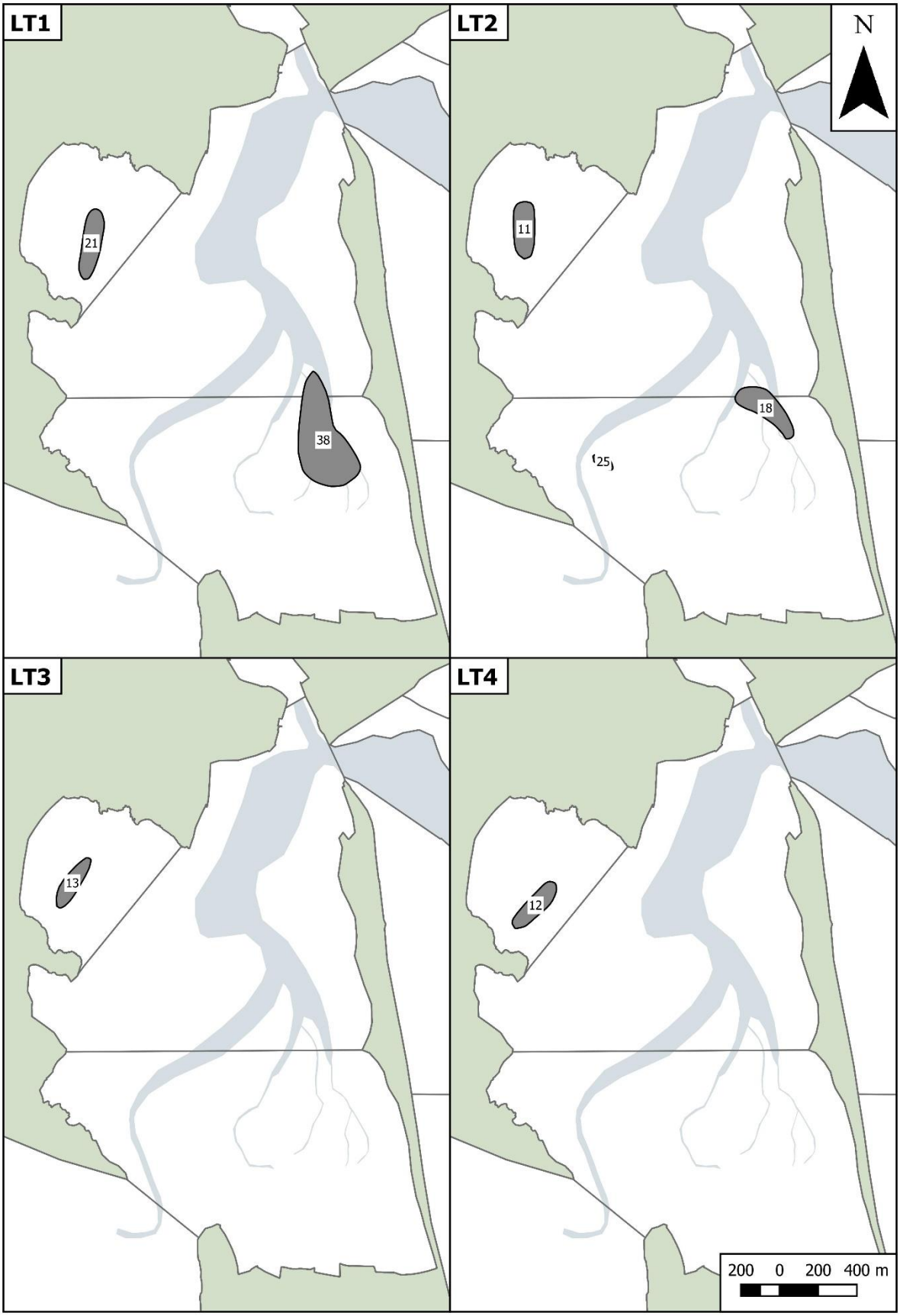


Figure D.1 - Grey Plover 20/02/2018, LT1-LT4

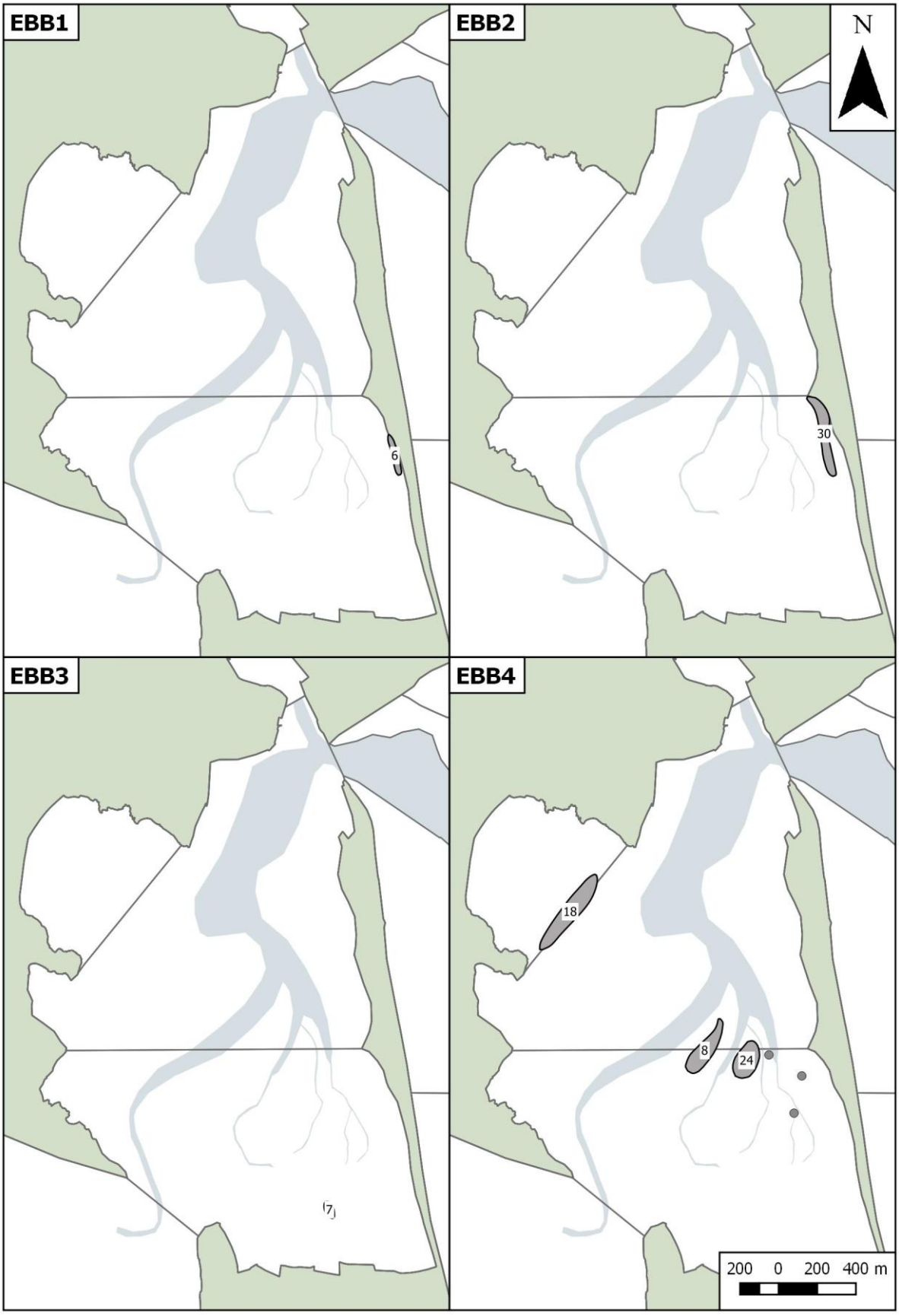


Figure D.1 - Grey Plover 06/03/2018, EBB1-EBB4

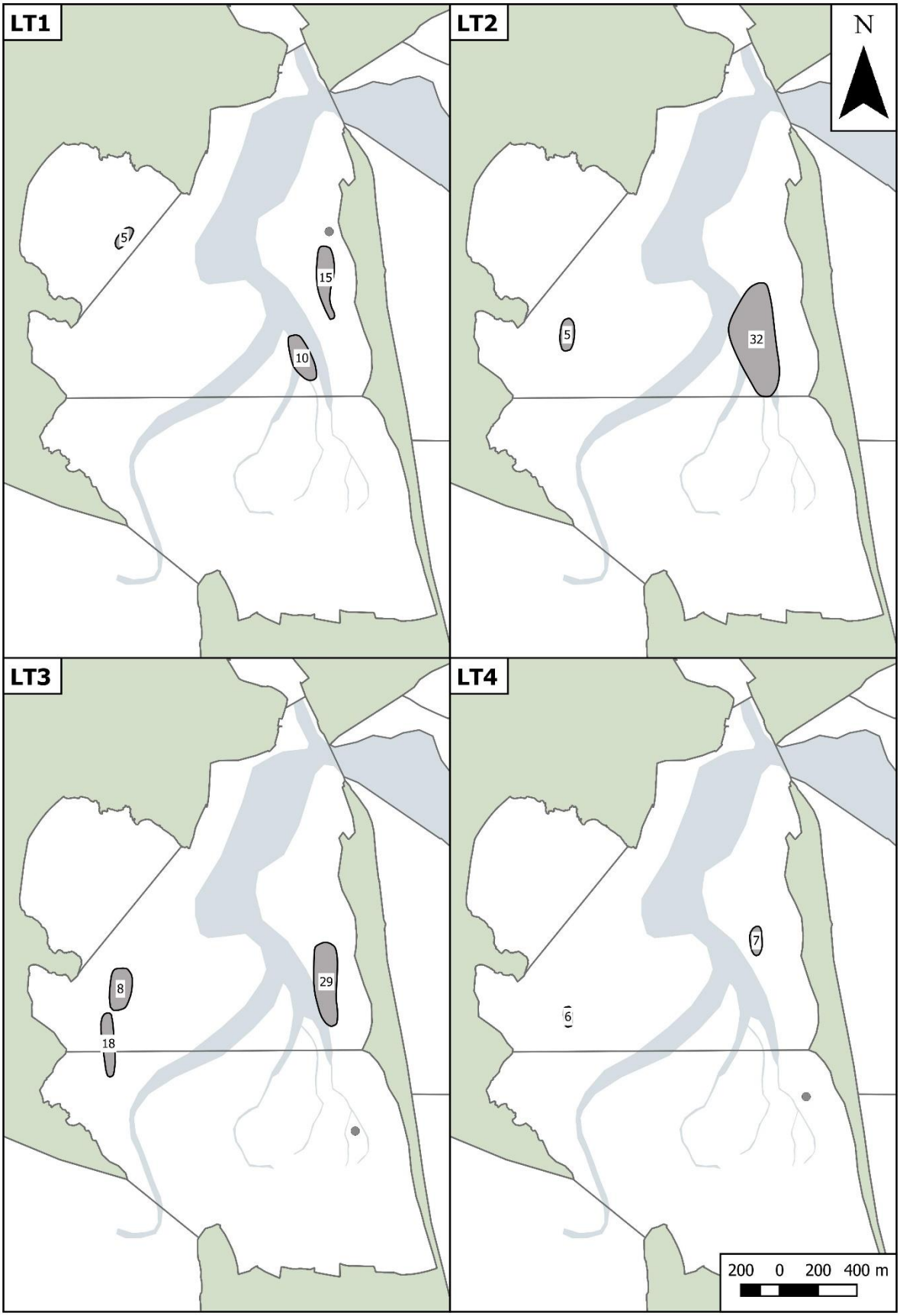


Figure D.1 - Grey Plover 06/03/2018, LT1-LT4

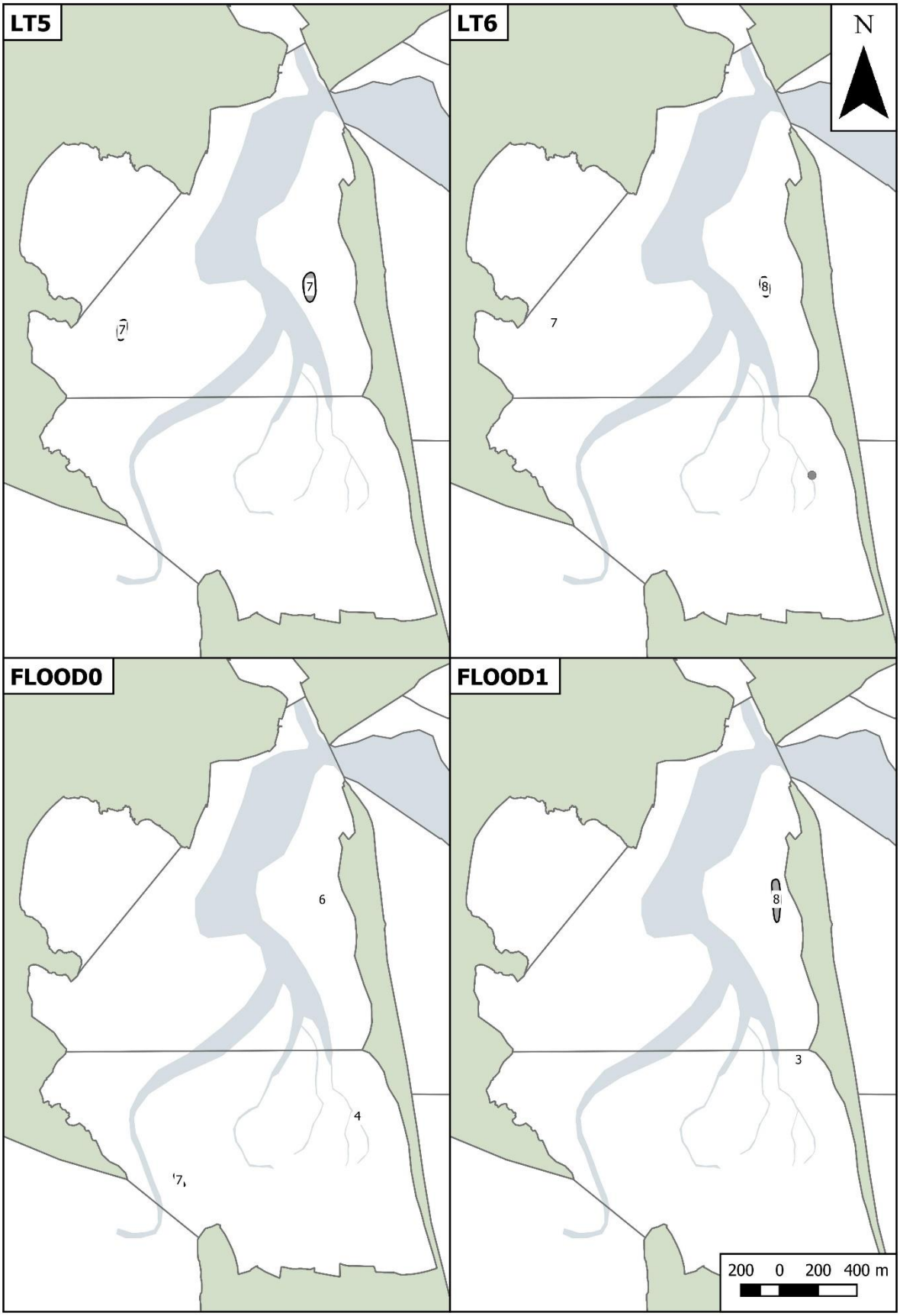


Figure D.1 - Grey Plover 06/03/2018, LT5-FLOOD1

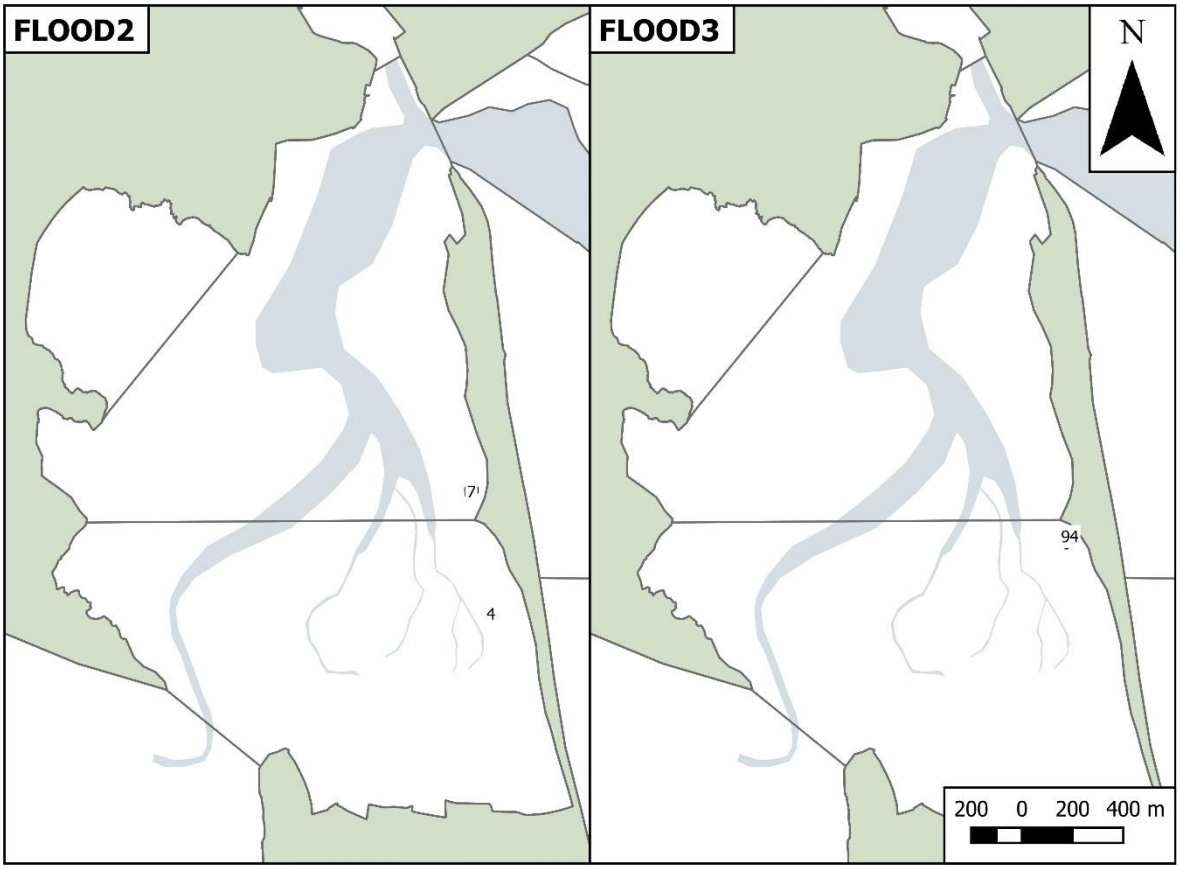


Figure D.1 - Grey Plover 06/03/2018, FLOOD-FLOOD3

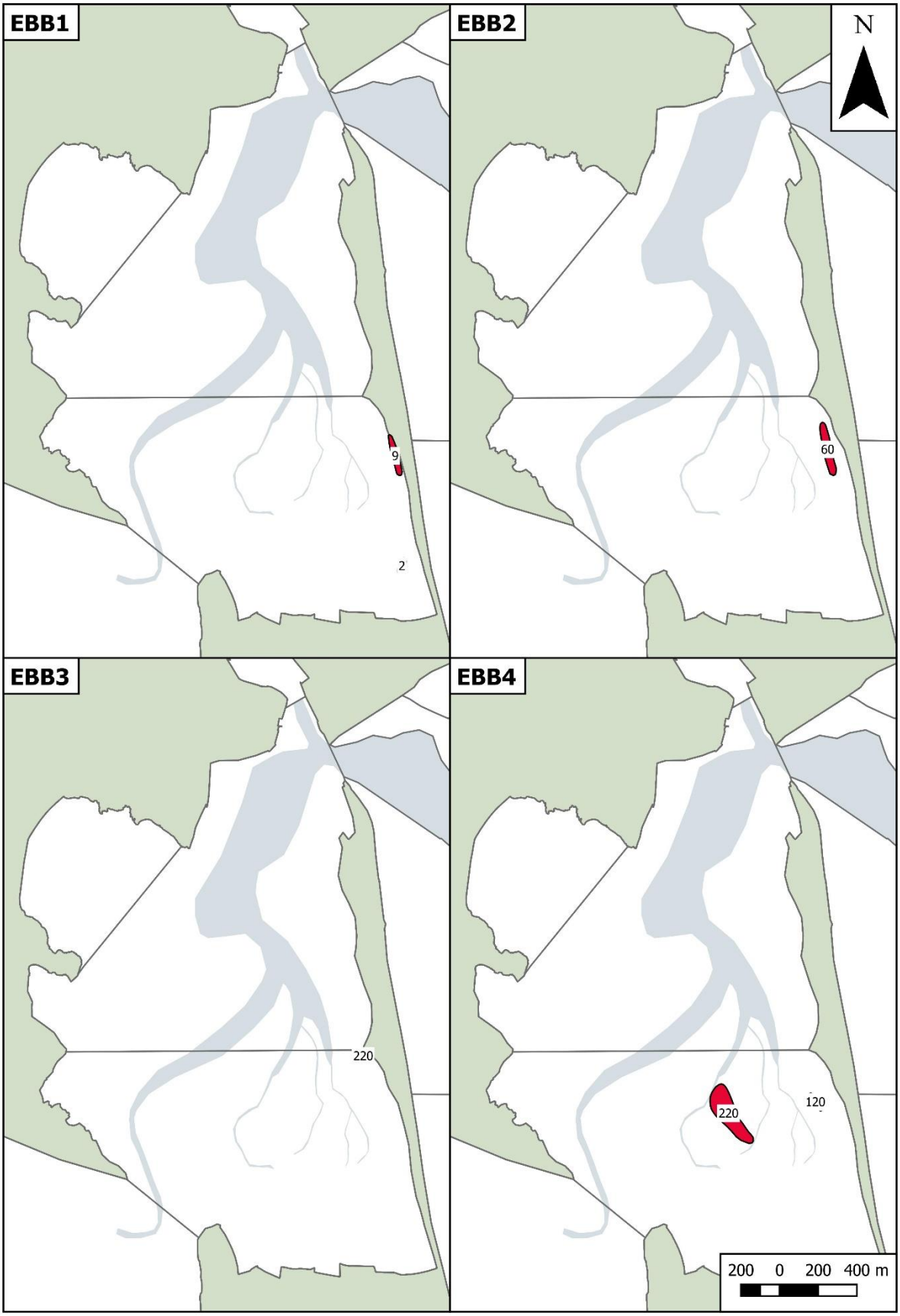


Figure D.1 - Knot 06/03/2018, EBB1-EBB4

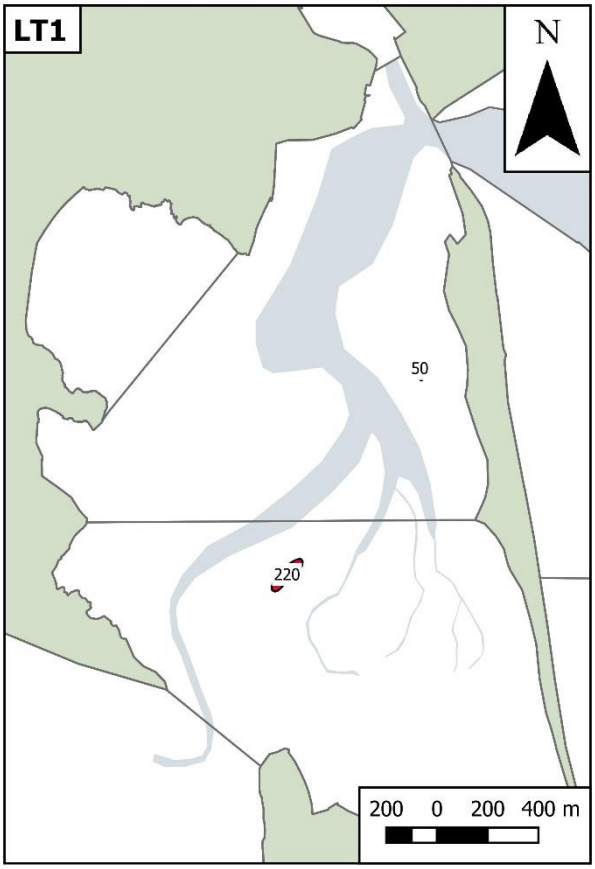


Figure D.1 - Knot 06/03/2018, LT1

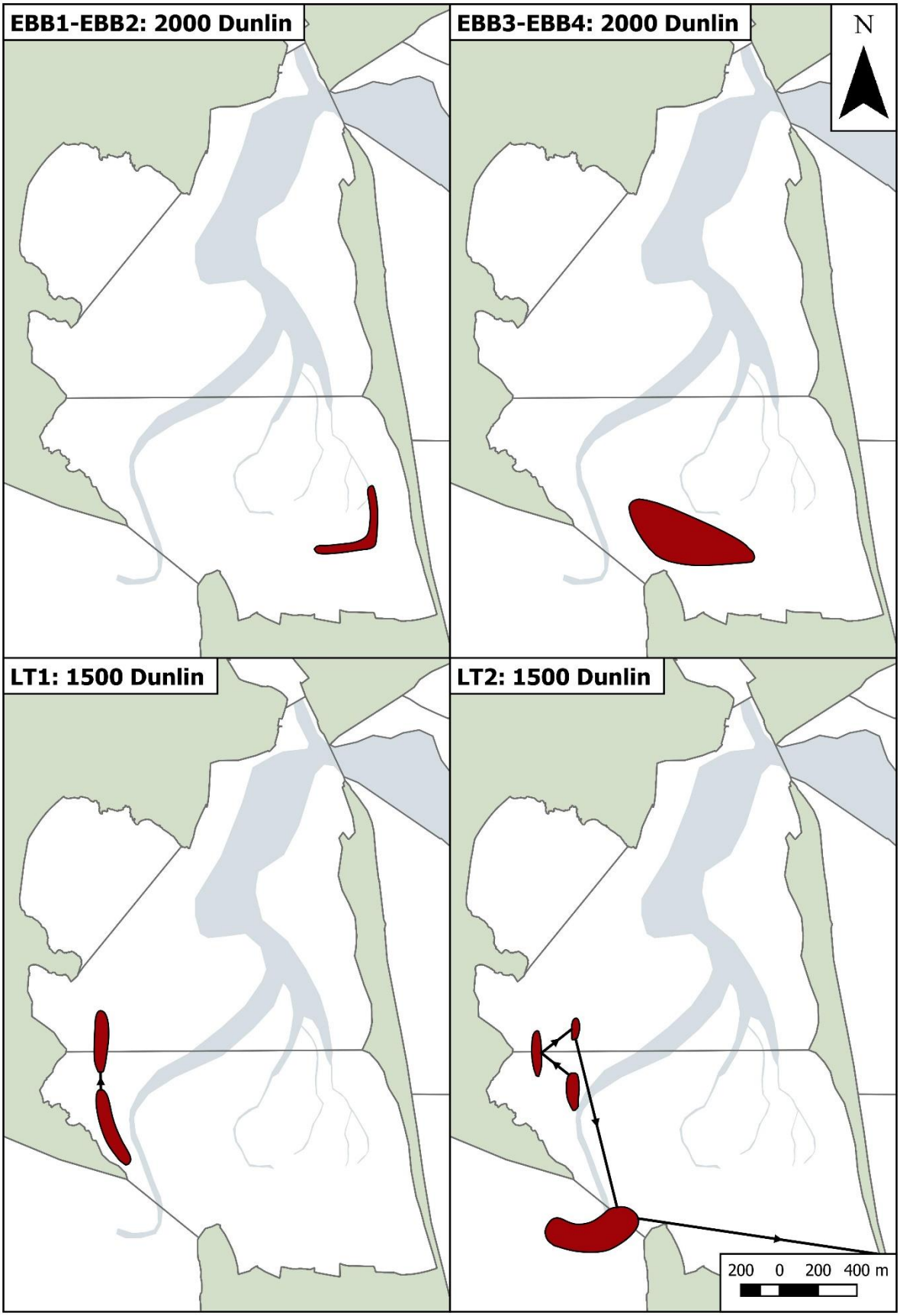


Figure D.1 - Dunlin 20/02/2018, EBB1-LT2

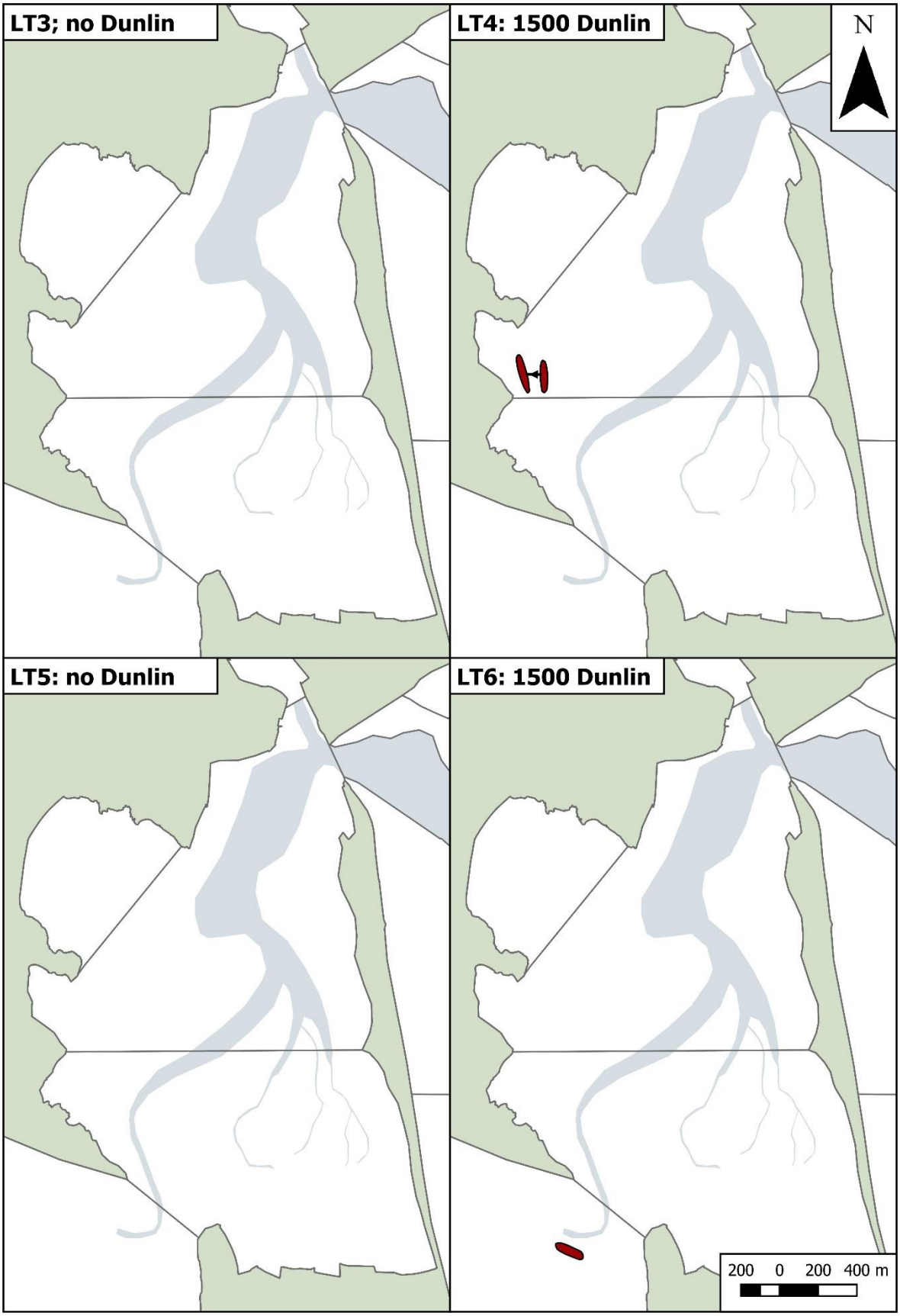


Figure D.1 - Dunlin 20/02/2018, LT3-LT6

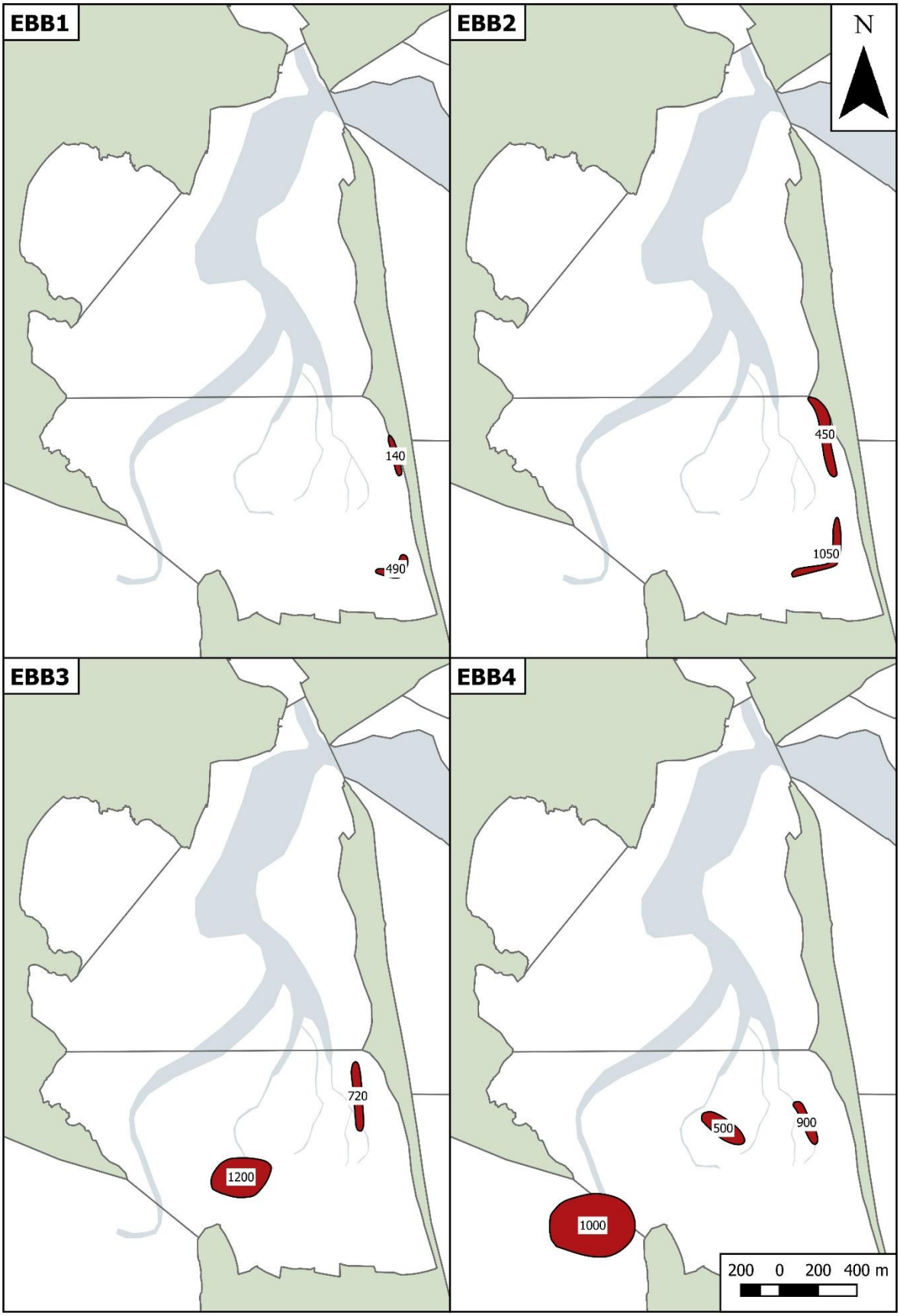


Figure D.1 - Dunlin 06/03/2018, EBB1-EBB4

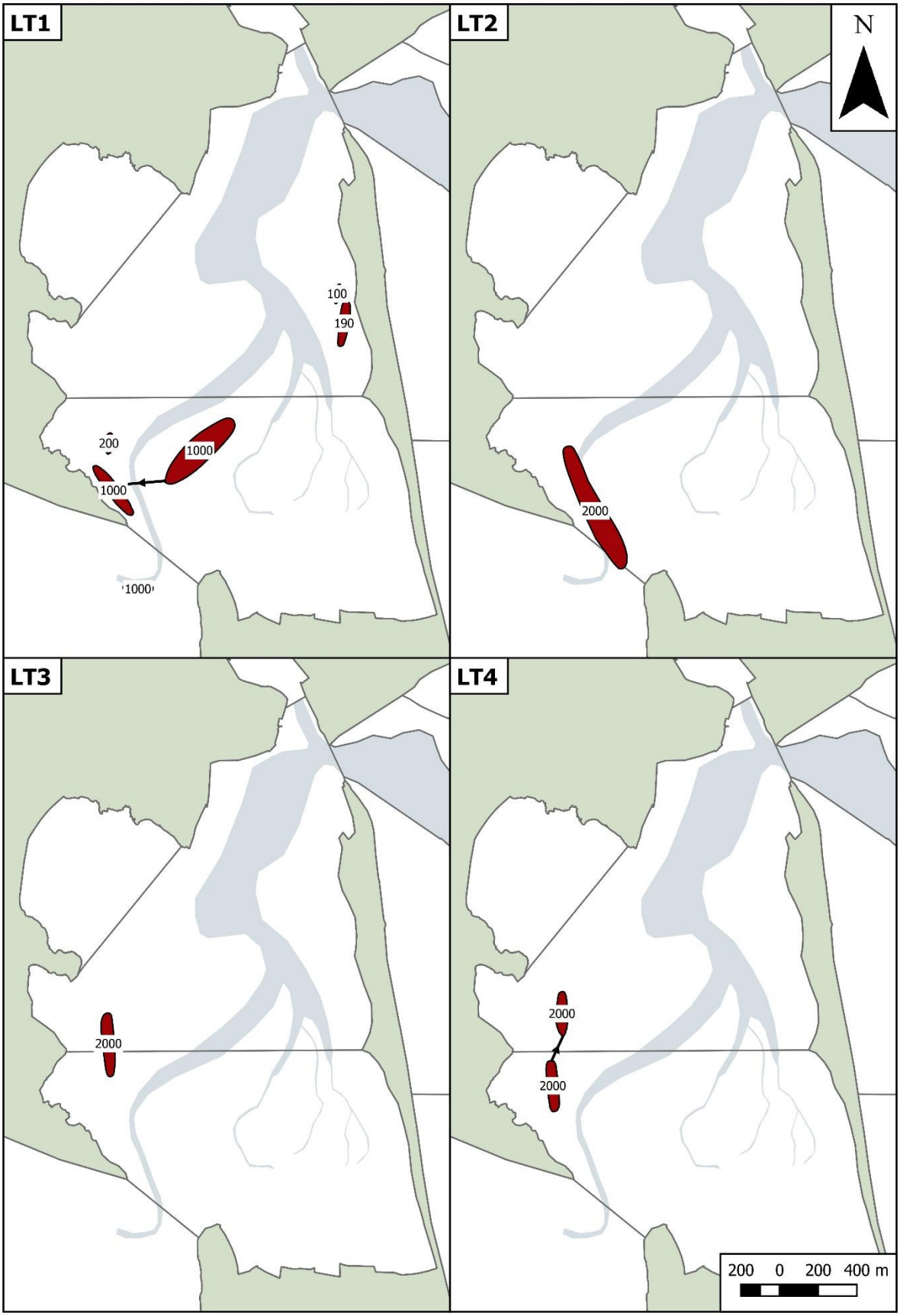


Figure D.1 - Dunlin 06/03/2018, LT1-LT4

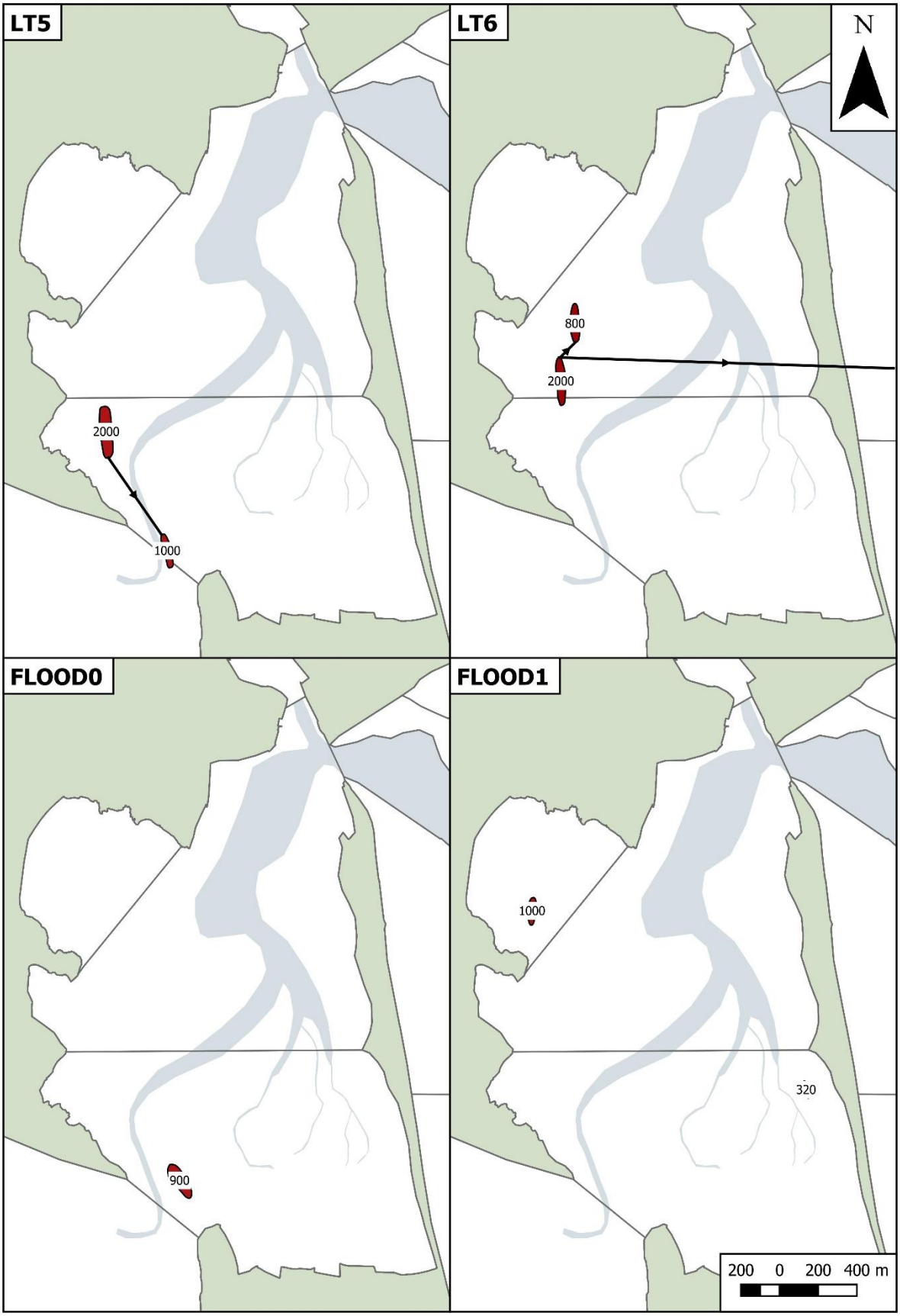


Figure D.1 - Dunlin 06/03/2018, LT5-FLOOD1

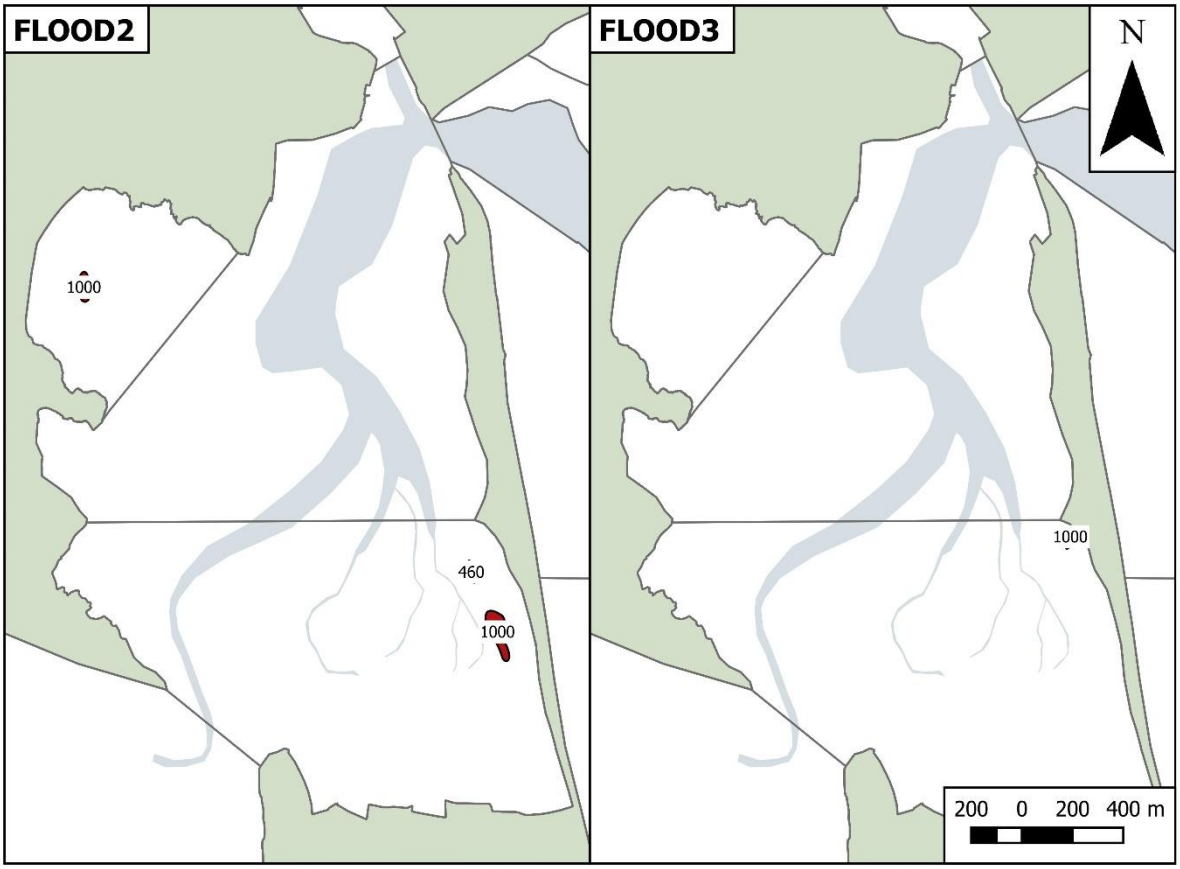


Figure D.1 - Dunlin 06/03/2018, FLOOD2-FLOOD3

Further details available on www.emff.marine.ie

Managing Authority EMFF 2014-2020	Specified Public Beneficiary Body
Department of Agriculture Food & the Marine Clogheen, Clonakilty, Co. Cork. P85 TX47 Tel: (+)353 (0)23 885 9500 www.agriculture.gov.ie/emff	Marine Institute Rinville, Oranmore, Co. Galway, H91 R673 Phone: (+)353 (0)91 38 7200 www.marine.ie

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