Rit LbhÍ nr. 90

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Landbúnaðarháskóli Íslands

Andakíll Ramsar Bird Monitoring Project 2017

2020

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ISBN 978-9979-881-61-2
ISSN 1670-5785

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Desember, 2020
Landbúnaðarháskóli Íslands

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Recommended citation: Tierney, N. & Tierney, R.A. 2020. Waterbirds in the Andakíll Ramsar site: distribution and abundance from bi-weekly surveys in 2017.

Cover photo – Rachel A. Tierney.

Executive Summary

This publication is part of a suite of surveys investigating bird abundance, diversity and seasonality in the Andakíll Ramsar site in Borgarfjörður, western Iceland (64°33'N, 21°46'W). Here, the estuarine part of the site was investigated. Greenland White-fronted Geese and breeding birds are covered elsewhere (Tierney & Stroud 2018; Tierney & Tierney 2020).

In order to capture the arrival and departure dates for the migratory waterbirds, surveys were conducted in each week between 12th March and 25th October 2017. One low tide and one rising tide survey was conducted each week to determine waterbird distribution and abundance at low tide, when the intertidal areas are exposed and available to feeding waterbirds; and rising/high tide, when most birds are at, or moving to, their high tide roosting areas. All waterbirds and seabirds were recorded, as well as each bird's behaviour and their use of different habitat zones.

A total of 31 low tide and 30 rising tide surveys were conducted, and 43 waterbird and seabird species were recorded.

Survey totals ranged from 51 birds (on 12th March) to 5,155 birds (on 7th August). Waterbird and seabird species diversity ranged from five species on 23rd March to 33 species on 8th May.

Overall, the total number of waterbirds and seabirds recorded increased throughout March and April and then remained relatively constant until the end of June, when the numbers doubled. Waterbird and seabird numbers declined throughout September until surveys ceased at the end of October.

The number of birds recorded during low tide surveys was generally higher than during rising tide surveys, especially for some wader species. This suggests that, for some birds, the site is important for foraging during low tide, and roosting refuges outwith the Andakíll Ramsar site are used during high tides.

High tide roost location, size and species composition was investigated. A total of 37 roosts were identified, and 12 of which were used consistently or by relatively large numbers of birds.

Species accounts are provided for 21 wildfowl, 12 waders, 10 seabirds and White-tailed Eagle. These accounts present: weekly abundance; site distribution maps (at low tide and rising tide, and during spring and autumn); and a summary of the proportion of time spent feeding or roosting at subsite level.

Low levels of anthropomorphic disturbance were observed.

This work represents an unprecedented level of information on the diversity, abundance, distribution and seasonality of the waterbirds and seabirds in the Andakíll Ramsar site throughout almost the entire period of the year when there are waterbirds present. However, it is recommended that some form of repeat surveys are conducted, ideally at regular intervals. These data are potentially useful for conservation casework and research purposes, but should be considered as a baseline, upon which further projects can be built.

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1. Introduction

The importance estuaries for waterbirds is well understood and documented (e.g. BirdLife International 2001; Boere *et al.* 2007; Prater 1981). Estuaries traditionally hold large numbers of waterbirds, especially during migratory staging periods and they are used by breeding and non-breeding waterbirds during the breeding season. Some of the waterbirds staging in Iceland in spring and autumn are en route between Greenland or Arctic Canada and western Europe, migrations that involve two considerable sea-crossings, and the prior deposition of considerable fat reserves. Therefore, the stopover sites that Iceland provides are crucial to the success of these migratory journeys. As waterbirds are highly visible, reactive to change and easily counted, they can serve as useful indicators of the health of wetland ecosystems and, over time, reveal changes brought about by natural and anthropogenic processes.

Human infrastructure developments on, and close to, wetland habitats has led to modification and loss of wetlands and to increased disturbance to waterbirds (Boere *et al.* 2007, van de Kam *et al.* 2004). Similarly, pressure from recreational activities has increased in many areas that are important for waterbirds and this is among the main cases of population declines (Goss-Custard & Yates 1992; Davidson & Rothwell 1993; van de Kam *et al.* 2004).

Sea level rise and an increasing frequency of significant storms associated with climate change will result in an increased risk of coastal flooding in low-lying areas (IPCC 2007). This is likely to cause significant losses of feeding and roosting areas for waterbirds (Watkinson *et al.* 2004; Galbraith *et al.* 2005; Durell *et al.* 2006). Waterbirds will also be affected by the indirect effects of climate change, such as: land-use change; changes in the condition of wetlands; alterations in prey availability; changes in matching of the timing of (migratory bird) arrival dates and prey dynamics; altered predation effects; disease and parasitism, amongst others (Poulin & Mouritsen 2006; Boere *et al.* 2007; Mustin *et al.* 2007; Thompson *et al.* 2012; Sutherland *et al.* 2012).

With these changes in land use and climate change, many bird populations are experiencing dramatic contractions or expansions (McCarty 2001; Bohning-Gaese & Lemoine 2004; McDonald *et al.* 2012) and at this time of unprecedented change, information on population sizes and site usage is especially important.

Waterbirds use estuarine sites differently at different stages of the tide as the changing water levels are constantly changing the area available for foraging (Dias 2009; Granadeiro *et al.* 2006). Most species segregate themselves according to preferences for sediment penetrability and water depth. As the tide rises waterbirds are pushed towards their roosting areas as the water deepens and the mud and sand flats become inundated, and either roost adjacent to the foraging areas or fly to high tide roosts in other parts of the site, or beyond. And then, when the foraging areas begin to uncover as the tide recedes, these high tide aggregations break up and the birds disperse across the estuary again. While waterbird distribution is mainly governed by prey availability, high tide roosts can be a crucial factor. Loss of favoured roost sites can decrease survival rates due to the increased energetic costs of flying further to suitable roosting areas (Durell *et al.* 2005). Furthermore, the availability of suitable roost locations can influence the distribution of waders at low tide, as birds seek to reduce energetic expenditure by foraging close to roosting areas (Rogers 2003), even if there are more profitable foraging areas in the vicinity (Dias *et al.* 2006; van Gils *et al.* 2006). The selection of these

foraging and roosting places can change between and within seasons depending on factors such as weather (wind direction), prey availability and variations in human disturbance.

So, in order to be fully informed about how waterbirds make use of sites, it is necessary to collate information on their abundance and distribution throughout the tidal cycle, or at least during low tide and high tide periods. And, information on the seasonality of site use is required for the complete picture. Waterbird usage of estuarine sites also changes through the year, with sites being used as stopover sites during spring and or autumn migration, during the breeding season, as post-breeding moulting sites or as wintering sites.

The aim of this study is to investigate the abundance, distribution and seasonality of waterbirds in the estuarine parts of the Andakíll Ramsar site in Borgarfjörður, western Iceland. The result is a baseline dataset with information on how waterbirds use the protected area during the spring and autumn staging periods and during the breeding season. It is hoped that when future studies are made on the waterbirds on the site, they can be conducted in a way that allows comparisons with the data collected as part of this study. In order to facilitate further monitoring, comprehensive rationale and methodology for this survey is presented as a *Survey Handbook* (Stroud & Tierney 2017).

2. Methods

2.1 Study area

The Andakíll Ramsar site is situated in Borgarfjörður, western Iceland (64°33'N, 21°46'W). The protected area is a 3,086-hectare wetland complex, a significant proportion of which is estuarine. The intertidal zone and areas of open water visible from land-based vantage points were surveyed by dividing the area into six subsites, and surveying them consecutively on each survey day. Initially (until 24th April), five subsites were surveyed, but from then onwards a sixth subsite, Flæðhöfðasker (Est 6) was included in the weekly surveys (Table 2-1; Figure 2-1).

Table 2-1. Subsites covered during low tide and rising tide surveys between 12th March and 25th October 2017

Subsite name	Subsite code	Central coordinates
Grjóteyrarklakkur	Est_1	64.538370, -21.835521
Kistufjörður	Est_2	64.539563, -21.800028
Kistuhöfðahólmar	Est_3	64.551628, -21.810875
Ásgarðshöfði	Est_4	64.562727, -21.790447
Hvítárleirur	Est_5	64.571413, -21.778509
Flæðhöfðasker[1]	Est_6	64.533389, -21.861501

[1] Surveyed from 24th April onwards.

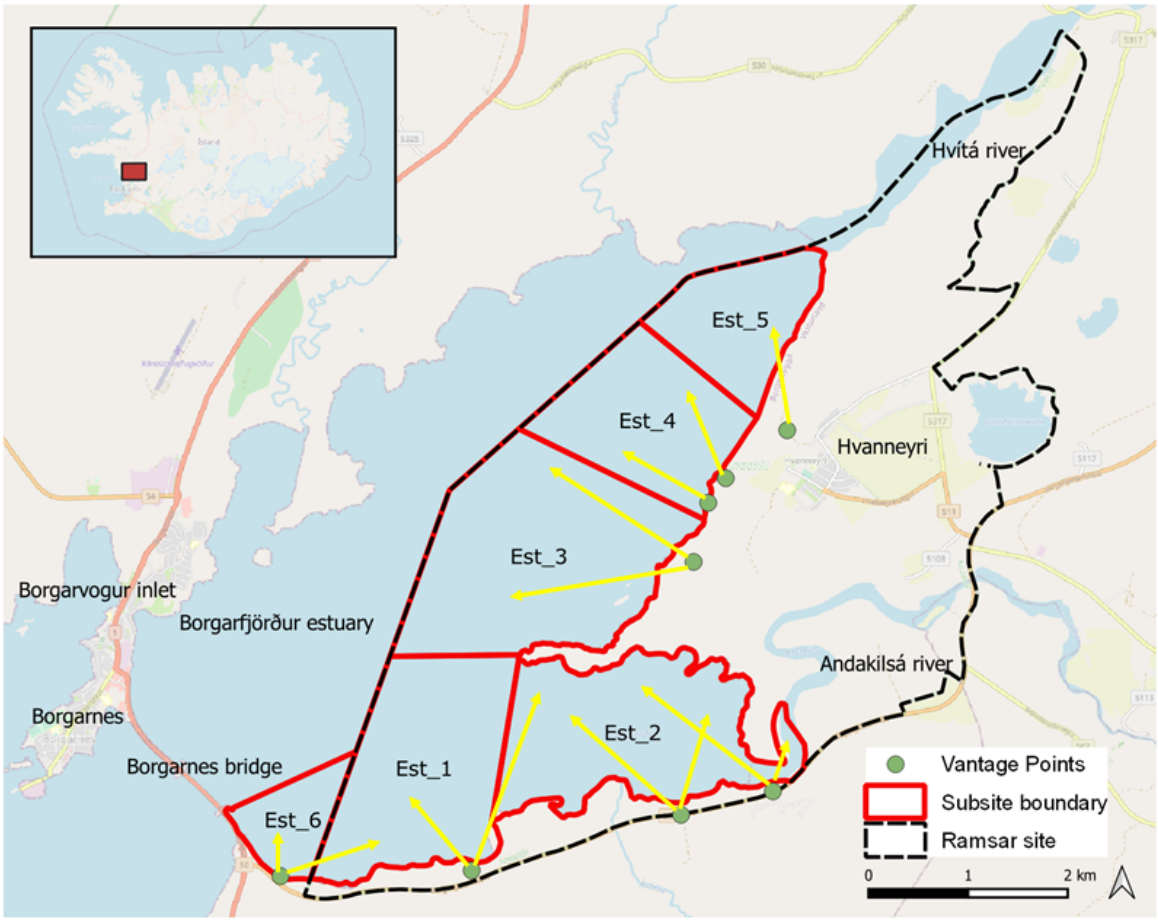

Figure 2-1. The study area in Borgarfjörður covering the estuarine part of the Andakíll Ramsar site. The subsite boundaries are show as red lines and vantage points used as green dots. The dashed black line shows the boundary of the Andakíll Ramsar site. The arrows represent the approximate areas covered from each vantage point. Subsite Est 6 was surveyed from the 24th April onwards.

2.2 Low tide and rising tide surveys

A combination of low tide and rising tide waterbird surveys covering the main part of Borgarfjörður and Kistufjörður were undertaken between 12th March and 25th October 2017 by two observers to determine waterbird distribution and abundance at low tide, when the intertidal flats are exposed and available to feeding waterbirds; and rising/high tide, when most birds are at, or moving to, their high tide roosting areas.

One low tide and one rising tide survey was undertaken in each week. Low tide surveys were used to establish the main feeding distributions of waterbirds and were carried out within a four-hour period, starting two hours before low tide and being completed within two hours after low tide. Rising tide surveys were used to establish waterbird distribution in the period before high tide, when waterbirds are congregating to roost. Surveys commenced three hours before high tide and were completed by high tide.

Surveys were carried out in daylight between the hours of 07:00 and 22:55. On each survey, the date, survey type, surveyors present, start and finish times, tidal state and extent of coverage were

recorded. Weather and visibility were recorded by assessing ice coverage, rain, wind and cloud cover (*see Appendix 2 – Field recording forms*).

In order to facilitate the interpretation of the count data, waterbird species were divided into three groups, wildfowl and allies, waders and seabirds, and the following families were recorded:

Wildfowl and allies: Gaviidae (divers), Podicipedidae (grebes), Phalacrocoracidae (cormorant), Anatidae (swans, geese and ducks).

Waders: Haematopodidae (oystercatchers), Charadriidae (plovers and lapwings), Scolopacidae (sandpipers and allies).

Seabirds: Procellariidae (fulmar), Laridae (gulls and terns) and Stercorariidae (skuas/jaegers).

Waterbirds were recorded within four habitat categories: intertidal, subtidal, supratidal and terrestrial (Table 2-2).

Table 2-2. Habitat categories used when recording waterbird and seabird location.

Zone	Description
Intertidal	Between the mean low-water and mean high-water lines, i.e. the area uncovered by the tide during the survey, usually dominated by mud or sand flats or rocky shores.
Subtidal	Area covered by water, i.e. offshore areas and pools and channels within the intertidal area.
Supratidal	Shore and habitats immediately above the mean high-water line.
Terrestrial	Above the intertidal and supratidal levels, and having no, or weak coastal influence, e.g. agricultural land.

The behaviour of all waterbirds was recorded as either 'feeding' or 'roosting/other'. Birds that were not actively foraging (roosting, loafing, or engaged in social interaction) were recorded as 'roosting/other'. The locations of all aggregations of waterbirds and seabirds were mapped on a fieldmap (see Appendix *2 – Field recording forms*). During rising tide surveys, the location of all aggregations of roosting birds was recorded. All activities and/or disturbance events and their duration were recorded. The presence of birds of prey were also recorded, whether they caused disturbance to waterbirds or not.

Equipment used for fieldwork included:

- binoculars (Zeiss Victory 8 x 42, Zeiss Dialyt 10 x 40 B)
- telescope and tripod (Swarovski ATS-65 HD 20-60 x 65 mm, Hawke Endurance 16-48 x 68)
- clicker-counter
- *WeatherWriter* clipboard
- bespoke Field recording forms and subsite-level fieldmaps (see *Appendix 2 – Field recording forms*)

2.3 Data storage and validation

All data were digitised from field maps following each survey. Survey data were entered into MS Excel which included data validation procedures. Live 'dashboards' and validation procedures were used to identify and check unusually high or low counts. Aggregations of birds (spatial data) were digitised in QGIS (v2.14.20). All records, including significant aggregations and roost sites were given a unique identifier, which was added to the field map after digitisation. Field maps were scanned and stored digitally.

2.4 Preparation of the species accounts

In the species accounts, dot density maps are used to present some of the count data. They show species distribution by presenting one dot per bird in the relevant subsite. The resulting map provides an indication of both numbers and density for each species. Dot-density maps do not show the precise location of individual birds - the dots are placed randomly within subsites - therefore no conclusions on distributions can be made at a scale finer than subsite. (However, see *Section 3.5 Roost sites* for an assessment of high tide roosts, which was undertaken at a finer scale than subsite). To account for the different lengths of time in the spring and autumn periods, the bird records have been divided by the number of weeks in the period (Spring – 13 weeks, Autumn – 16 weeks). This explains why there are fewer dots on the seasonal dot density maps compared with low tide and rising tide maps.

The following information is presented for each species:

- the total number of birds in the site at each low tide and rising tide survey;
- two dot density maps of the six subsites showing distribution during low tide and rising tide;
- two dot density maps of the six subsites showing distribution during spring and autumn;
- two maps showing the birds' behaviour (feeding or roosting/other) within each subsite during low tide and rising tide.

For species that were observed on relatively few occasions, only relevant maps are presented (e.g., if a species was not recorded during rising tide surveys, no rising tide map is presented). Maps were not produced for species with fewer than 100 records throughout the survey period.

In order to account for potential differences in numbers before and after the breeding season, the survey period is divided in two. Spring is defined as the 13-week period between weeks 12 and 23 (12th March – 7th June), and Autumn is defined as the 16-week period between weeks 24 and 43 (12th June – 25th October).

3. Results

3.1 Site level results

A total of 31 low tide and 30 rising tide counts were undertaken between 12th March and 25th October 2017.

In total, 43 waterbird and seabird species were recorded (Table 3-2), with the highest species diversity occurring in May (Figure 3-1), when 36 species were recorded.

The highest species diversity within a single survey occurred during the low tide survey in week 19 (on 8th May) when 33 species were recorded. The lowest species diversity on a single survey day was on the rising tide count in week 12 (23rd March), when 5 species were recorded.

Overall, the total number of waterbirds and seabirds recorded increased throughout March and April and then remained relatively constant until the end of June, when the numbers doubled. No surveys took place during week 33 and 34 (14th August – 27th August). Numbers started to decline throughout September and surveys ceased at the end of October (Figure 3-2). The differences in the numbers of birds recorded during low tide and rising tide surveys are discussed in Section 3.4.

The highest number of all waterbirds and seabirds recorded on a single survey was 5,155, and was recorded during the rising tide survey in week 32 (7th August) (Figure 3-2). The peak number of birds recorded during a low tide survey was 4,513 and also occurred in week 32 (6th August). The lowest total number of birds was 51 recorded during the rising tide survey in week 12 (12th March).

With regard to peak numbers within the species groups (Table 3-1), wildfowl and allies numbers were highest during the surveys on 6th and 7th July. Wader numbers were highest during surveys on 6th and 7th August (but note no surveys took place in the second half of August so these numbers may have been surpassed). The highest number of seabirds occurred at low tide on 15th May, and at rising tide on 6th September.

Table 3-1. Peak numbers of waterbirds and seabirds recorded during low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Species group	Low-tide	Rising-tide
Wildfowl and allies	2,195 (6th July)	1,920 (7th July)
Waders	2,620 (6th August)	2,810 (7th August)
Seabirds	673 (15th May)	854 (6th September)

Table 3-2. Waterbird and seabird species recorded during estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Species listed in order of International Ornithological Congress (IOC) (Gill *et al.* 2020).

English name	Scientific name	Icelandic name
Greylag Goose	*Anser anser*	Grágæs
Pink-footed Goose	*Anser brachyrhynchus*	Heiðagæs
Greenland White-fronted Goose	*Anser albifrons flavirostris*	Blesgæs
Whooper Swan	*Cygnus cygnus*	Álft
Common Shelduck	*Tadorna tadorna*	Brandönd
Eurasian Wigeon	*Mareca penelope*	Rauðhöfðaönd
Mallard	*Anas platyrhynchos*	Stokkönd
Northern Pintail	*Anas acuta*	Grafönd
Eurasian Teal	*Anas crecca*	Urtönd
Greater Scaup	*Aythya marila*	Duggönd
Common Eider	*Somateria mollissima*	Æðarfugl
Harlequin Duck	*Histrionicus histrionicus*	Straumönd
Long-tailed Duck	*Clangula hyemalis*	Hávella
Barrow's Golden Eye	*Bucephala islandica*	Húsönd
Goosander	*Mergus merganser*	Gulönd
Red-breasted Merganser	*Mergus serrator*	Toppönd
Red-throated Diver	*Gavia stellata*	Lómur
Great Northern Diver	*Gavia immer*	Himbrimi
Northern Fulmar	*Fulmarus glacialis*	Fýll
Slavonian Grebe	*Podiceps auritus*	Flórgoði
Great Cormorant	*Phalacrocorax carbo*	Dílaskarfur
Eurasian Oystercatcher	*Haematopus ostralegus*	Tjaldur
European Golden Plover	*Pluvialis apricaria*	Heiðlóa
Ringed Plover	*Charadrius hiaticula*	Sandlóa
Common Snipe	*Gallinago gallinago*	Hrossagaukur
Black-tailed Godwit	*Limosa limosa*	Jaðrakan
Whimbrel	*Numenius phaeopus*	Spói
Common Redshank	*Tringa totanus*	Stelkur
Ruddy Turnstone	*Arenaria interpres*	Tildra
Red Knot	*Calidris canutus*	Rauðbrystingur
Dunlin	*Calidris alpina*	Lóuþræll
Purple Sandpiper	*Calidris maritima*	Sendlingur
Red-necked Phalarope	*Phalaropus lobatus*	Óðinshani
Black-legged Kittiwake	*Rissa tridactyla*	Rita
Black-headed Gull	*Chroicocephalus ridibundus*	Hettumáfur
Common Gull	*Larus canus*	Stormmáfur
Great Black-backed Gull	*Larus marinus*	Svartbakur
Glaucous Gull	*Larus hyperboreus*	Hvítmáfur
Iceland Gull	*Larus glaucoides*	Bjartmáfur
Herring Gull	*Larus argentatus*	Silfurmáfur
Lesser Black-backed Gull	*Larus fuscus*	Sílamáfur
Arctic Tern	*Sterna paradisaea*	Kría
Parasitic Jaeger	*Stercorarius parasiticus*	Kjói

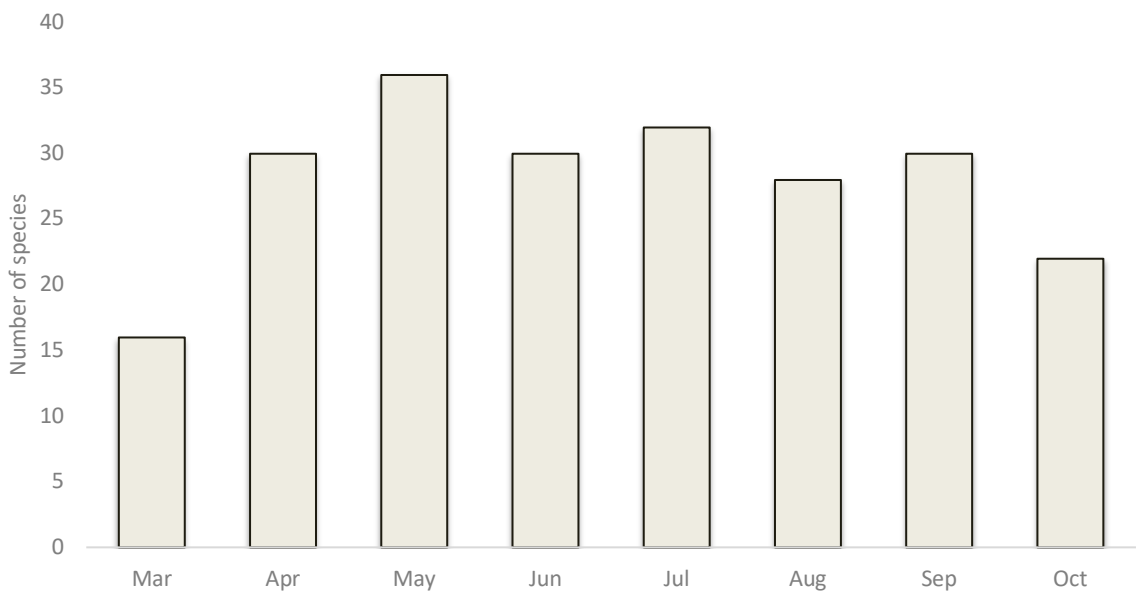

Figure 3-1. Number of waterbird and seabird species recorded each month during estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Eight surveys were conducted each month, except for March and August, when five surveys were conducted.

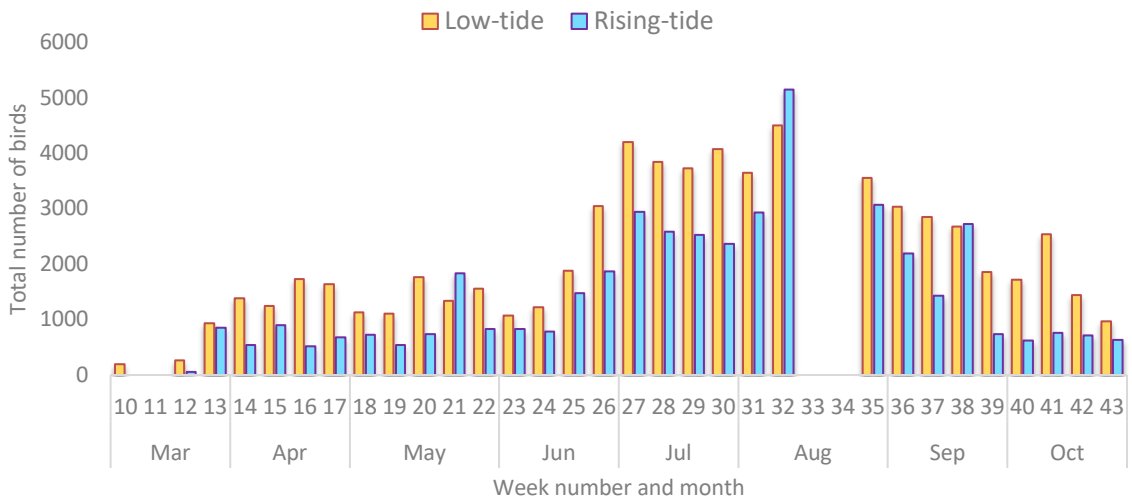

Figure 3-2. Total number of waterbirds and seabirds recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. No surveys were conducted during weeks 33 and 34.

3.2 Subsite usage

Birds' preferences for particular parts of a site are likely driven by the type of substrate; density or availability prey; shelter from winds or waves; disturbance; distance to high tide roosts; or perceived or actual predation pressure.

Kistufjörður (Est 2) supported a higher density of birds, during both low tide and rising tide surveys, than the other subsites. Bird density was higher during low tide surveys in Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2) and Flæðhöfðasker (Est 6) during low tide surveys, compared to rising tide surveys (Figure 3-3). For the other three subsites the density of birds-records was similar during low tide and rising tide surveys. While no benthic sampling was carried out within the study area as part of this study or previously, the birds' apparent preference for Kistufjörður (Est 2), Grjóteyrarklakkur (Est 1) and to Flæðhöfðasker (Est 6) during low tides is likely driven by prey availability. These subsites have a higher proportion of muddier substrates than the other subareas and are the least exposed to wind and waves (especially Kistufjörður (Est 2)). Such conditions typically support high numbers of benthic invertebrates (Little 2000; McLusky & Elliot 2004; Fujii 2012), with sandier sediments supporting comparatively fewer invertebrates (Prater 1981). Furthermore, the Andakílsá river flows into for Kistufjörður (Est 2). This is a productive river and supports high levels of biodiversity (Ólafsson et al. 2006). The particulate organic carbon values for Andakílsá are among the highest recorded in Iceland, and much of this particulate matter is algae that flows from Lake Skorradalsvatn (c. 10 km inland) (Eiríksdóttir et al. 2010). When this enters the calm waters of the estuary, a large portion of it is deposited onto the estuarine mud, promoting the benthic invertebrate communities that are important for waterbirds. Subareas 3, 4, and 5 are sandier and comprise the outflow of the glacial Hvítá river, which is likely to carry fewer nutrients.

For wildfowl, by far the highest density was recorded in Kistufjörður (Est 2) (Figure 3-4). The highest density of waders was recorded in Kistufjörður (Est 2). Relatively high densities of waders were recorded in Grjóteyrarklakkur (Est 1) compared to the other subsites (Figure 3-4). For seabirds, highest densities were recorded in Flæðhöfðasker (Est 6). This is mostly driven by an Arctic Tern colony, which is adjacent to Flæðhöfðasker (Est 6).

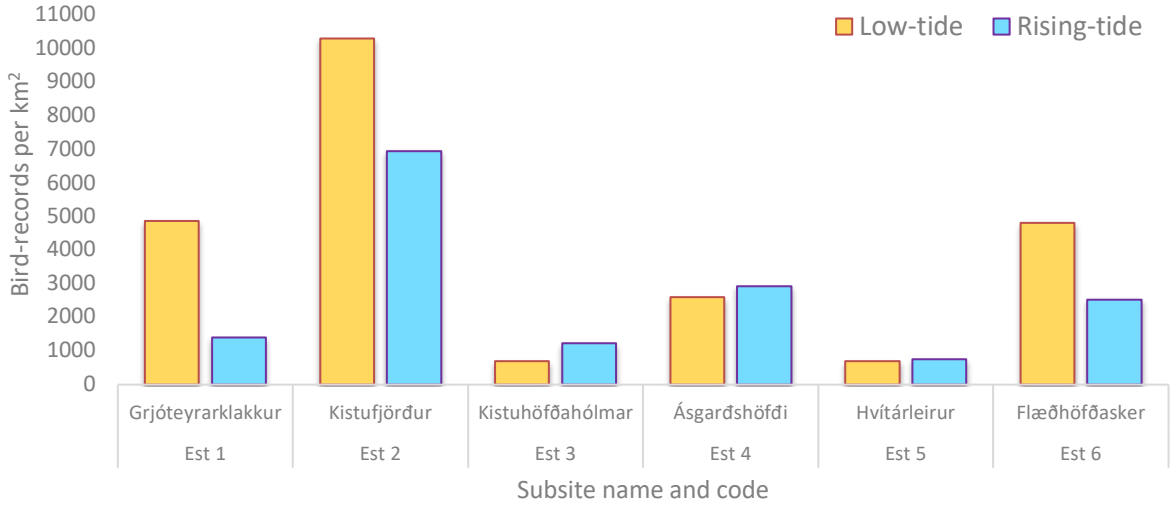

Figure 3-3. Waterbird and seabird density in each of the six subsites during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October, 2017. See Figure 2-1 for subsite locations and boundaries.

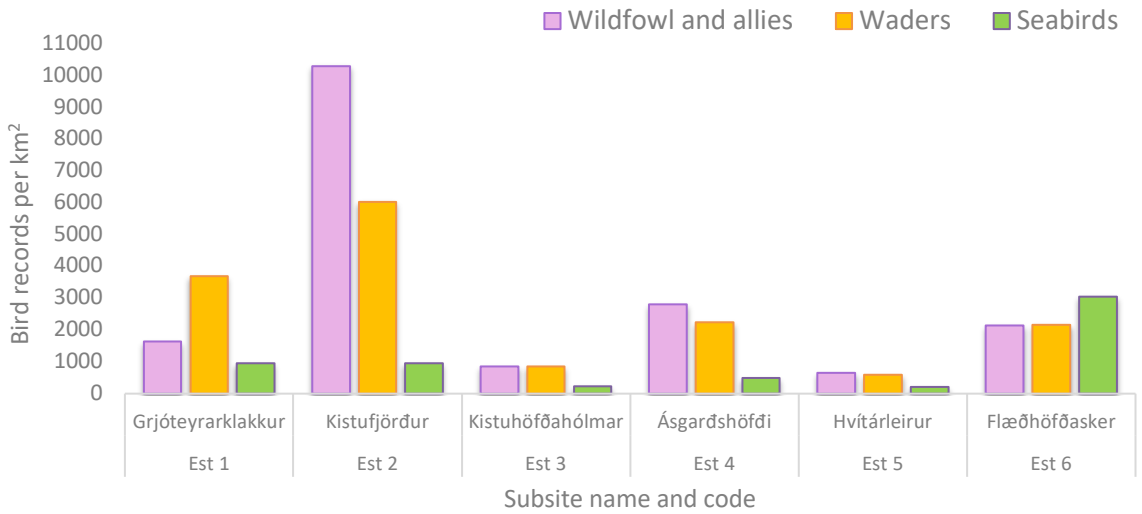

Figure 3-4. Total number of bird-records in six subsites in the estuarine habitat of the Andakíll Ramsar site recorded in weekly low tide and rising tide estuarine surveys between 12th March and 25th October, 2017. See Figure 2-1 for subsite locations and boundaries.

Some species or species groups have specific requirements, whereas others have a wider tolerance for different conditions. Those with specific requirements are more likely to be impacted by changes or developments in, or close to, the site. The distribution of each species at subsite level is presented in Table 3-3. This shows that some species were regularly recorded in different subsites, and others showed a preference for a particular subsite (or subsites). For example, Teal and Oystercatcher were recorded disproportionately in Kistufjörður (Est 2) during low tide and rising tide surveys and Eider showed a preference for Flæðhöfðasker (Est 6) during low tide surveys. Greenland White-fronted Geese were disproportionately recorded in Ásgarðshöfði (Est 4), and were rarely encountered in other subsites. Fulmars were recorded in Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2) as they commuted between the breeding colony at Brekkufjall (*c.* 1.5 km south of the survey area) and the open sea, and were not recorded as 'using' the site for foraging or roosting.

Table 3-3 Waterbird and seabird species distribution across six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017 showing the percentage of all records in each subsite. The total number of bird-records is also included. Heavier shading indicates a higher proportion of bird-records in the subsite. See Figure 2-1 for subsite locations and boundaries. Sixteen species with fewer than 100 bird-records are excluded.

	Low-tide							Rising-tide						
Species	**Est 1**	**Est 2**	**Est 3**	**Est 4**	**Est 5**	**Est 6**	Bird-records	**Est 1**	**Est 2**	**Est 3**	**Est 4**	**Est 5**	**Est 6**	Bird-records
Greylag Goose	19	68	2	6	1	4	2992	14	42	15	4	13	11	494
Greenland White-fronted Goose	0	0	0	98	2	0	249	0	12	0	79	10	0	205
Whooper Swan	41	41	4	2	2	9	1999	27	20	17	27	4	6	839
Common Shelduck	5	65	6	23	1	0	13884	14	48	13	19	5	0	1122
Mallard	24	42	12	9	3	10	612	20	16	36	11	14	2	91
Eurasian Wigeon	11	61	0	10	18	0	669	22	9	5	49	15	0	195
Eurasian Teal	1	95	0	1	3	0	6334	0	79	6	9	5	0	1215
Common Eider	4	26	0	2	0	68	170	4	7	0	9	0	80	45
Long-tailed Duck	17	16	0	0	0	67	125	8	46	0	44	0	2	90
Red-breasted Merganser	28	31	1	0	0	39	1529	25	48	3	18	2	4	296
Northern Fulmar	4	2	0	0	0	94	51	21	25	0	2	0	53	57
Great Cormorant	28	19	1	0	0	52	105	27	45	0	0	0	27	11
Eurasian Oystercatcher	70	24	3	1	0	2	2751	19	76	2	1	1	1	624
European Golden Plover	23	61	5	4	6	1	7448	0	17	43	28	11	0	977
Ringed Plover	47	34	1	0	3	16	355	11	18	11	22	31	7	45
Black-tailed Godwit	28	41	12	2	2	15	755	3	44	29	10	7	7	146
Common Redshank	32	54	4	4	0	6	8499	7	65	9	13	2	4	949
Ruddy Turnstone	29	23	0	0	0	48	1246	43	38	7	0	0	12	131
Red Knot	30	60	0	10	0	0	133	0	95	0	1	0	3	147
Dunlin	35	46	2	15	0	1	7482	3	26	18	40	13	0	1152
Purple Sandpiper	72	25	0	0	0	3	1827	44	56	0	0	0	0	411
Black-headed Gull	32	41	14	1	0	12	2750	34	12	0	22	8	24	1051
Common Gull	19	52	18	1	0	9	522	11	40	2	9	5	33	88
Great Black-backed Gull	9	19	11	40	8	13	306	5	14	5	62	10	5	21
Glaucous Gull	12	32	1	0	0	56	113	22	11	0	11	0	56	9
Lesser Black-backed Gull	14	22	37	16	3	8	830	36	5	7	13	17	22	83
Arctic Tern	36	32	3	1	1	27	1934	29	10	2	2	1	57	595

3.3 Use of substrates and waterbird behaviour

Conservation of species and sites relies on knowing the number of individuals, but it is important also to understand how these individuals use sites, both in time and space. A principle aim of this work was to understand the feeding and roosting habitats used by the birds at low and high tides.

Wildfowl were most frequently recorded in the intertidal areas during low tide surveys, and subtidal, intertidal and supratidal areas during rising tide surveys. Waders were found exclusively in intertidal areas during low tide surveys and in intertidal and supratidal areas during rising tide surveys. Seabirds were mostly recorded in intertidal areas during low tide surveys and were encountered in intertidal, subtidal and terrestrial areas during rising tide surveys.

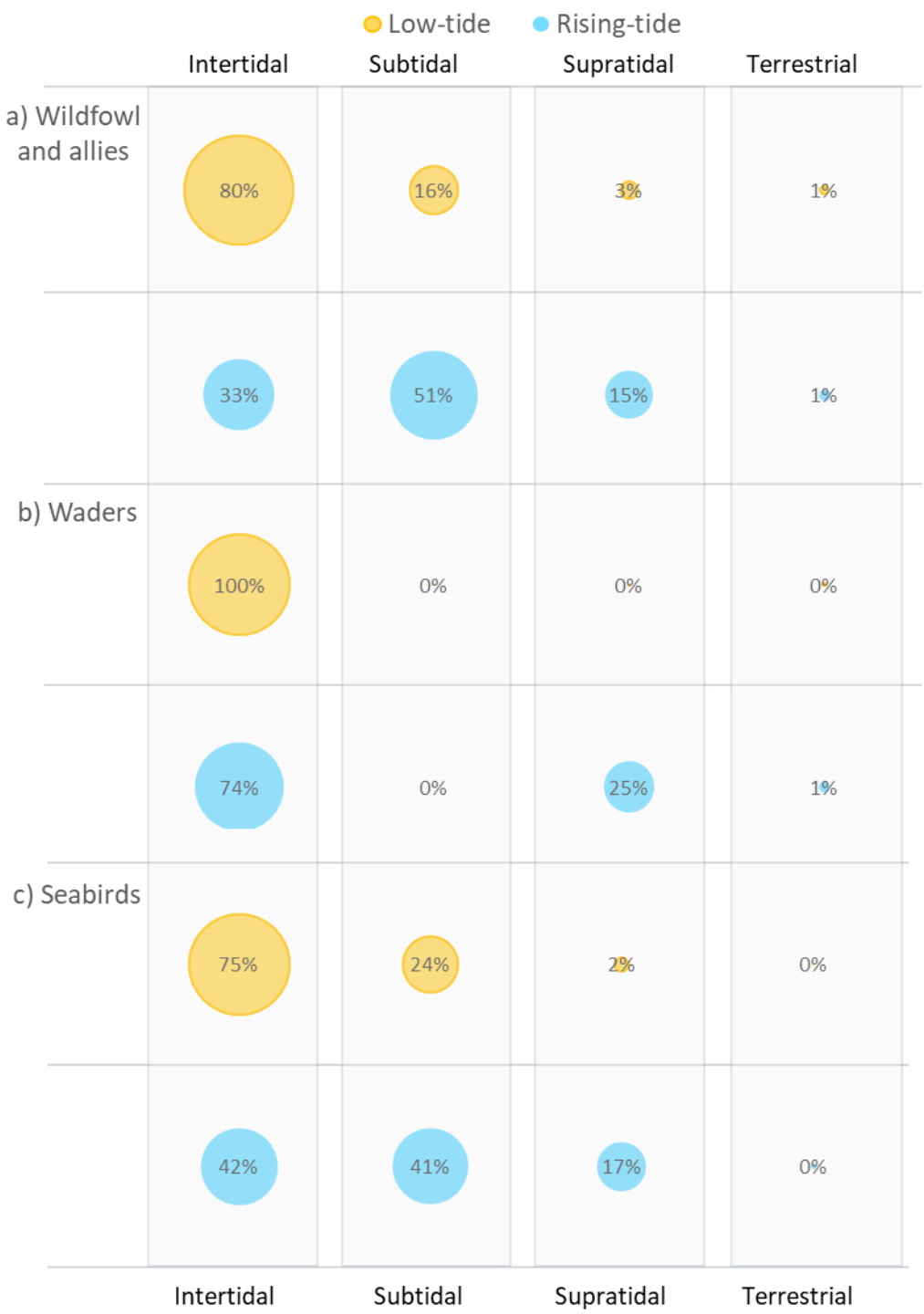

Figure 3-5. The proportion of a) wildfowl and allies b) waders and c) seabirds recorded in four habitat zones during low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. See Table 2-2 for a description of each zone.

Figure 3-6. Proportion of encounters of a) wildfowl and allies b) waders and c) seabirds during low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017 according to their location in four habitat zones. Numbers in brackets indicate the number of bird-records. See Table 2-2 for a description of each zone.

For wildfowl and their allies, regardless of the habitat zone, more birds were recorded foraging during low tide surveys and as roosting during rising tide surveys (Figure 3-6 (a)). Small numbers of wildfowl were recorded in terrestrial areas, and these birds were more frequently recorded foraging than roosting. Waders were mostly recorded as foraging in intertidal and subtidal areas, and roosting in supratidal and terrestrial areas (Figure 3-6 (b)). The records of waders in subtidal areas are Red-necked Phalaropes which swims while foraging. Seabirds were most commonly recorded foraging when in intertidal and subtidal areas, and roosting when in supratidal areas (Figure 3-6 (c)).

3.4 Waterbird abundance during surveys: low tide versus rising tide

In most cases, the number of birds recorded during low tide surveys was greater than during rising tide surveys (Figure 3-2). This is often the case for surveys like this, and indeed is the reason that rising tide surveys were undertaken rather than high tide surveys. Waterbirds are easier to count when they are dispersed across extensive intertidal areas at low tide, compared to at high tide, when they are squeezed together in high tide roosts, and often obscured by vegetation or rocks. Therefore, in some cases the explanation for higher counts during low tide surveys may be greater detectability. However, this pattern may also reflect differential use of the site for foraging (at low tide) and roosting (at high tide). It is apparent that, for some species, some birds use high tide roosting areas outside the survey area and forage in the survey area when the intertidal sand and mudflats are exposed at low tide.

During the spring, Oystercatcher, Golden Plover, Ringed Plover, Black-tailed Godwit, Redshank, Turnstone, Dunlin and Purple Sandpiper were recorded in considerably larger numbers during low tide surveys compared to rising tide surveys. In the autumn, considerably more Golden Plover, Ringed Plover, Redshank, Turnstone and Dunlin were recorded during low tide surveys compared to rising tide surveys. This suggests that they avail of high tide refuges outside the Andakíll Ramsar site. It is also possible that some small or inconspicuous roost sites were missed during these surveys. This highlights the importance of conducting both low tide and rising tide surveys to understand the complete picture on how the birds use the protected area. However as systematic surveys were not conducted outside the Andakíll Ramsar site, it is not known if there are regular high tide roosts that these birds commute to.

3.5 Roost sites

In the context of a tidal ecosystem, a roost site is generally considered to be a place where birds congregate when feeding on intertidal mud or other estuarine habitats is not possible due to the depth of water. Roost sites are of vital importance to waterbirds, especially waders, during the high tide period. Information on the location and composition of roosts is valuable for conservation, as it can help to determine if proposed developments or activities could lead to negative impacts for a given species or assemblage of waterbirds.

As the tide rises, many species follow the tidal edge and may continue to forage as the tide pushes them to a high tide roost, or at some point stop feeding and fly to a high tide roost in another part of the site or beyond. Waders are constrained to forage in shallow water or intertidal flats, and roost close to the high tide line. Similarly, some other waterbirds and seabirds prefer shallow water for foraging and also roost at high tide when the water is deepest. Waterfowl and gulls often roost alongside waders above the high tide line, or in the water, adjacent to the wader roost.

Roosting behaviours are not site- and species specific (Scheiffarth *et al.* 1996), but can vary between years depending on factors such as weather (e.g. direction of prevailing wind), variability in prey abundance and availability, and variations in predation pressure. This highlights the value of monitoring over several years a way to more thoroughly understand how waterbirds and seabirds use wetland sites.

The definition of a roost has, for the purposes of this report is any place where birds regularly congregate during rising or high tides. Birds roosted extensively throughout the survey area, and 37 roosts were recorded. Fourteen roosts that were infrequently used, or were comprised of relatively small numbers of birds (< 100 bird-records throughout the survey period), are not documented here. Of the remaining 23 roosts, some were not consistently used, either in space or time. Some formed at various places along a stretch of coastline, and others were used in one part of the season and not another. For these reasons, these 23 roosting locations were amalgamated into 12 main roosts, and these are described here.

Most roosts were small comprising several hundred birds. Roosts were recorded in all subsites except Hvítárleirur (Est 5). Most of the roosting assemblages, in terms of frequency of use, consistency in location and abundance of birds were recorded in Kistufjörður (Est 2) both in spring and in autumn (Figure 3-7, Figure 3-8). The majority of its northern shore was used by roosting birds at some point in the survey period, making it a very important area for roosting waterbirds. The number of birds using each roost was generally greater in autumn (than in the spring), corresponding to the greater abundance of birds at this time. However, some roosts (e.g. Roost 6), were important in spring and practically unused in autumn and vice versa.

Overall, the roosts that supported greatest numbers, or most consistently supported birds were Roosts 2, 3 ,5 and 6. The species composition, abundance (in spring and autumn) and frequency of use of the main roosts is outlined in Table 3-4.

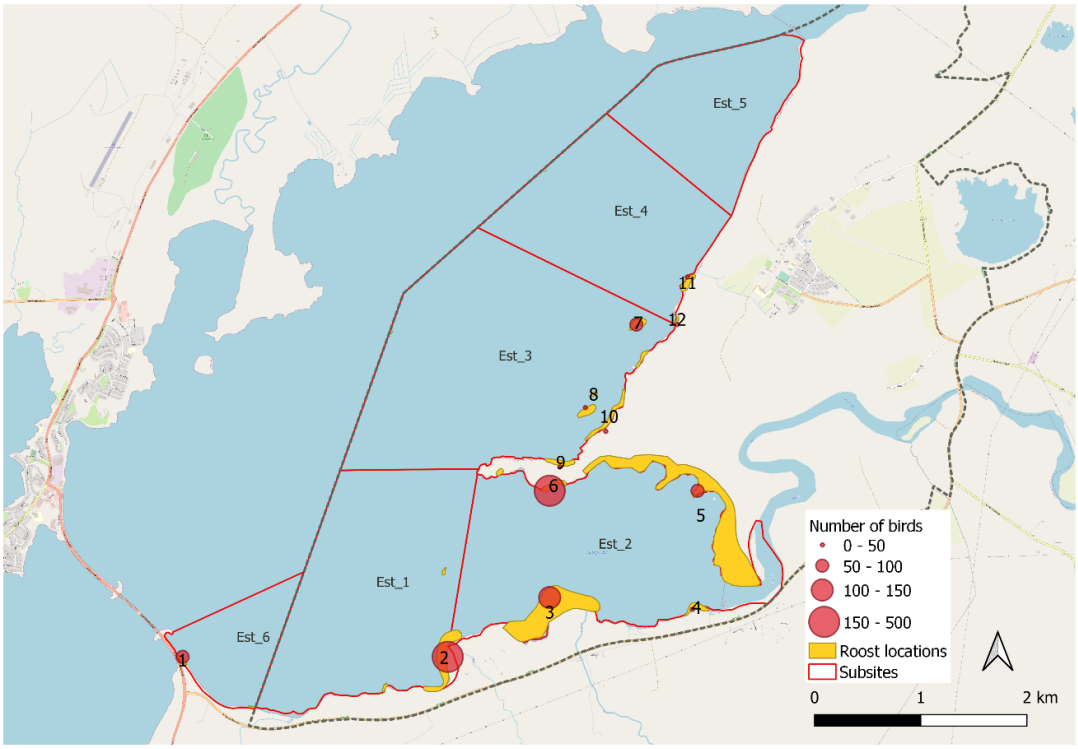

Figure 3-7. Location of roost sites (orange) and twelve main roosts (red) recorded during weekly rising tide estuarine surveys in the Andakíll Ramsar site in spring (12th March and 7th June 2017).

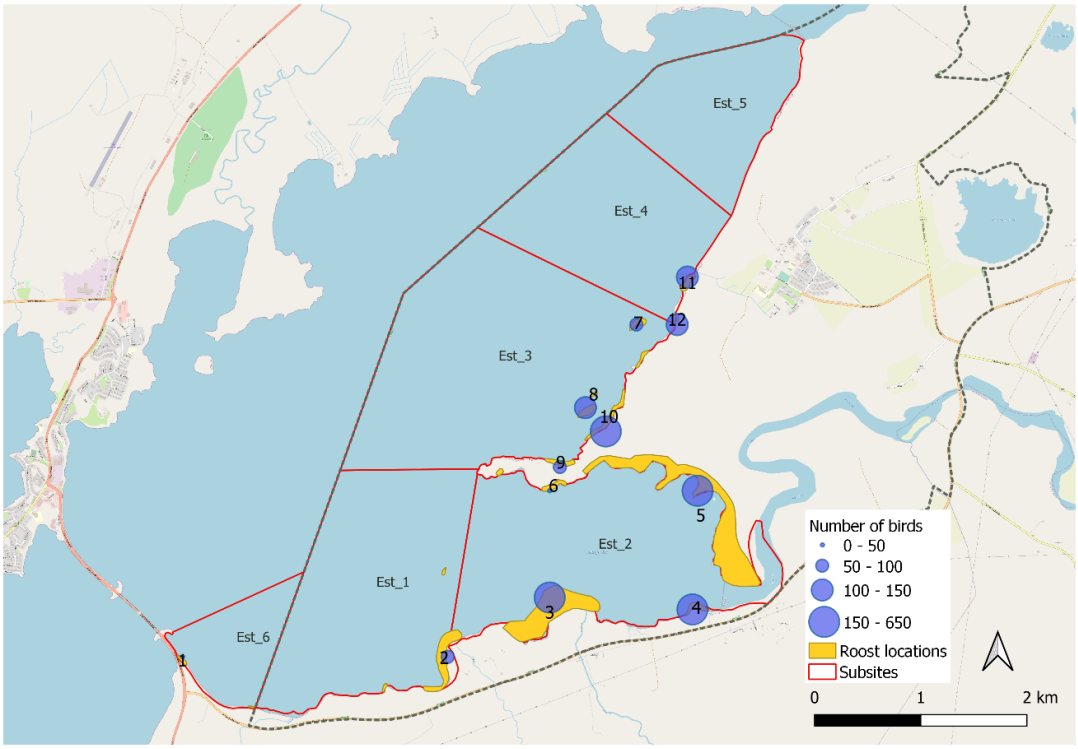

Figure 3-8. Location of roost sites (orange) and twelve main roosts (blue) recorded during weekly rising tide estuarine surveys in the Andakíll Ramsar site in autumn (12th June and 25th October 2017).

Table 3-4. The main roosting areas in the Andakíll Ramsar site, including waterbird and seabird composition, numbers in spring and autumn and total records throughout the survey period. (spring = 12th March - 7th June; autumn = 12th June - 25th October).

Roost number	Subsite	Coordinates	Number of birds		Total records	Description and species usage
			Spring	Autumn		
1	Est_6	64.530, -21.884	0-100	<50	229	Gravel bank exposed on all tides. Almost exclusively used by Arctic Tern.
2	Est_1	64.530, -21.832	0-200	0-100	1114	Saltmarsh, exposed on all but the highest tides. Consistently used, mainly by Shelduck, Arctic Tern, Black-headed Gulls and Oystercatcher.
3	Est_2	64.535, -21.812	0-150	0-300	1501	Used regularly, mainly by Shelduck, gulls, Oystercatcher and Turnstone.
4	Est_2	64.534, -21.784	<50	0-650	727	Saltmarsh margin. Used infrequently by Redshank.
5	Est_2	64.544, -21.783	0-100	0-450	1626	Extensive area that includes vegetated headlands and bays. Used regularly, particularly in autumn by Greylag goose, Whooper Swan, Shelduck and Redshank.
6	Est_2	64.544, -21.812	0-500	<50	1133	Rocky outcrops, exposed on all tides. Used regularly during spring, mainly by Oystercatcher. Used infrequently in autumn.
7	Est_3	64.558, -21.795	0-100	0-100	277	Vegetated island, exposed on all tides. Used regularly, especially in autumn, mainly by Shelduck.
8	Est_3	64.551, -21.805	<50	0-150	338	Vegetated island, exposed on all tides. Used infrequently by Shelduck, Whooper Swan and Redshank.
9	Est_3	64.546, -21.810	<50	0-100	162	Saltmarsh. Exposed on most tides. Used infrequently, by Shelduck, Redshank and Dunlin.
10	Est_3	64.549, -21.801	<50	0-450	1303	Saltmarsh with freshwater inlet. Exposed on most tides. Used infrequently in spring and consistently in autumn by Shelduck, Redshank and Dunlin.
11	Est_4	64.562, -21.785	0	0-150	234	Saltmarsh. Exposed on most tides. Regularly used, mainly by Shelduck and Redshank in autumn.
12	Est_4	64.558, -21.787	0	0-150	167	Saltmarsh. Occasionally used, mainly by Dunlin and Shelduck.

3.6 Human activities, birds of prey and disturbance

The presence or absence of human activities and birds of prey was recorded during each low tide and rising tide survey. The types of human activity, and, based on the birds' reaction, whether it was deemed to be affecting waterbirds or not, was recorded.

Potential sources of disturbance were recorded on 59 occasions (38 surveys) and disturbance to waterbirds was observed on 14 occasions (12 surveys). Disturbance usually resulted in some of the birds present flying a short distance. There were no observed incidences of disturbance that caused birds to fly out of the survey area entirely, or to be in flight for prolonged periods of time. Birds of prey were the most frequently observed cause of disturbance to foraging or roosting waterbirds. This was followed by aircraft and humans (on foot) (Figure 3-9).

White-tailed Eagle, Gyr Falcon, Merlin and Arctic Skua[1] were recorded during surveys. The presence of a bird of prey was recorded on 47 occasions (32 surveys), and were observed to cause disturbance to waterbirds on 10 occasions (9 surveys). When one or both of the resident pair of White-tailed Eagles were present, they were recorded as a potential source of disturbance to the waterbirds. The eagles were mainly recorded loafing on or close to the eerie or on commuting flights. On three occasions one of both of the pair were observed actively hunting; and Shelducks, Greylag Geese and Lesser Black Backed-Gulls flew to another location within the subsite or to an adjacent subsite. There were two occasions where an Arctic Skua flushed waders, prompting them to move short distances. Similarly, a Gyrfalcon was observed flushing waders and gulls on one occasion. The disturbance caused by particular raptor species is broadly aligned with the predation risk posed by each species. Light aircraft were recorded on seven occasions (six surveys), and caused some birds to relocate within the subsite on two occasions (two surveys). Humans (on foot) were recorded on four occasions (four surveys), and caused some birds to relocate a short distance on one occasion.

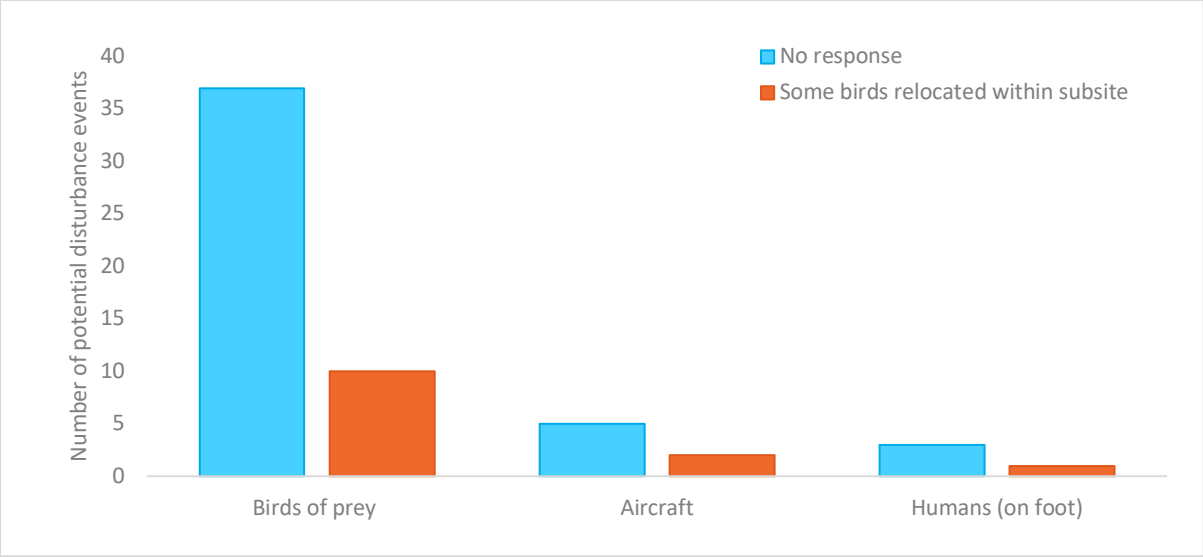

Figure 3-9. Frequency of disturbance sources recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017, including the number of times when the (potential) disturbance source was recorded and the number of occasions when the birds reacted by relocating to another part of the subsite.

[1] Due to their kleptoparasitic nature and tendency to harass other seabirds and waterbirds, Arctic Skuas often cause birds to flush. For this reason, they were classed as 'birds of prey' for the purpose of the assessment of disturbance factors.

3.7 Species accounts

Wildfowl and allies

Overall, the wildfowl abundance was principally driven by Shelduck, Greylag Geese, Whooper Swans and Teal. The increase in the number of wildfowl during April, May and June was mainly driven by the sustained increase in the number of Shelduck. However, the peak numbers of wildfowl recorded in July were due to Greylag Geese and Whooper Swans arriving to moult in the protected area. Peaks in wildfowl numbers in August and September are mainly a result of high numbers of Teal. While the numbers of birds recorded during rising tide surveys is generally lower than during low tide surveys, the general trends in abundance are consistent between both survey types (Figure 3-10).

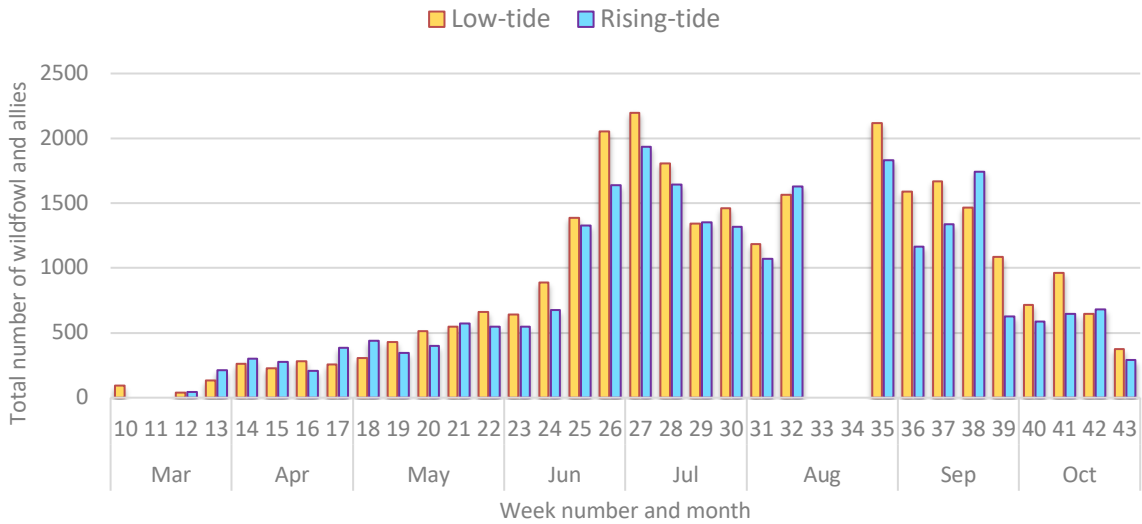

Figure 3-10. Number of wildfowl and allies recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Greylag Goose	*Anser anser*	Grágæs

Greylag Geese were recorded in low-numbers on the estuary throughout the spring, with generally less than 20 birds recorded on each survey during April and May. No dedicated effort was made to search for or quantify the numbers of nesting pairs, but three nests were located on islands within the estuary on 3rd June (clutch sizes: 3, 4, and 6). The first sightings of goslings in the survey area were on 6th June. The highest number of family groups was recorded during a single survey was on 24th July, when 12 families were observed. Throughout June, July and August, brood sizes between one and eight were recorded. Adult numbers increased from the second week of June and peaked in July, with 502 birds recorded in mid-July. Kistufjörður (Est 2) was the most important subsite during autumn for this moulting flock. They were most often recorded roosting (/loafing) during surveys, presumably taking the refuge on the open water by day and foraging on the coastal and terrestrial vegetation in the vicinity of the Kistufjörður by night, but this was not confirmed in the field. The vast majority of Greylag Geese had emigrated by the first week in September. From 6th September onwards, counts were lower than 60 birds per survey, and there were no birds recorded after 2nd October.

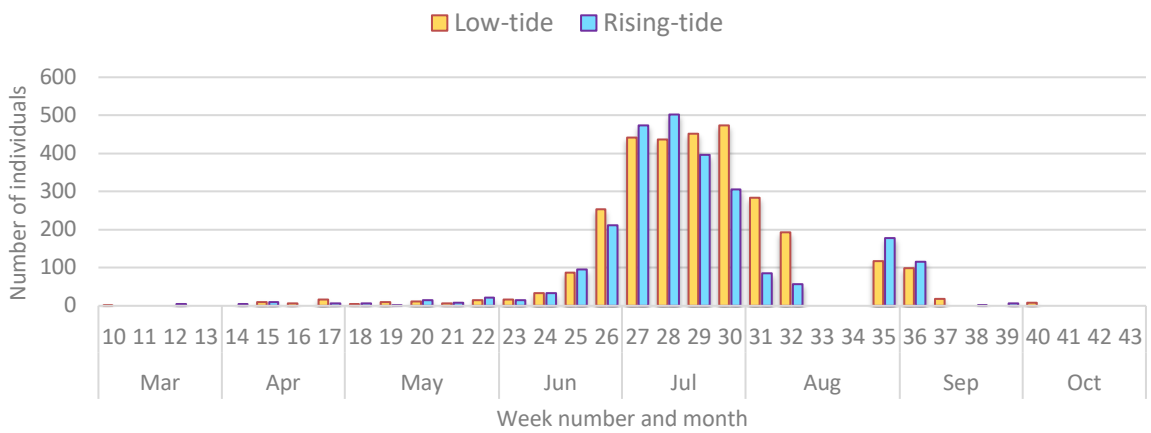

Figure 3-11. Number of *Anser anser* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

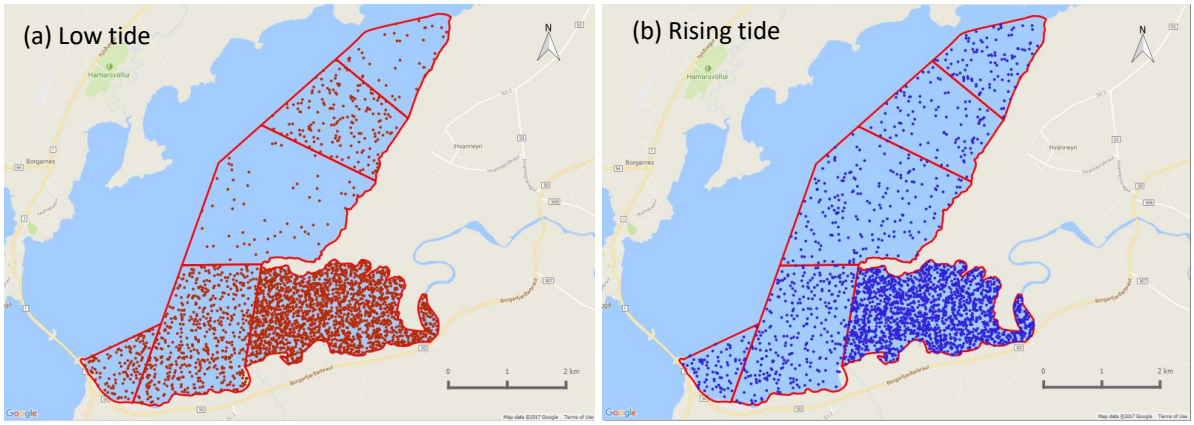

Figure 3-12. Relative abundance of *Anser anser* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

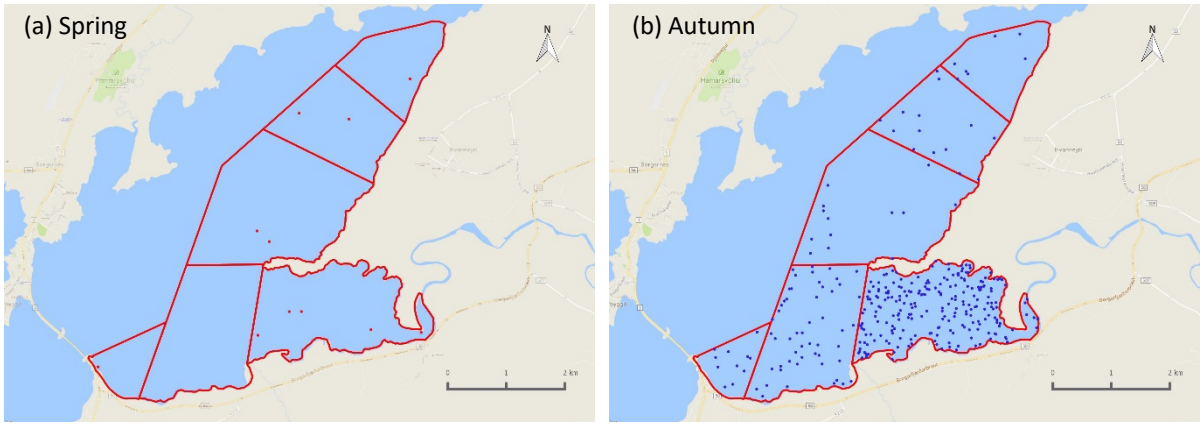

Figure 3-13. Relative abundance during (a) spring and (b) autumn of *Anser anser* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

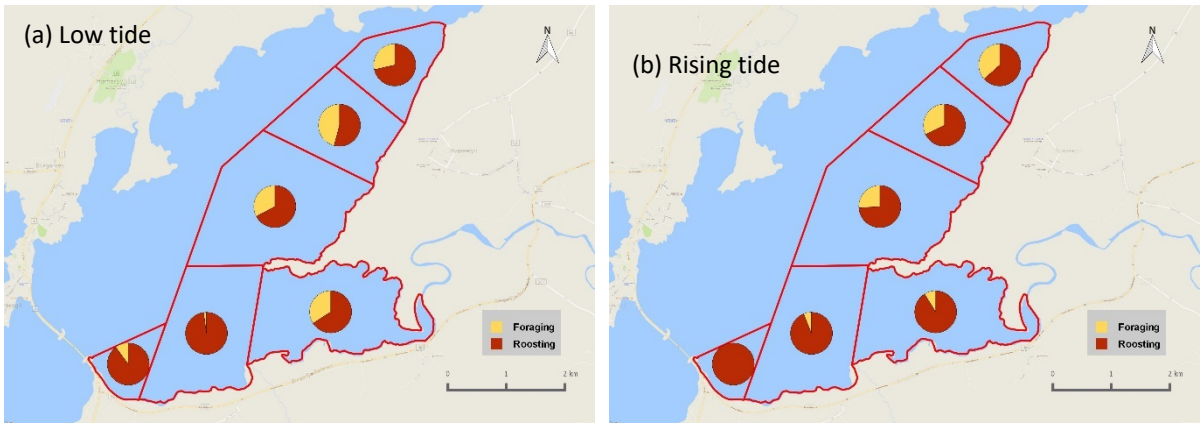

Figure 3-14. Proportion of foraging and roosting *Anser anser* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Pink-footed Goose	*Anser brachyrhynchus*	Heiðagæs

The only record of Pink-footed Geese was recorded in Flæðhöfðasker (Est 6) during the low tide survey on 7th June, when a single individual was observed. However, small numbers were observed foraging in the hay meadows on Hvanneyri farm with Greenland White-fronted Geese during spring and autumn. Season maxima of 6 and 13 birds were recorded in spring and autumn respectively (Tierney & Stroud, 2018).

Greenland White-fronted Goose	*Anser albifrons flavirostris*	Blesgæs

The Andakíll Ramsar site is an important stopover site for this species during spring and autumn, and this contributed significantly to the designation of the site under the Ramsar Convention (Thrainsson *et al.* 2013). The site provides the full range of different functional habitats needed by the birds: the estuarine component of the Ramsar site is the principal night time roosting area and the agricultural areas the principal foraging areas. On Hvanneyri farm in 2017, average numbers of 808 and 1,584 individuals were recorded during spring (24th March - 10th May) and autumn (6th September – 3rd November), respectively (Tierney and Stroud, 2018).

Greenland White-fronted Geese were occasionally recorded during estuarine surveys in spring and autumn. During spring staging, small flocks (<50 birds) were recorded in Ásgarðshöfði (Est 4) and Hvítárleirur (Est 5). On two surveys during the autumn staging period, flocks of greater than 160 birds were recorded on Ásgarðshöfði (Est 4). These day-time congregations are generally short-lived and occur as a result of farm activity or another disturbance at their foraging areas in the hay meadows, which are *c*. 1 km away. A comprehensive account on this species in the Andakíll Ramsar site in 2017 is provided by Tierney and Stroud (2018). This includes arrival and departure dates, daily numbers at Hvanneyri farm during the spring and autumn staging periods, and detail on fattening rates during spring and the age-profile (proportion of adults and juveniles) of the flock in the autumn.

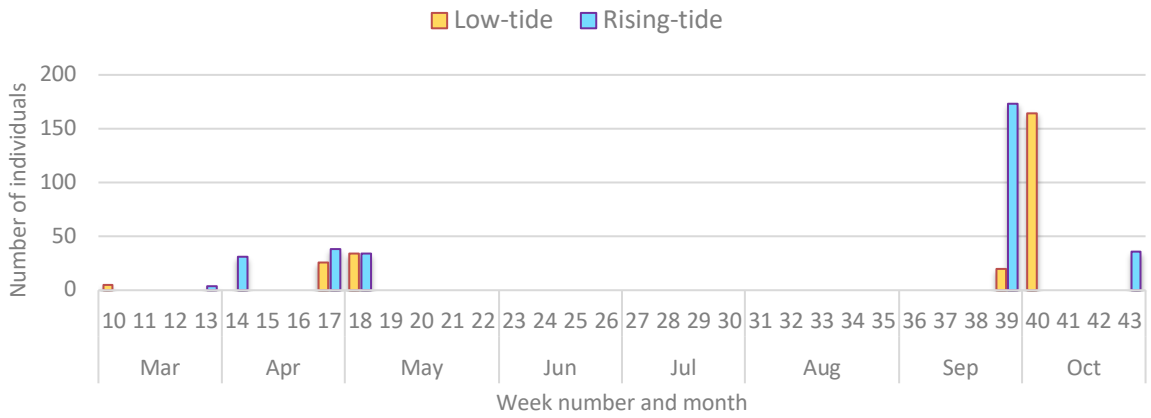

Figure 3-15. Number of *Anser albifrons flavirostris* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

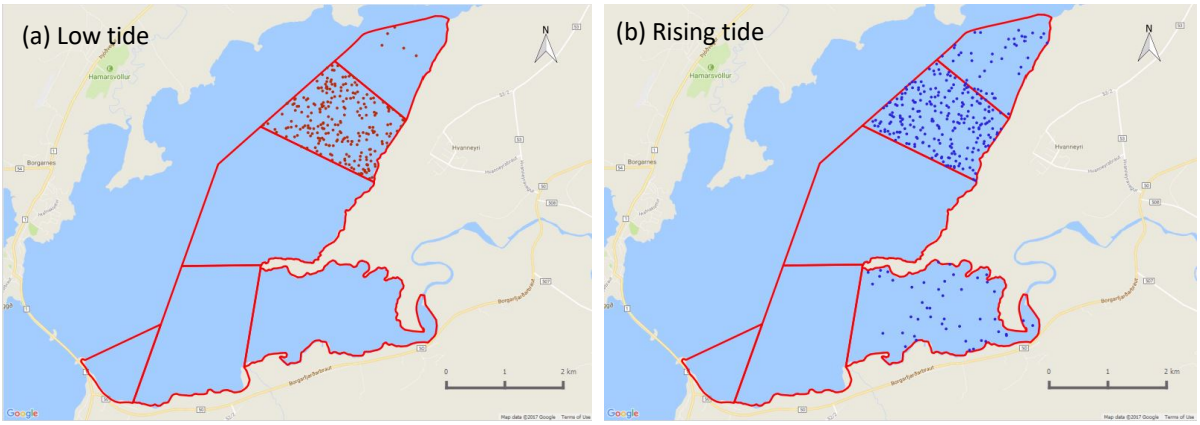

Figure 3-16. Relative abundance of *Anser albifrons flavirostris* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

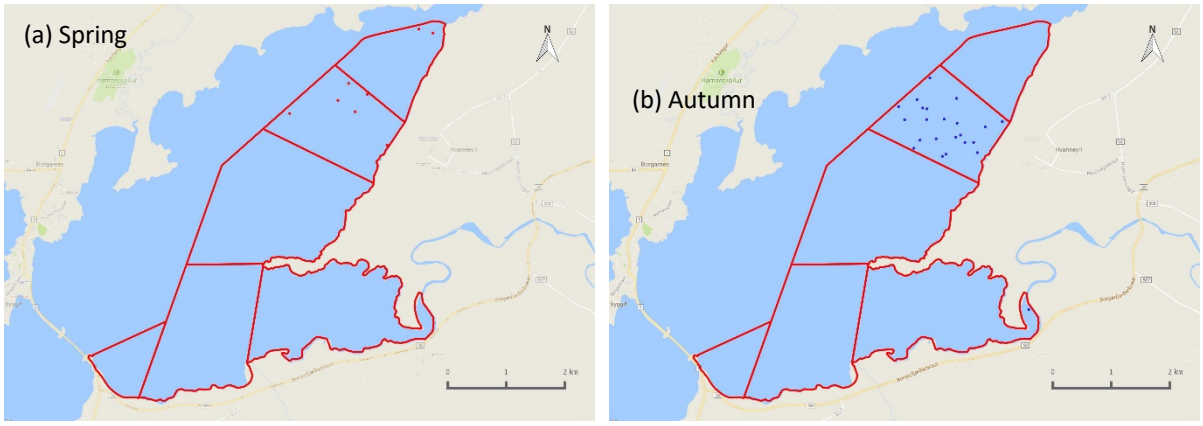

Figure 3-17. Relative abundance during (a) spring and (b) autumn of *Anser albifrons flavirostris* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

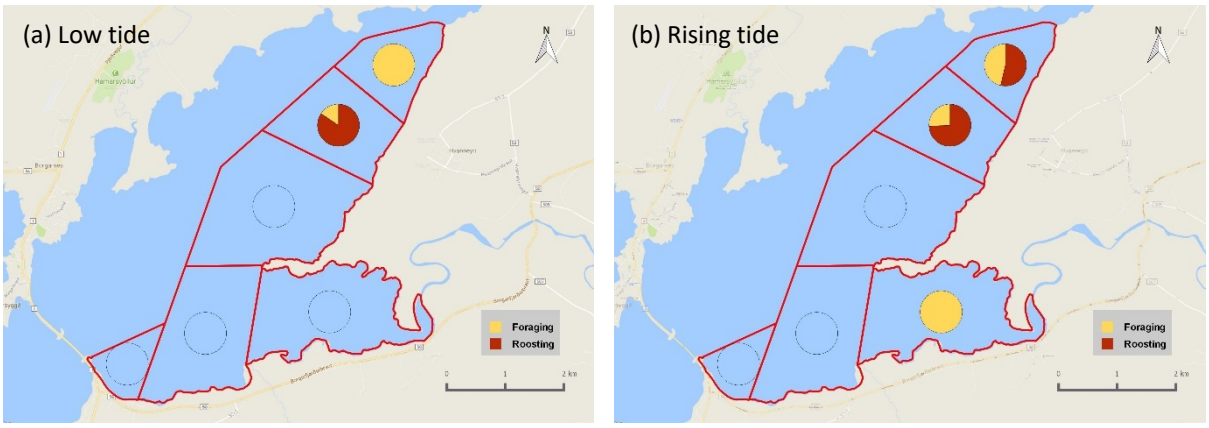

Figure 3-18. Proportion of foraging and roosting *Anser albifrons flavirostris* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Whooper Swan	*Cygnus cygnus*	Álft

Whooper Swans were recorded in low-numbers throughout the spring, with generally fewer than 10 birds recorded during March, April and May. No dedicated effort was made to search for or quantify the numbers of nesting swans. However, several territorial pairs were detected (<10) within the Ramsar site. The first sightings of cygnets in the survey area were on 12th June, and broods of two, three and four cygnets were observed from June through to October.

Adult numbers increased from the second week of June and peaked in the last week of July, when 399 birds were recorded. These moulting birds were most often located in Kistufjörður (Est 2) and Grjóteyrarklakkur (Est 1), but the other subsites were also used, especially during rising tide surveys. They were most often recorded roosting (/loafing) during surveys, and presumably moved from the water to forage on coastal and terrestrial vegetation in adjacent areas by night, however, this was not confirmed in the field. By the first week of September, the vast majority of the swans had emigrated, and last record on the estuary was a single swan on 11th October.

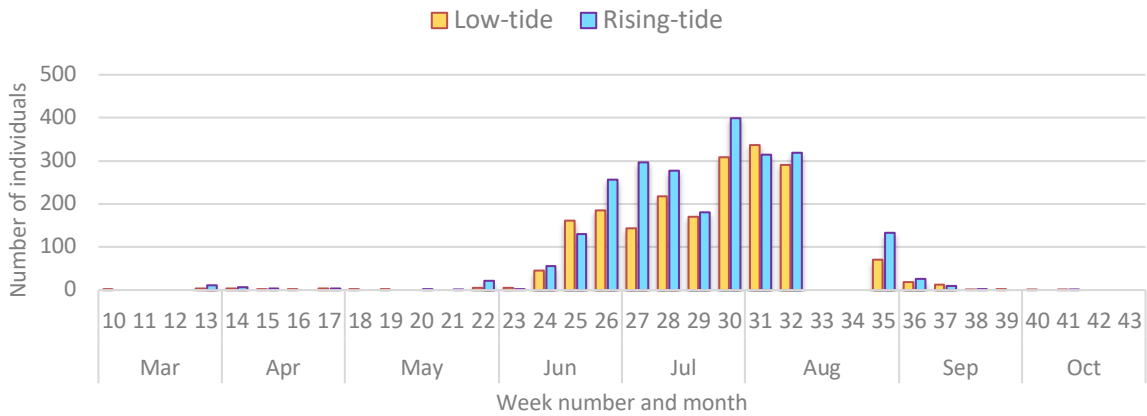

Figure 3-19. Number of *Cygnus cygnus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

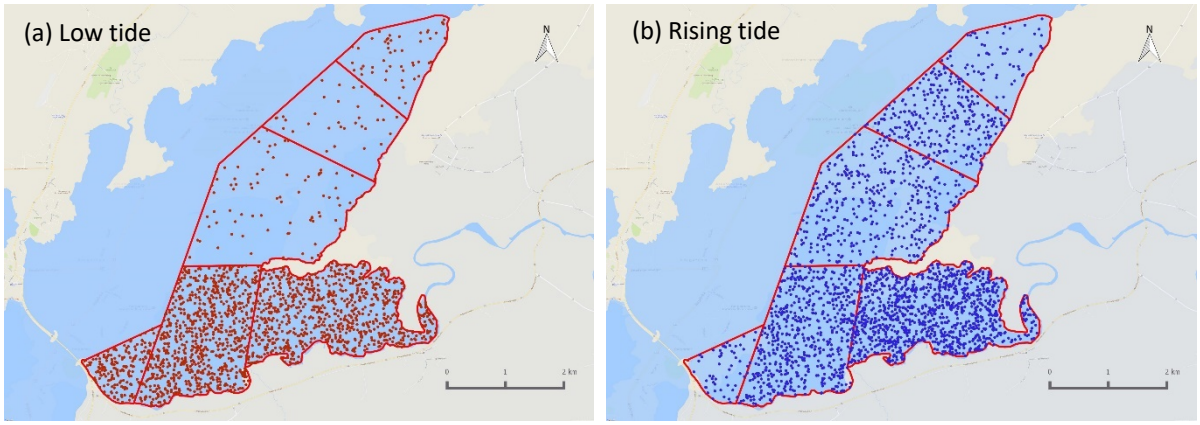

Figure 3-20. Relative abundance of *Cygnus cygnus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

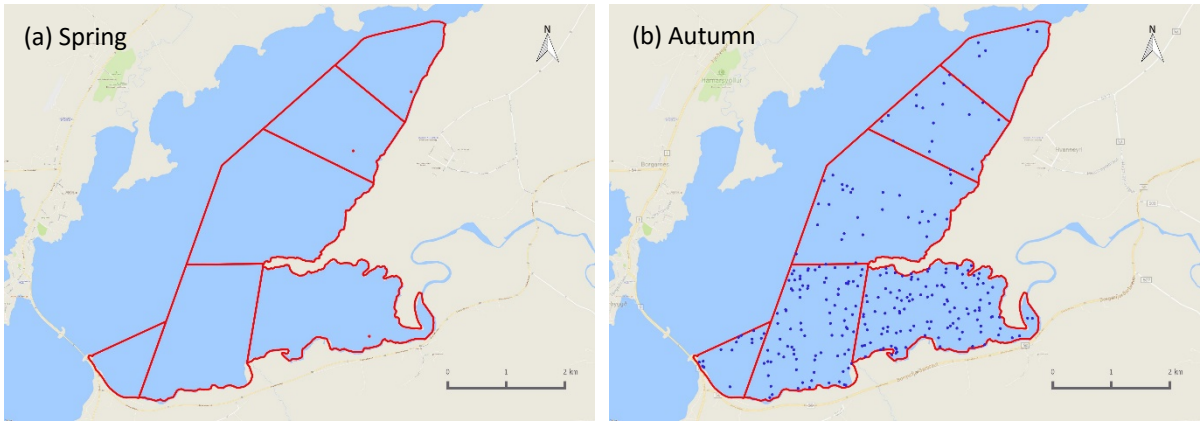

Figure 3-21. Relative abundance during (a) spring and (b) autumn of *Cygnus Cygnus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

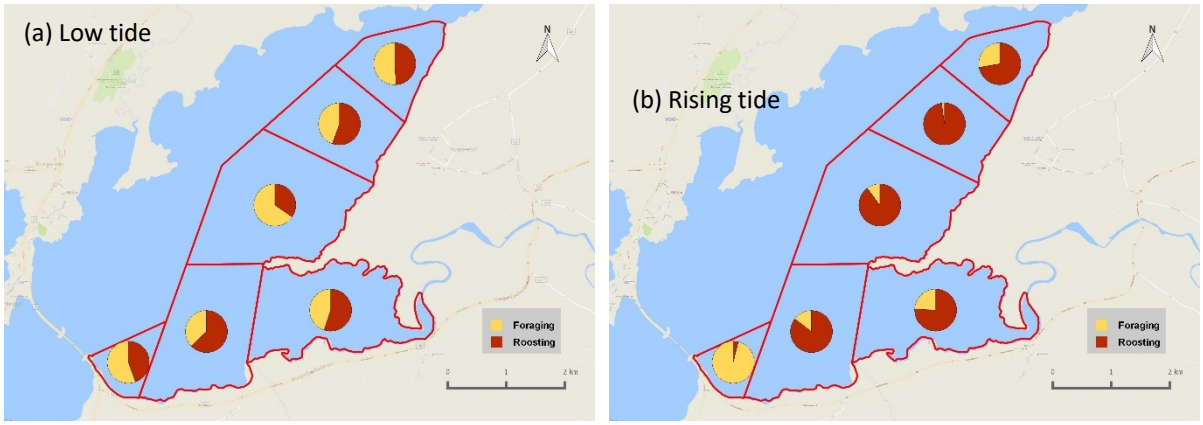

Figure 3-22. Proportion of foraging and roosting *Cygnus cygnus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Common Shelduck	*Tadorna tadorna*	Brandönd

Shelduck were present on the estuary during all surveys. Numbers rose during March and there were *c*. 200 birds present throughout April. Numbers rose again throughout May and June and peaked at 1,368 in the last week of June. Numbers gradually declined throughout August, September and October, and there were 100 birds recorded on the last survey of the season, on 25th October. In 2019, two additional surveys on 12th and 18th October resulted in totals of 1,176 and 1,025 birds, respectively. These counts are unprecedented, both in scale and timing. This disparity in October numbers between 2017 and 2019 suggest considerable interannual differences in migratory behaviour.

While Shelduck were recorded in each of the six subsites during low tide and rising tide surveys, greatest numbers were routinely found in Kistufjörður (Est 2) and Ásgarðshöfði (Est 4). There was increased usage of Ásgarðshöfði (Est 4) in the autumn, compared to the spring. It is not clear whether this expansion (into Ásgarðshöfði (Est 4)) was driven by new, seasonal availability of food there, increased feeding competition in Kistufjörður (Est 2), immigration of new birds into the estuary, or other factors. Birds were most often recorded as foraging during low tide surveys and roosting during rising tide surveys, with the exception of Ásgarðshöfði (Est 4), where birds were more frequently recorded as foraging during rising tide surveys.

The Ramsar site supports the biggest aggregations of Shelduck in Iceland and an estimated 158 breeding pairs (Tierney *et al.* 2020).

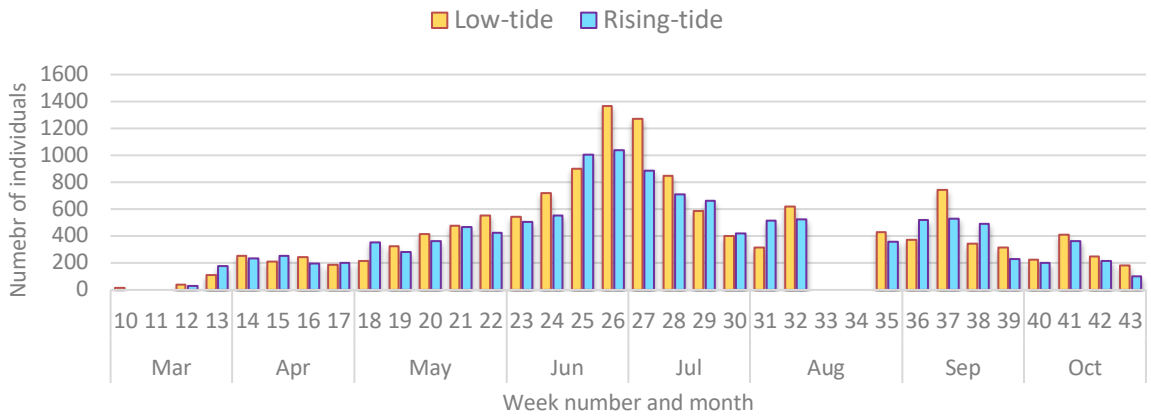

Figure 3-23. Number of *Tadorna tadorna* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

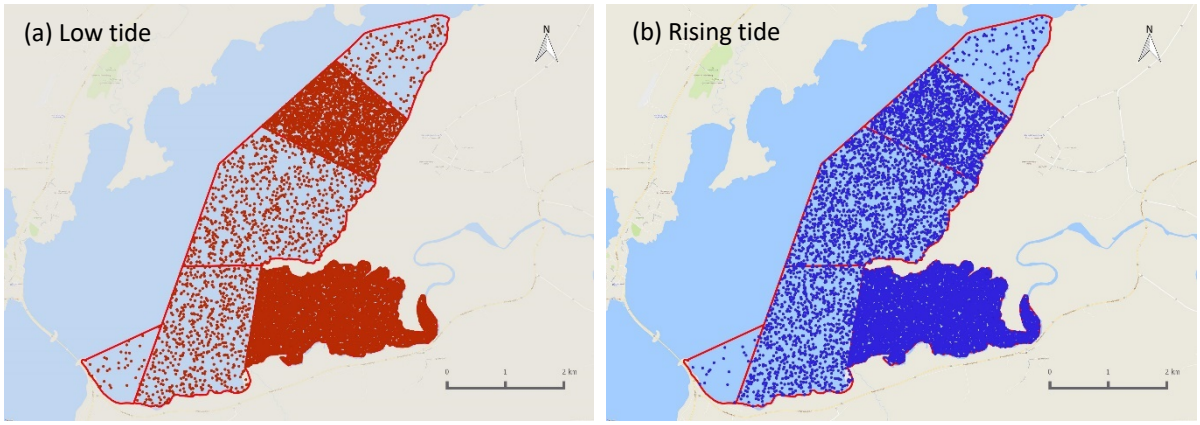

Figure 3-24. Relative abundance of *Tadorna tadorna* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

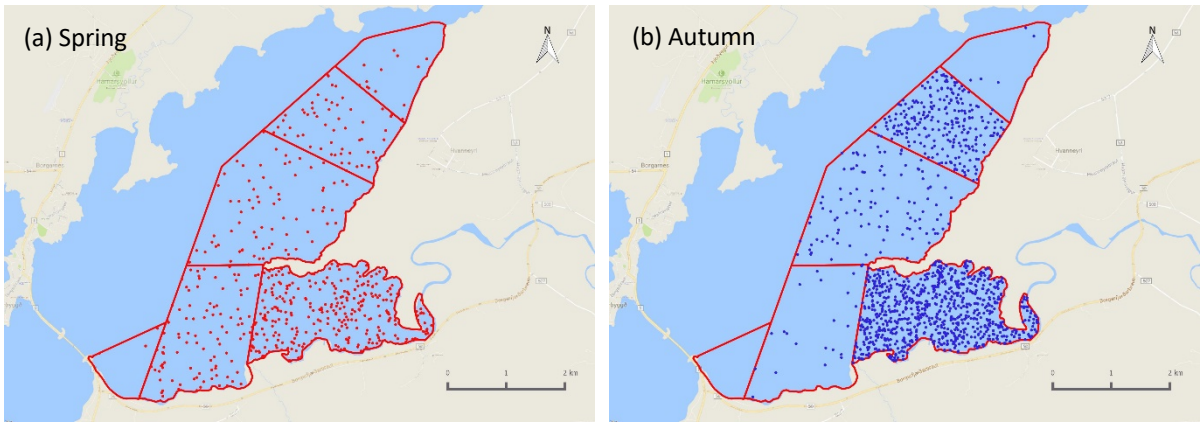

Figure 3-25. Relative abundance during (a) spring and (b) autumn of *Tadorna tadorna* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

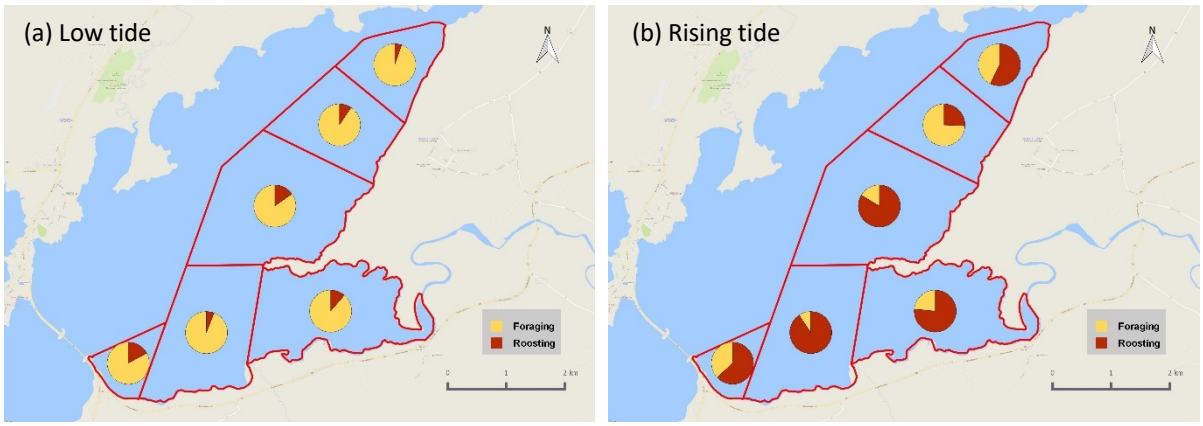

Figure 3-26. Proportion of foraging and roosting *Tadorna tadorna* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Eurasian Wigeon	*Mareca penelope*	Rauðhöfðaönd

Wigeon were recorded sporadically between March and August, until an influx in late August. During September and October, Wigeon were recorded on all surveys except one. A peak of 148 birds was recorded in early October. They were well distributed across the site being recorded in all but two subsites during low tide survey, and all but one during rising tide surveys. The peak in late June/July may represent moulting males (and non-breeders) (Delany *et al.* 2006). The late-August influx may represent moulting females, or staging ahead of onward migration to North America or Western Europe (BirdLife International 2020).

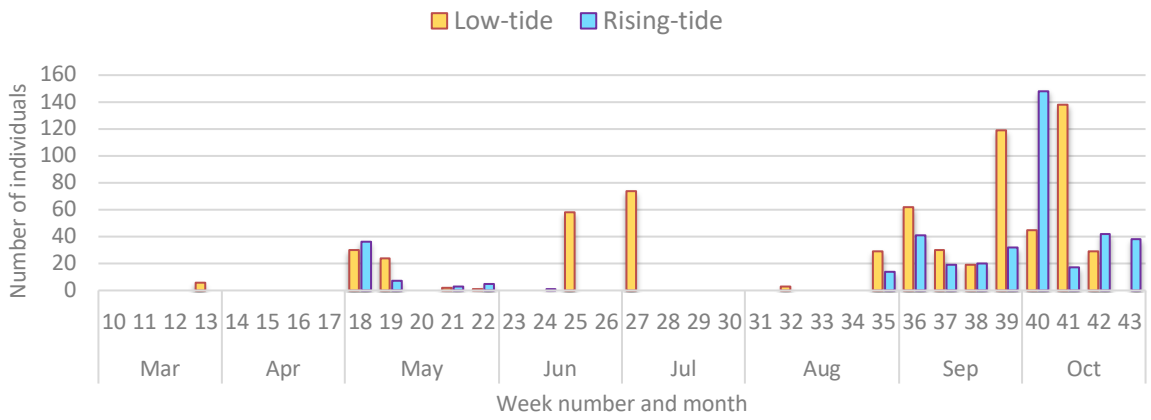

Figure 3-27. Number of *Mareca penelope* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

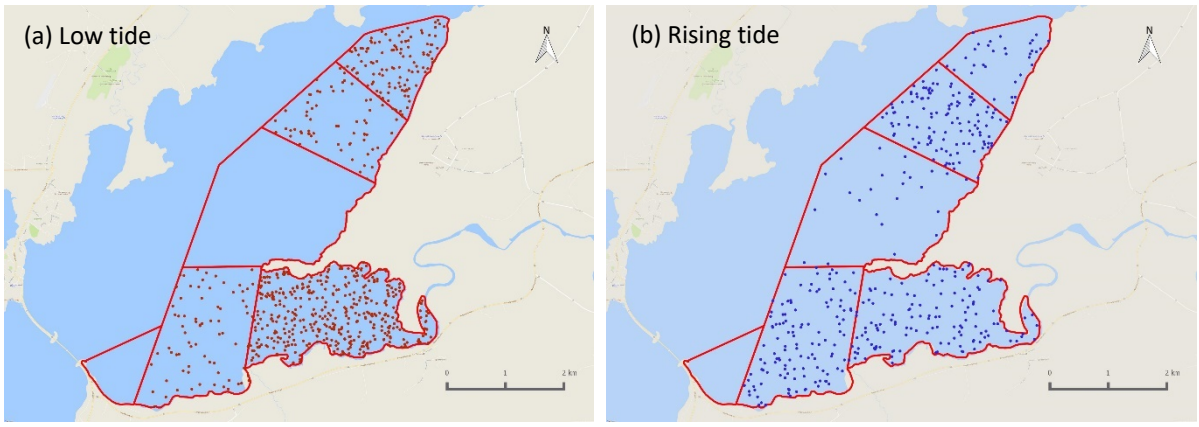

Figure 3-28. Relative abundance of *Mareca penelope* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

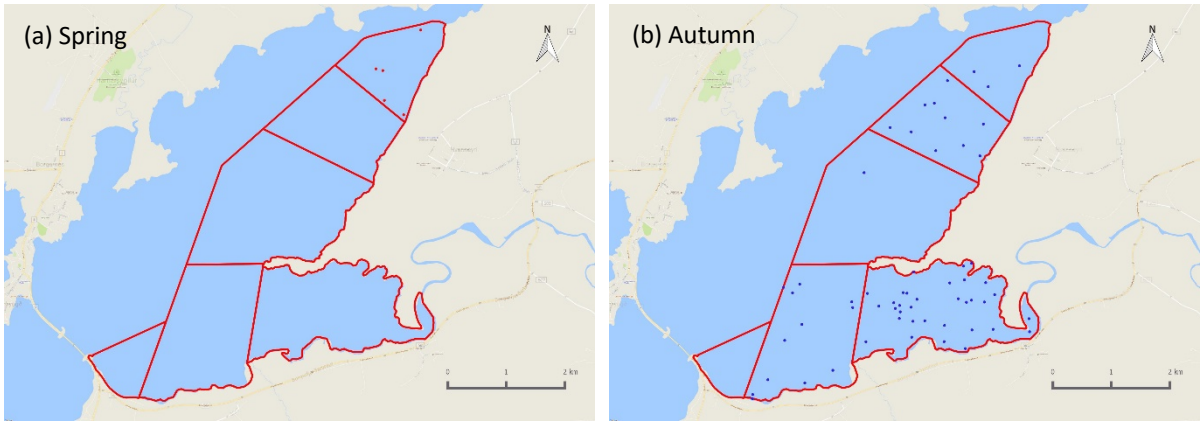

Figure 3-29. Relative abundance during (a) spring and (b) autumn of *Mareca penelope* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

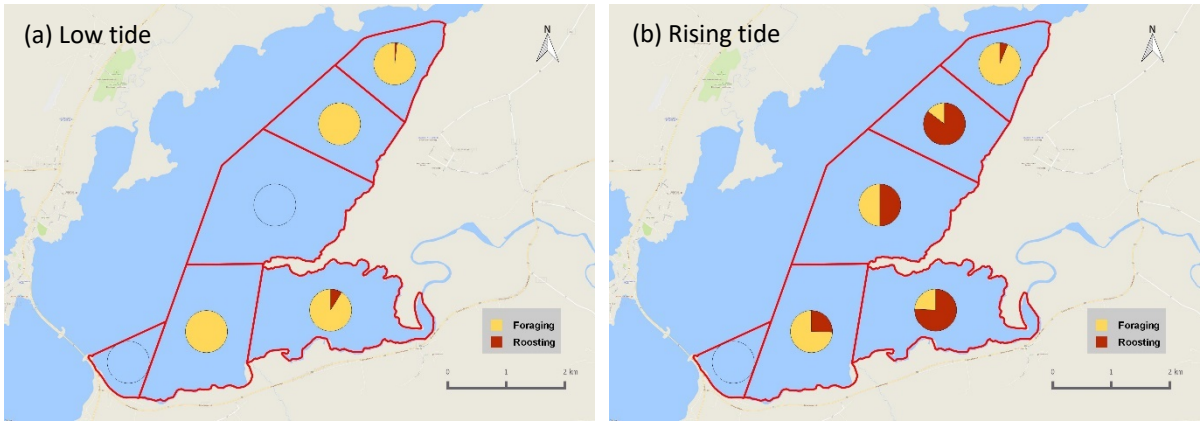

Figure 3-30. Proportion of foraging and roosting *Mareca penelope* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Mallard	*Anas platyrhynchos*	Stokkönd

Mallard occurred on all surveys but were generally observed in low numbers (< 30). A peak of 106 birds was recorded in late June. Mallards were recorded feeding and roosting in all of the subsites during low tide and rising tide surveys but were most commonly recorded in Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2). There were *c*. 20 Mallard present during the last surveys in late October.

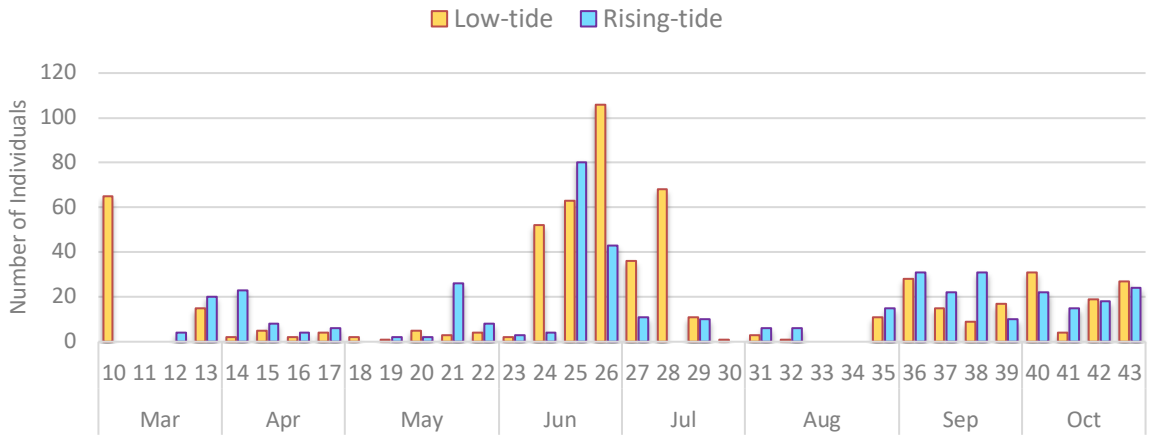

Figure 3-31. Number of *Anas platyrhynchos* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

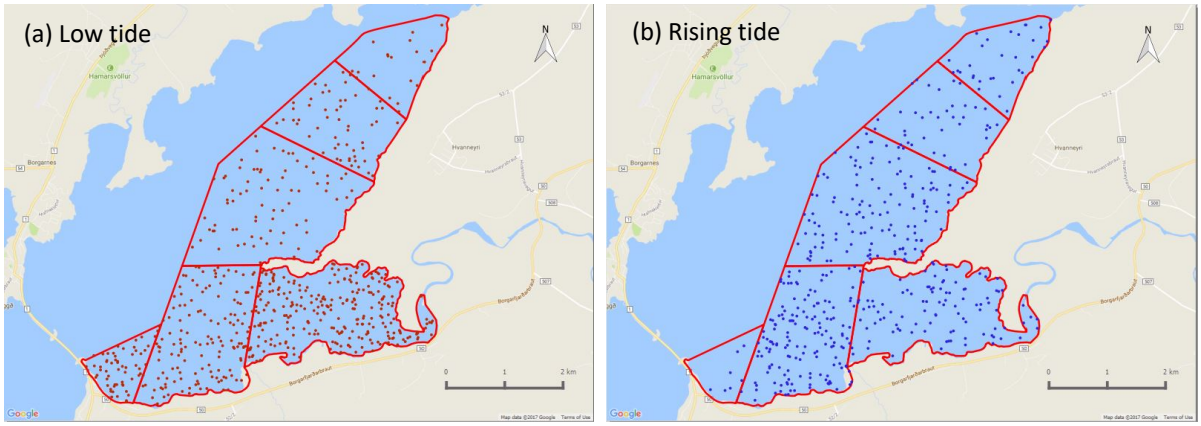

Figure 3-32. Relative abundance of *Anas platyrhynchos* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

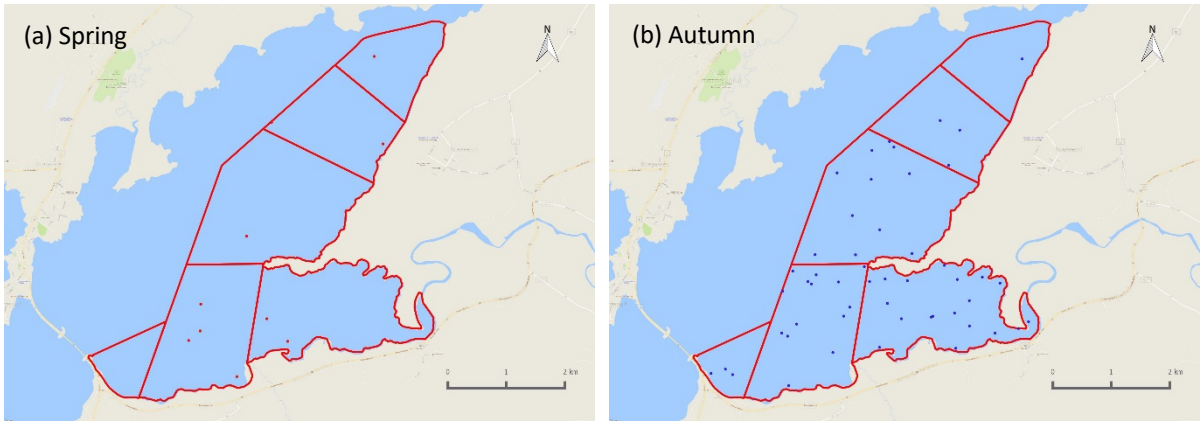

Figure 3-33. Relative abundance during (a) spring and (b) autumn of *Anas platyrhynchos* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

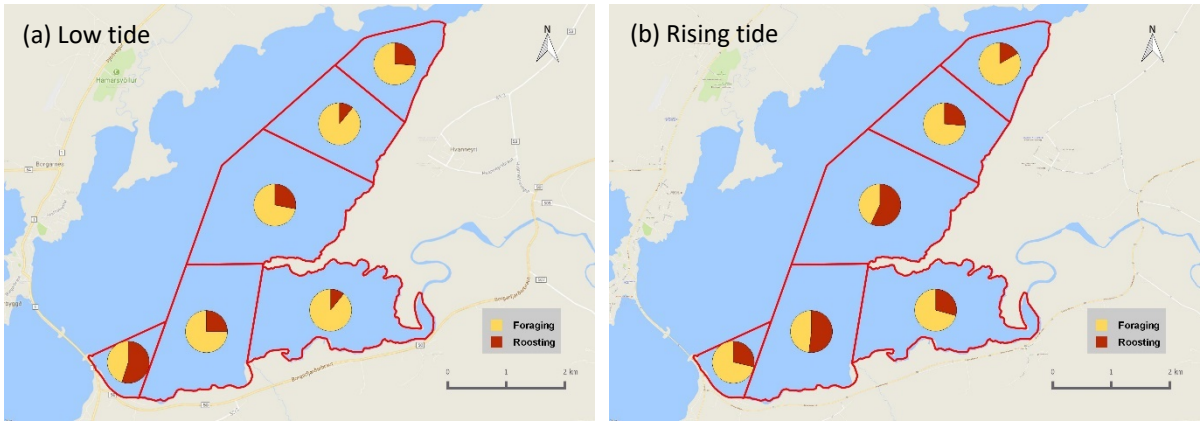

Figure 3-34. Proportion of foraging and roosting *Anas platyrhynchos* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Northern Pintail	*Anas acuta*	Grafönd

Pintail occurred in low-numbers, with a peak of nine on the rising tide survey on the 19th June. Otherwise, three sightings of two individuals occurred in April and June.

Eurasian Teal	*Anas crecca*	Urtönd

Teal were recorded in low-numbers (< 50 birds), sporadically, until the end of July. Numbers grew throughout August and peaked at 1,327 birds on 30th August. These numbers were sustained through September (*c*. 900 birds). There were 200-400 birds recorded during October. The Icelandic population of Teal is estimated at 3,000-5,000 breeding pairs (Skarphéðinsson *et al* 2006). Therefore, the numbers recorded in late-August and September represent a significant proportion of the national population. Birds were most often recorded in Kistufjörður (Est 2) during both low tide and rising tide surveys.

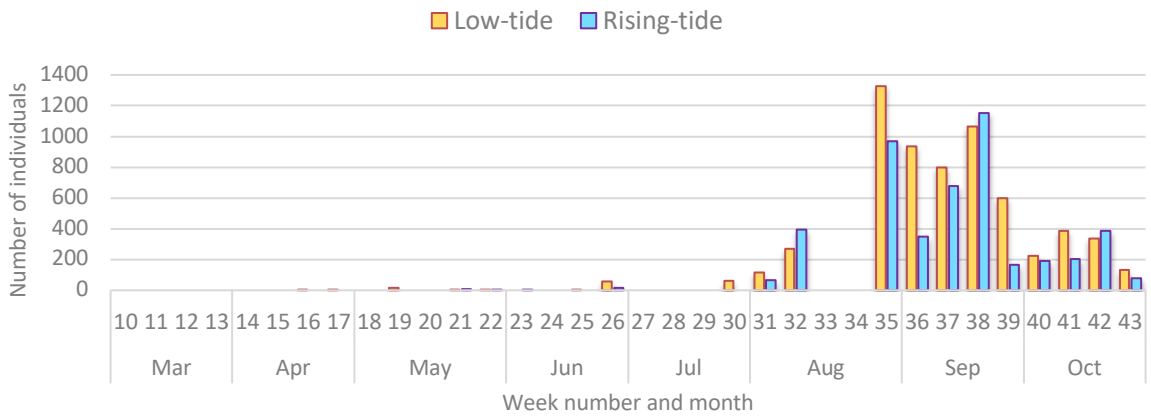

Figure 3-35. Number of *Anas crecca* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

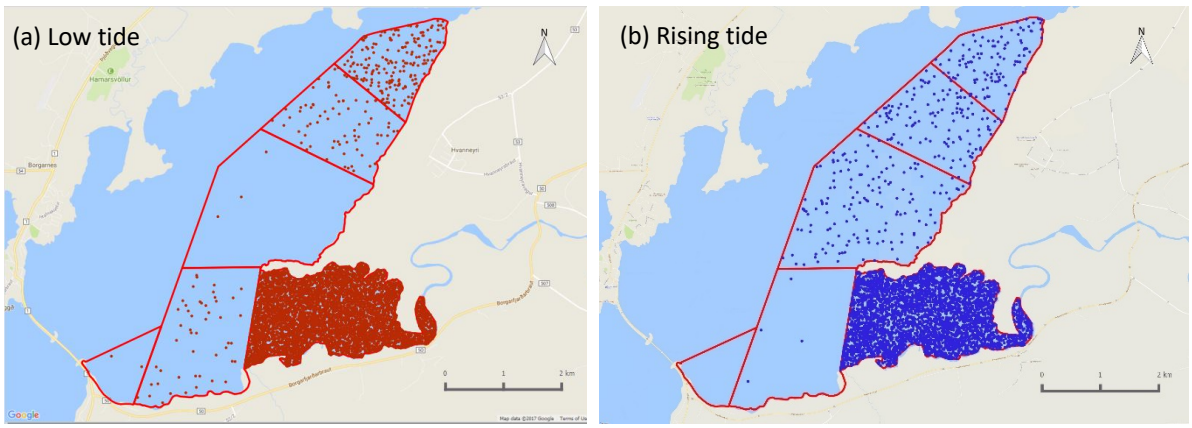

Figure 3-36. Relative abundance of *Anas crecca* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

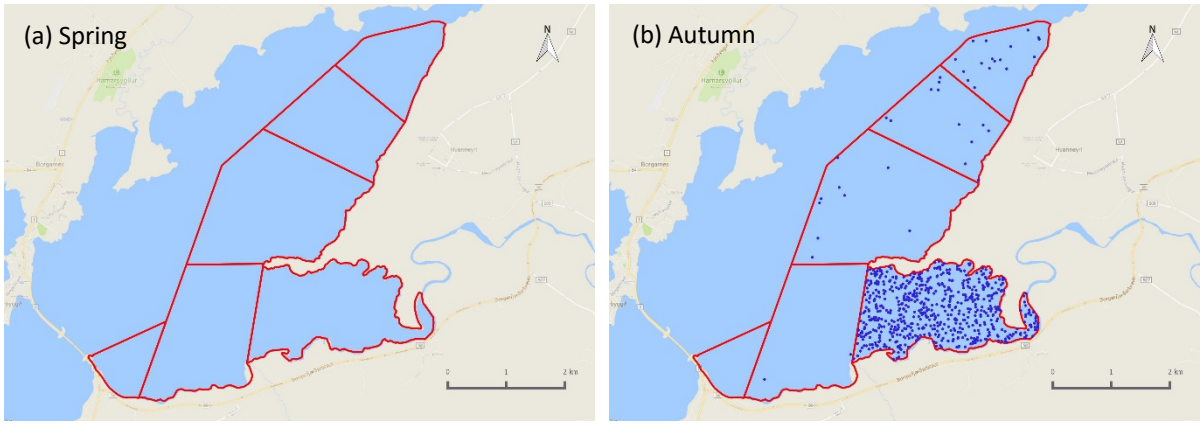

Figure 3-37. Relative abundance during (a) spring and (b) autumn of *Anas crecca* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

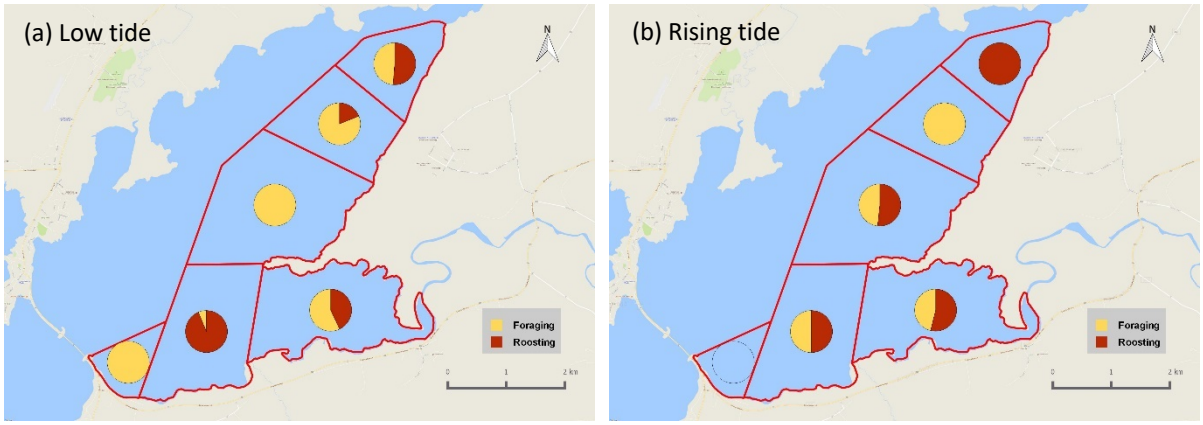

Figure 3-38. Proportion of foraging and roosting *Anas crecca* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Greater Scaup	*Aythya marila*	Duggönd

Small numbers of Scaup were recorded between mid-May and mid-August, with a peak of 15 birds on 19th July. Scaup were almost exclusively recorded in Kistufjörður (Est 2).

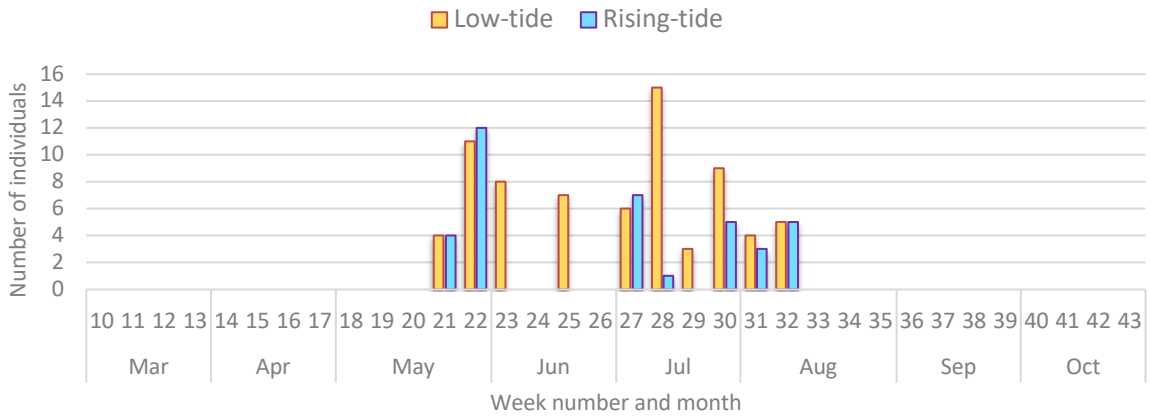

Figure 3-39. Number of *Aythya marila* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

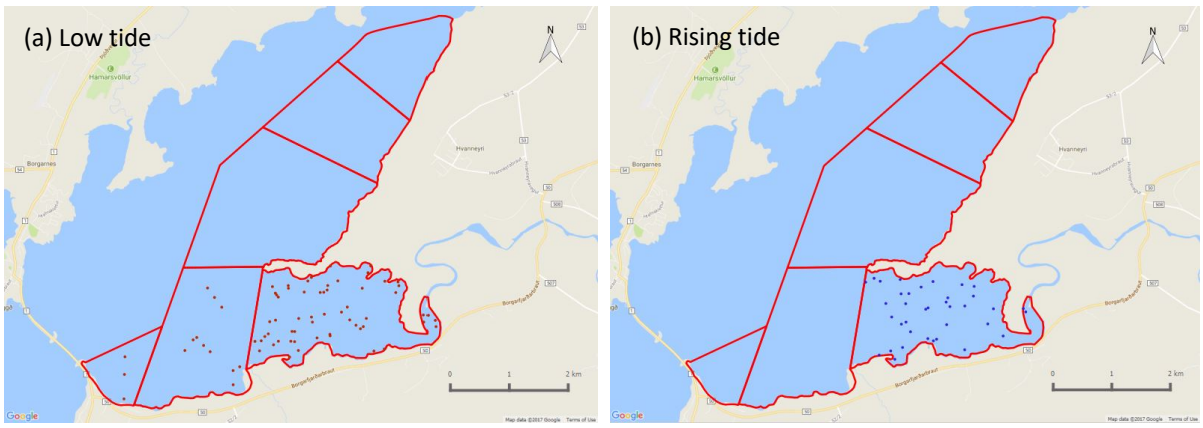

Figure 3-40. Relative abundance of *Aythya marila* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

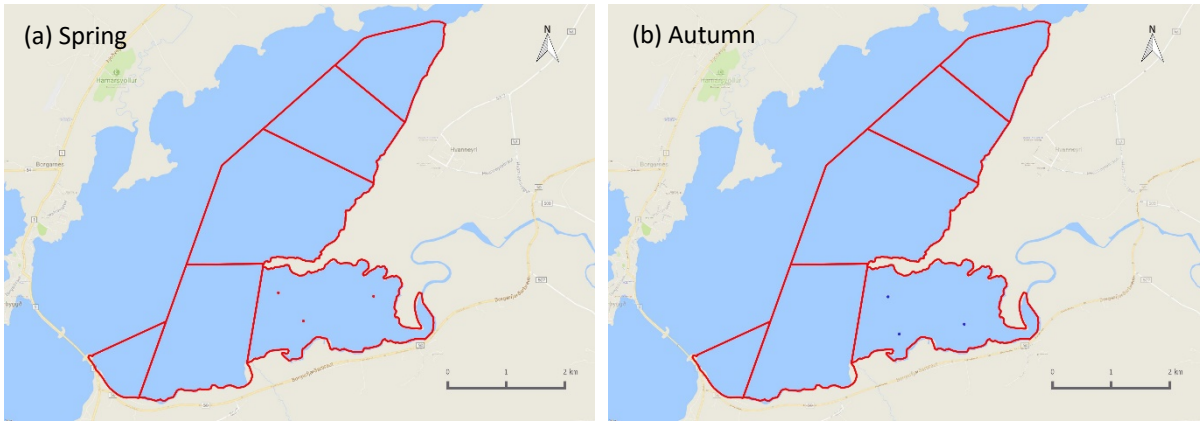

Figure 3-41. Relative abundance during (a) spring and (b) autumn of *Aythya marila* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

Common Eider	*Somateria mollissima*	Æðarfugl

Eider were not numerous within the survey area and there were generally 10 – 15 birds recorded per survey. The highest number of birds was recorded in the last week of April, and the last record occurred on the first week of October. Eider showed a strong preference for Flæðhöfðasker (Est 6), which is adjacent to Borgarnes Bridge, the west side of which is a popular area for Eider. Small Eider ducklings were observed in the survey area on 21st June. Due to their small size, these birds must have hatched near to, or in, the Ramsar site, but no nests were found.

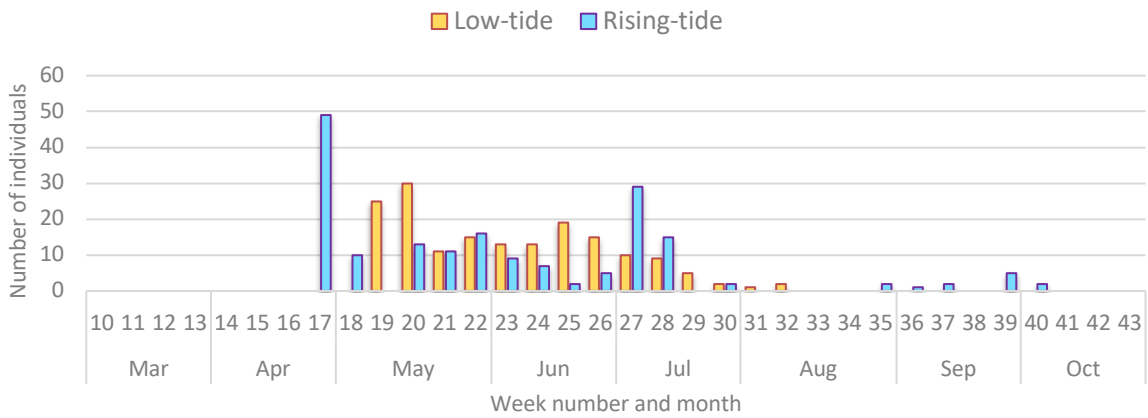

Figure 3-42. Number of *Somateria mollissima* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

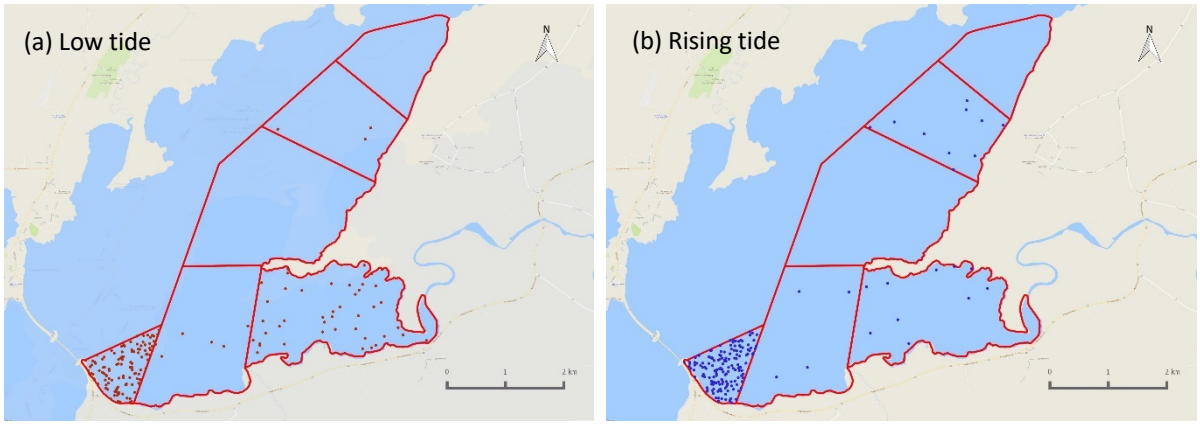

Figure 3-43. Relative abundance of *Somateria mollissima* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Harlequin Duck	*Histrionicus histrionicus*	Straumönd

Harlequin Duck occurred in low-numbers on the site with a peak of two individuals on the low tide survey on 12th June, and two records of one individual on the rising tide surveys on 5th June and 18th September.

Long-tailed Duck	*Clangula hyemalis*	Hávella

Long-tailed Ducks were recorded between mid-April and the end of June, with a peak of 66 birds in the last week of April. There were no records after June. They were recorded in the southern three subsites: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2), during low tide surveys, and during rising tide surveys they were also recorded in Ásgarðshöfði (Est 4).

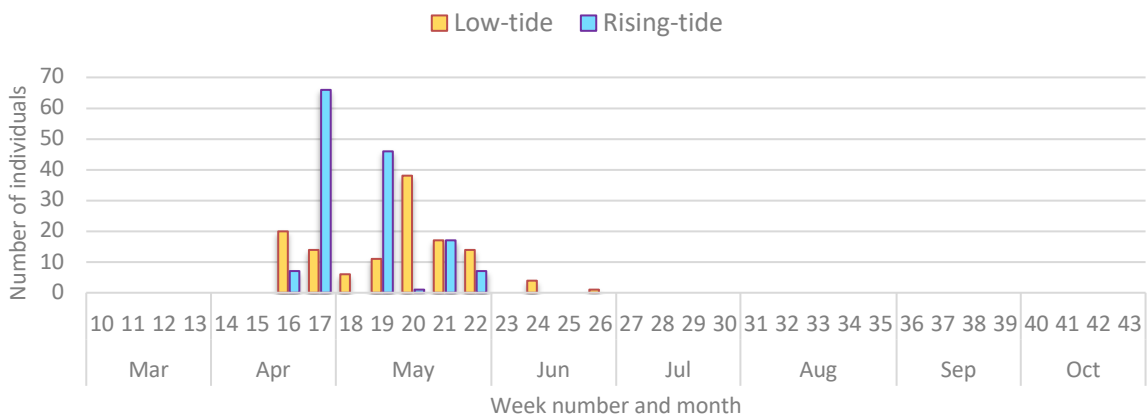

Figure 3-44. Number of *Clangula hyemalis* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

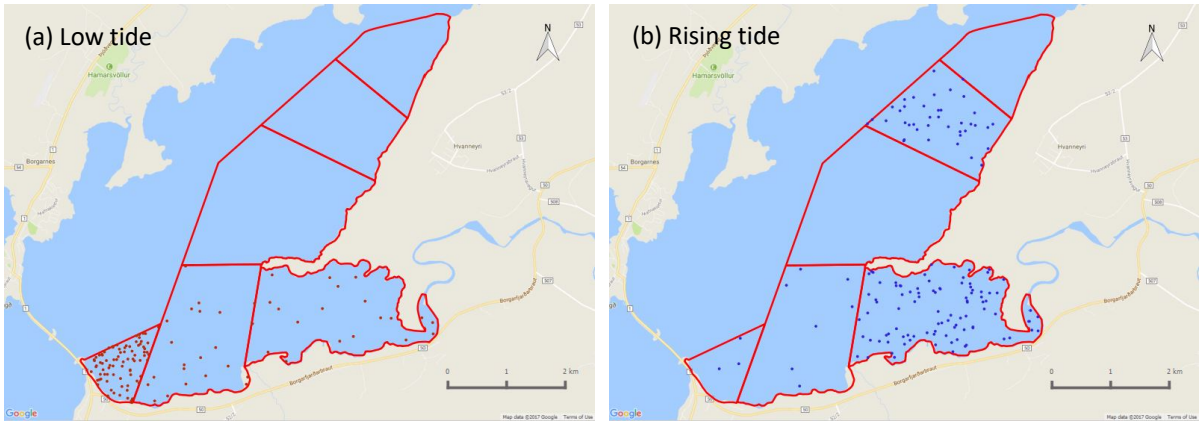

Figure 3-45. Relative abundance of *Clangula hyemalis* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

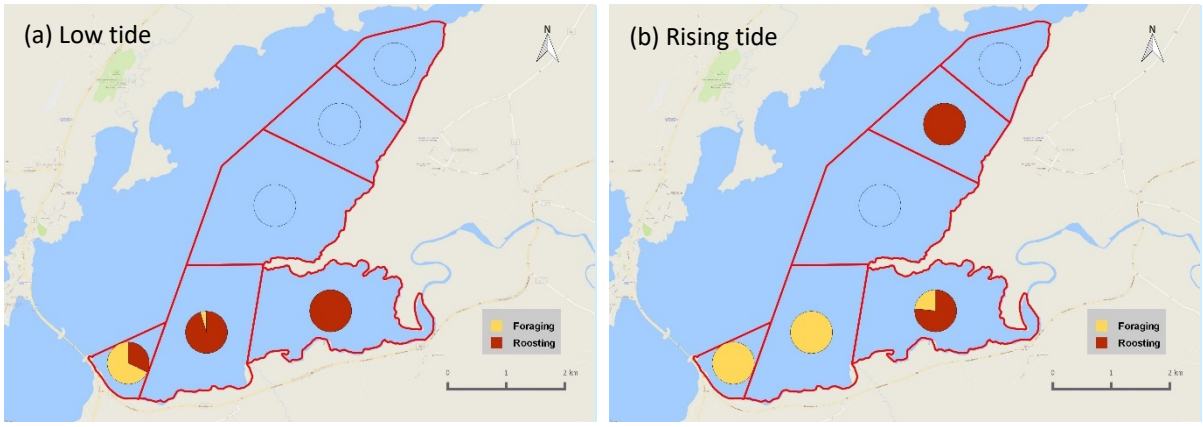

Figure 3-46. Proportion of foraging and roosting *Clangula hyemalis* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Barrow's Golden Eye	*Bucephala islandica*	Húsönd

There were three sightings of individual Barrow's Golden Eye throughout the survey period. These occurred on 10th and 17th July and 11th September.

Goosander	*Mergus merganser*	Gulönd

Apart from a record of three Goosanders on 21st March, there were no Goosanders recorded until September. The majority of birds were recorded in October, with a peak of 35 birds during a rising tide survey on the 11th. Goosanders were mainly found foraging in the main channels of the Hvítá and Andakílsá rivers. With a national population estimate of 100-300 breeding pairs (Skarphéðinsson *et al* 2006) the site supported an important proportion of the national population in October.

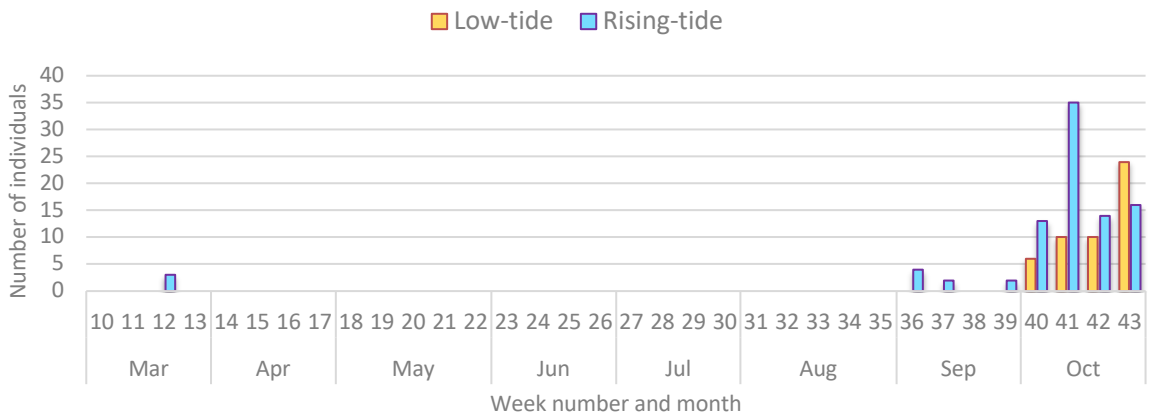

Figure 3-47. Number of *Mergus merganser* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

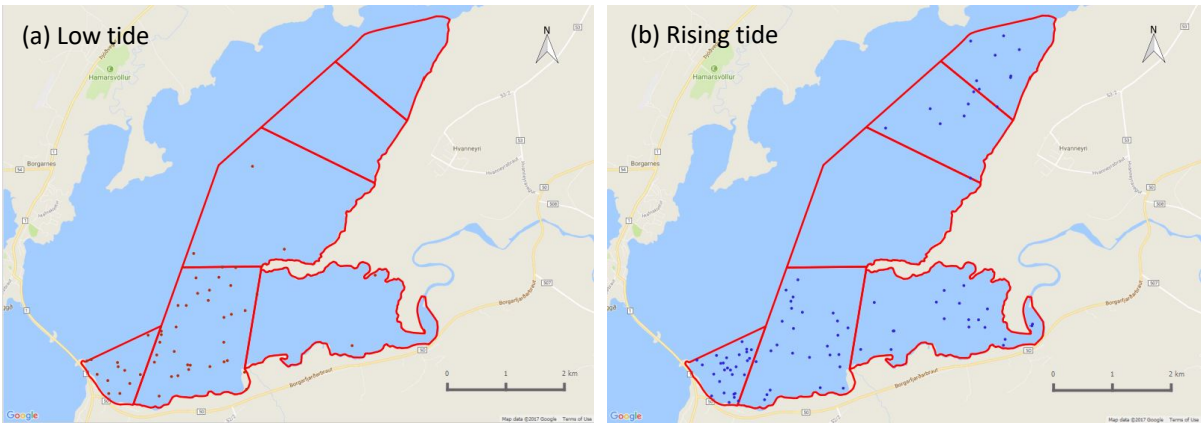

Figure 3-48. Relative abundance of *Mergus merganser* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

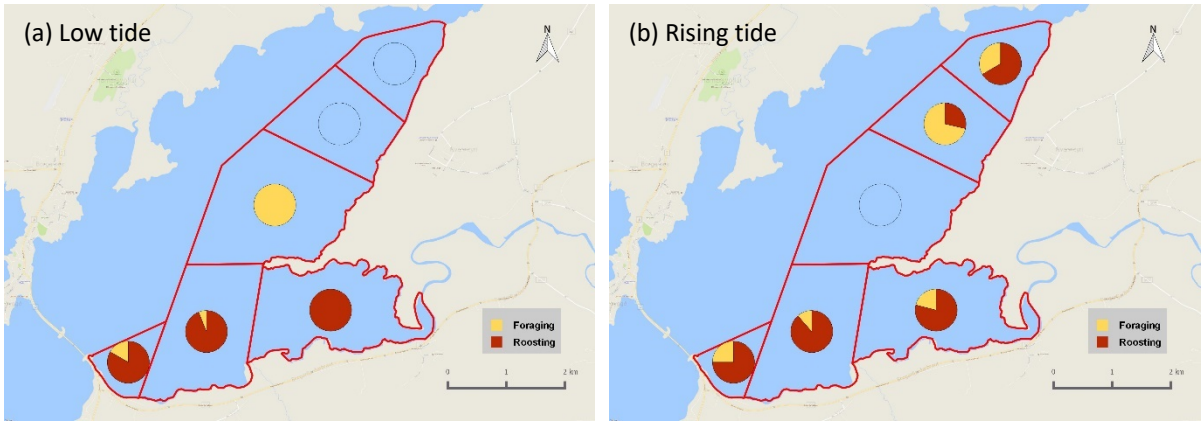

Figure 3-49. Proportion of foraging and roosting *Mergus merganser* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Red-breasted Merganser	*Mergus serrator*	Toppönd

There were three Red-breasted Mergansers recorded in the first week of March. They were not subsequently present in the estuary until the third week of April, after which their numbers gradually increased throughout May and June. There was a notable increase in July, presumably as birds arrived to moult, and numbers peaked at 320 on 7th August. As no surveys were conducted over a two-week period in late August, the pattern of abundance during this period is unknown. However, with an estimated 2,000-4,000 breeding pairs in Iceland (Skarphéðinsson *et al* 2006), the site supported an important proportion of the population. There is a sustained decline in numbers from 30th August onwards and most of the birds had emigrated by the end of September. A single Red-breasted Merganser was recorded on the final rising tide survey on 25th October. During low tides the birds favoured the southern portion of the site: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2), but they were also recorded in Ásgarðshöfði (Est 4) during rising tide surveys.

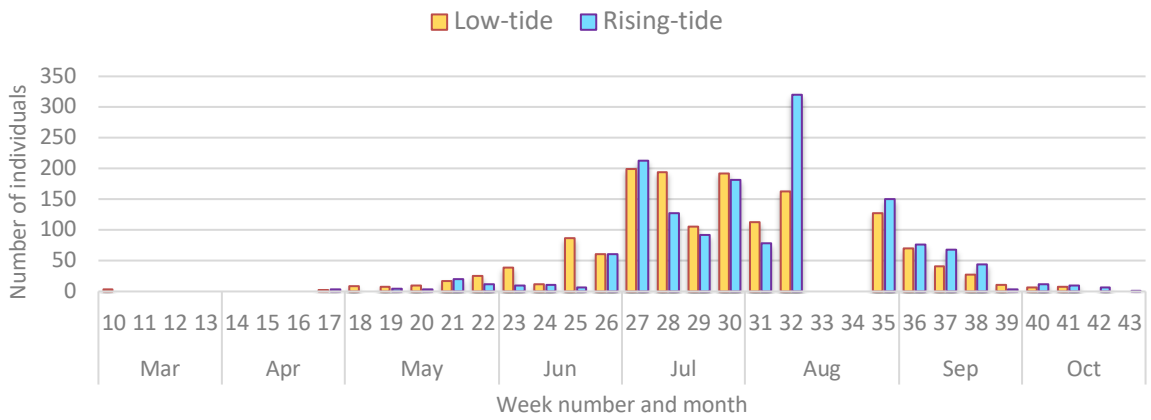

Figure 3-50. Number of *Mergus serrator* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

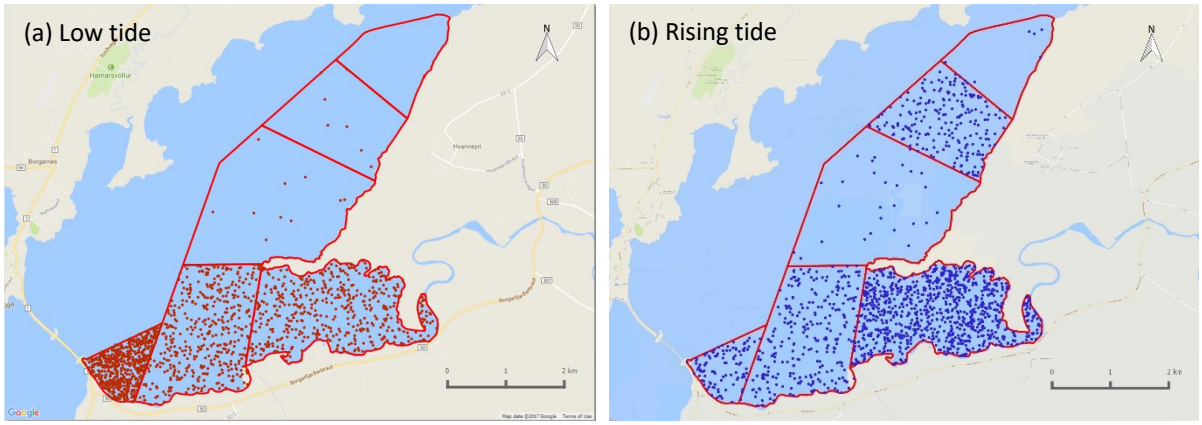

Figure 3-51. Relative abundance of *Mergus serrator* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

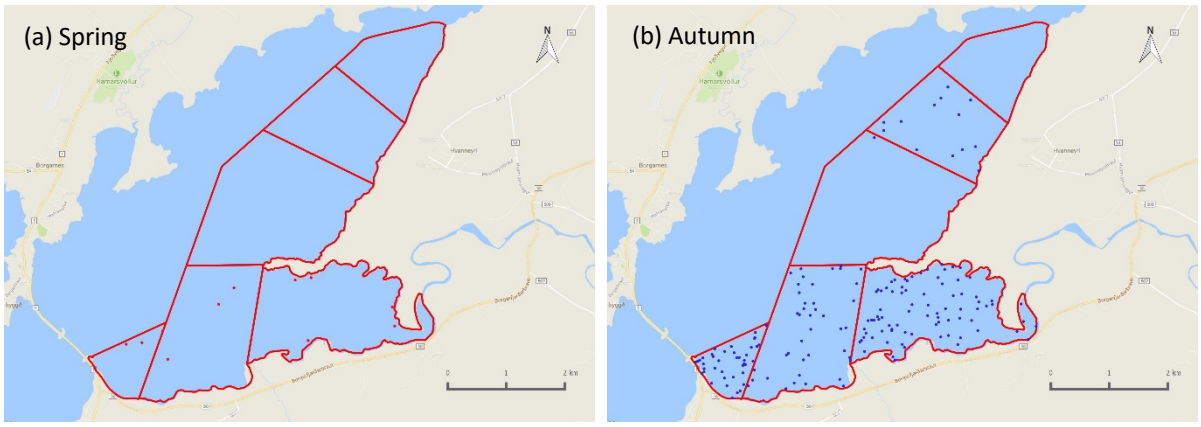

Figure 3-52. Relative abundance during (a) spring and (b) autumn of *Mergus serrator* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

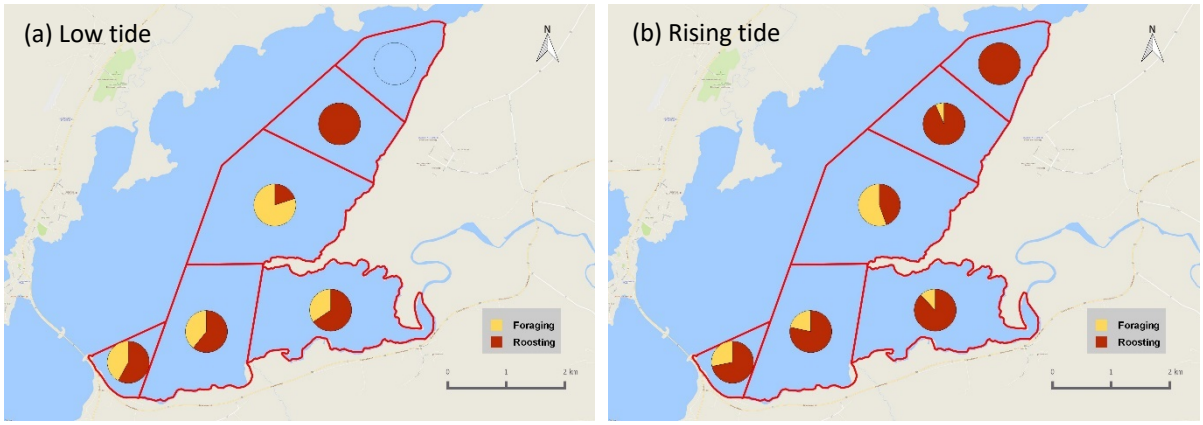

Figure 3-53. Proportion of foraging and roosting *Mergus serrator* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Red-throated Diver	*Gavia stellata*	Lómur

Red-throated Divers were recorded sporadically throughout the majority of the survey period. Highest numbers (14 birds) occurred on 29th May, and the species was recorded on most surveys between mid-May and mid-August. Up to six birds were recorded on Lake Vatnshamravatn throughout April, with high counts of 14 and 10 birds recorded there on 24th and 27th April respectively. Two nesting territories were observed on Lake Vatnshamravatn on 28th May. Both pairs successfully hatched chicks, and broods of two and one unfledged chicks were observed on 9th July. There were intermittent records in the estuarine survey area during August and September. The last record was of a single bird on 25th September. While Red-throated Divers were recorded in each of the six subsites during low tide and rising tide surveys, greatest numbers were routinely found in the three southernmost subsites, Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2).

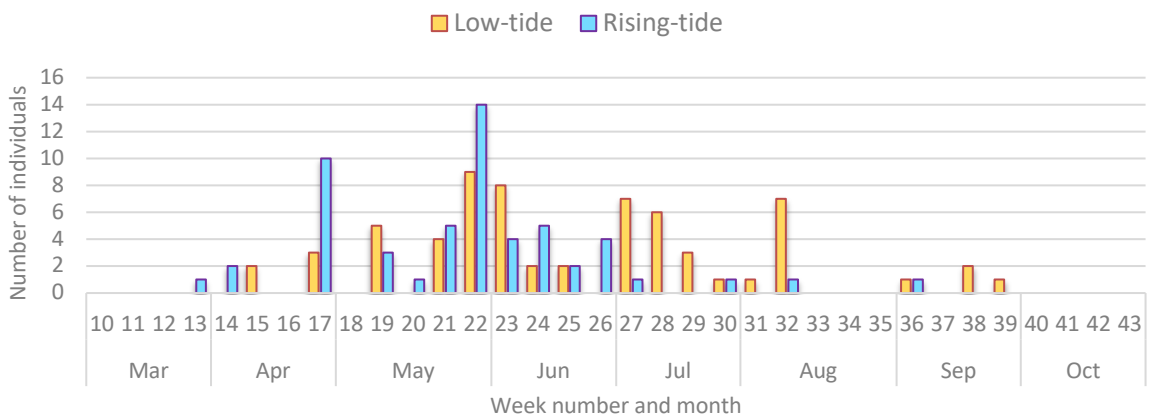

Figure 3-54. Number of *Gavia stellata* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

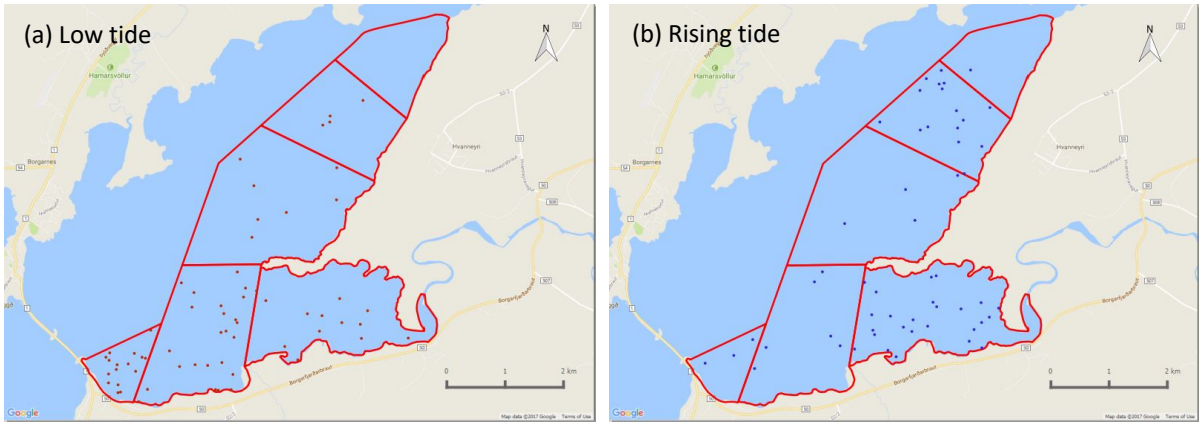

Figure 3-55. Relative abundance of *Gavia stellata* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

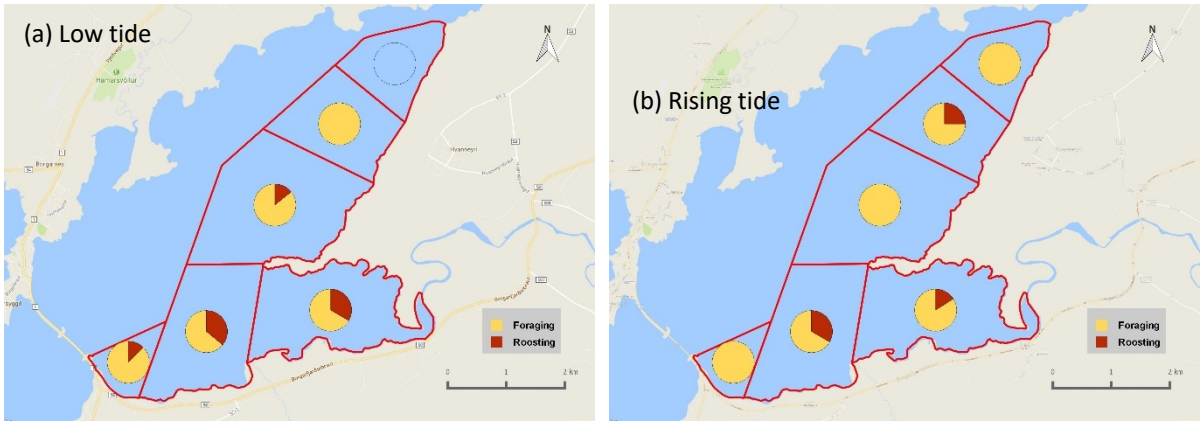

Figure 3-56. Proportion of foraging and roosting *Gavia stellata* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Great Northern Diver	*Gavia immer*	Himbrimi

Great Northern Divers were regularly recorded in the estuary, with one or two birds recorded on most surveys between late May and mid-September.

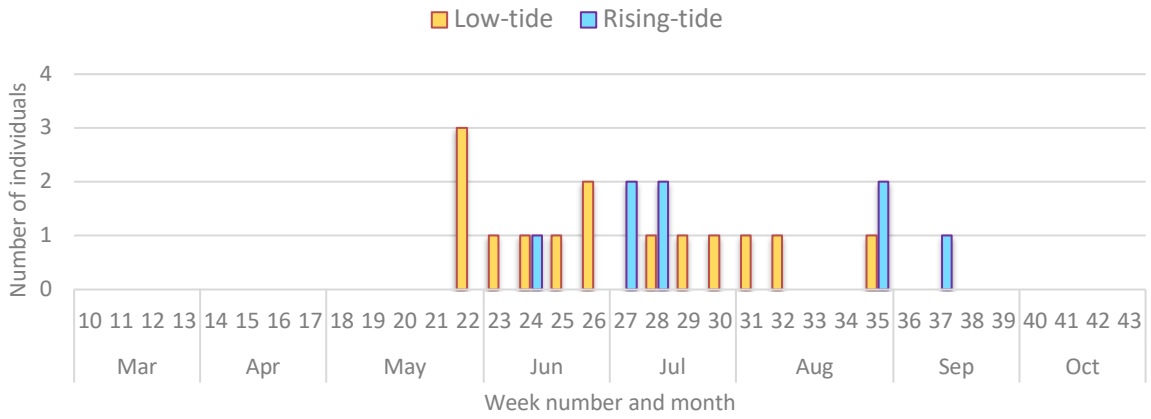

Figure 3-57. Number of *Gavia immer* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

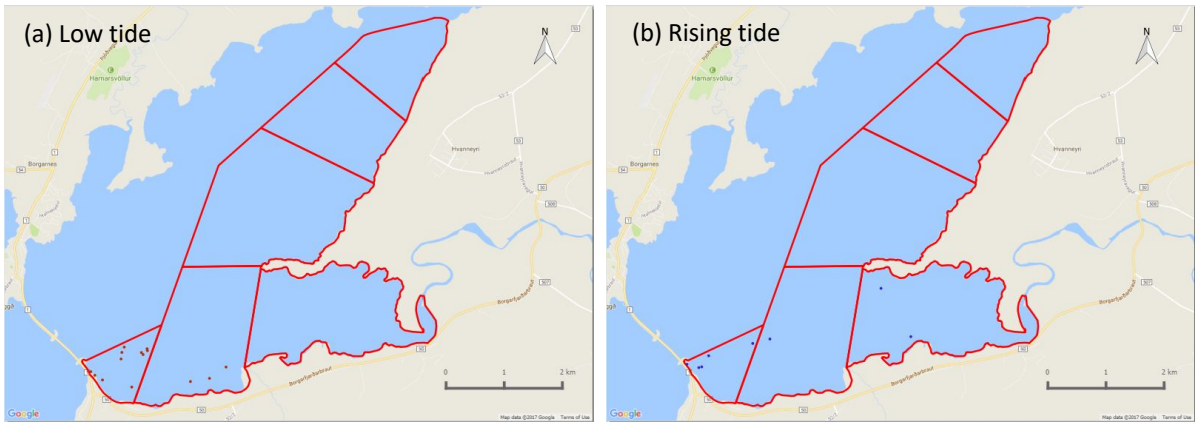

Figure 3-58. Relative abundance of *Gavia immer* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Slavonian Grebe	*Podiceps auritus*	Flórgoði

Two Slavonian Grebes were recorded in Flæðhöfðasker (Est 6) during the low tide survey on 24th May. An additional Slavonian Grebe was recorded on Vatnshamrarvatn on 1st May.

Cormorant	*Phalacrocorax carbo*	Dílaskarfur

Cormorants were recorded in most surveys from late April until the last survey on 25th October. A peak of 13 birds was recorded in July. There were no records of birds breeding within the Andakíll Ramsar site, but as several juveniles were recorded during July and August. Birds were most frequently recorded fishing or roosting in the three southernmost subsites, Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2).

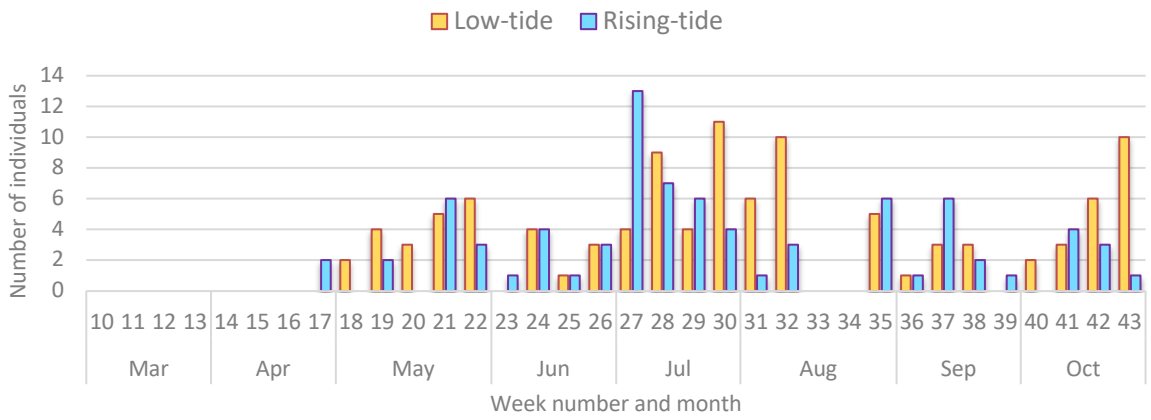

Figure 3-59. Number of *Phalacrocorax carbo* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

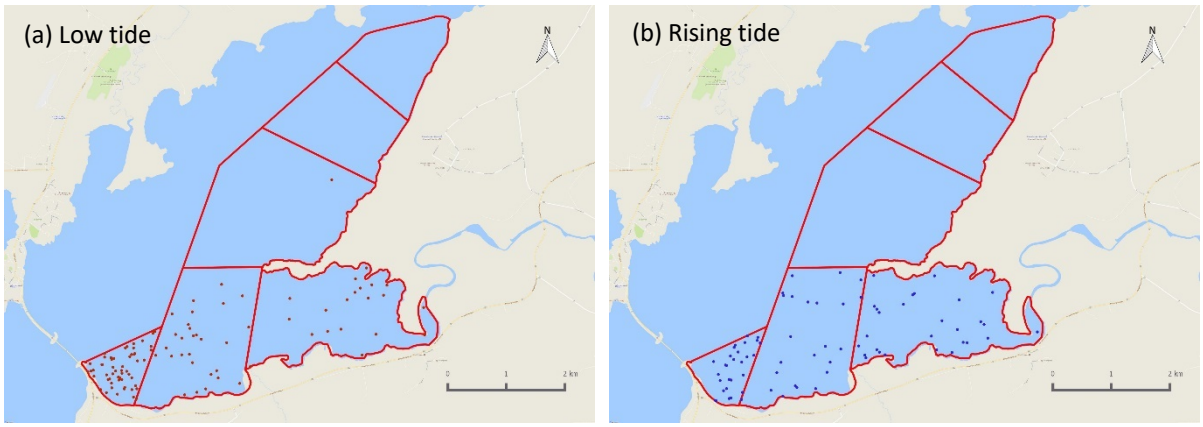

Figure 3-60. Relative abundance of *Phalacrocorax carbo* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Waders

There were two distinct peaks in the number of waders using the site, in late April and late August.

In almost all weeks, the number of birds recorded during low tide surveys was greater than during rising tide surveys (Figure 3-61). This is often the case for surveys like this, and indeed is the reason that rising tide surveys were undertaken rather than high tide surveys. Waders are easier to count when they are dispersed across extensive intertidal areas at low tide, compared to rising or high tides when they are squeezed together in high tide roosts, and often obscured by vegetation or rocks. Therefore, in some cases the explanation for higher counts during low tides may be greater detectability at this time. However, it is more likely that this pattern reflects differential use of the site for foraging (at low tide) and roosting (at high tide).

During the spring, Oystercatcher, Golden Plover, Ringed Plover, Black-tailed Godwit, Redshank, Turnstone, Dunlin and Purple Sandpiper were recorded in considerably larger numbers during low tide surveys compared to rising tide surveys. In the autumn, considerably more Golden Plover, Ringed Plover, Redshank, Turnstone and Dunlin were recorded during low tide surveys compared to rising tide surveys. This suggests that they avail of high tide refuges outside the Andakíll Ramsar site. It is also possible that some small or inconspicuous roost sites were missed during surveys, but this is unlikely to account for the considerable and consistent differences in low tide and rising tide survey totals. This highlights the importance of conducting both low tide and rising tide surveys to gain the complete picture on how the birds use the protected area.

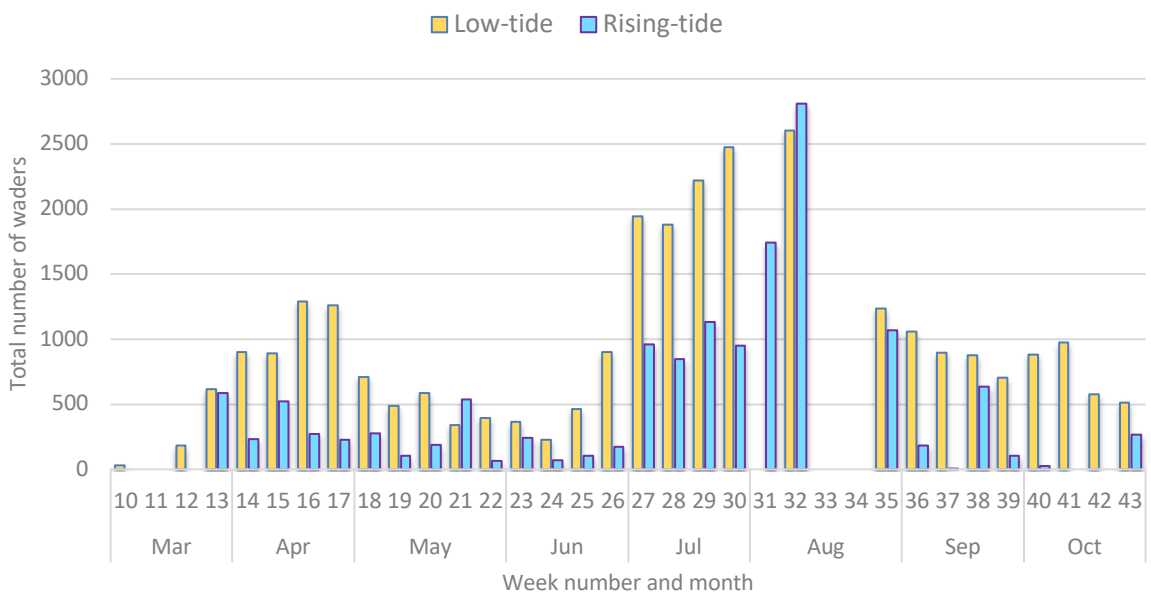

Figure 3-61. Number of waders recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Eurasian Oystercatcher	*Haematopus ostralegus*	Tjaldur

Oystercatchers were first recorded on 12th March, and then in all surveys between 27th March and 7th August. The last records of Oystercatcher in the survey area was ten birds on 9th October. At least 200 birds were recorded during all surveys in April, with a peak count of 585 on 18th April. Numbers reduced considerably in May and remained at a low-level (*c.* 30 birds of less) throughout June, July and until 7th August. Oystercatchers nested throughout the Andakíll Ramsar site: on the fringes of the fjord and within the farmland and village (Tierney & Tierney 2020). While Oystercatchers were recorded in all subsites, they displayed a preference for Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2) during low tides, and for Kistufjörður (Est 2) during rising tides. As the available foraging area in Grjóteyrarklakkur (Est 1) was inundated on rising tides, the birds foraged in Kistufjörður (Est 2), before roosting on the rocks at the north of the subsite.

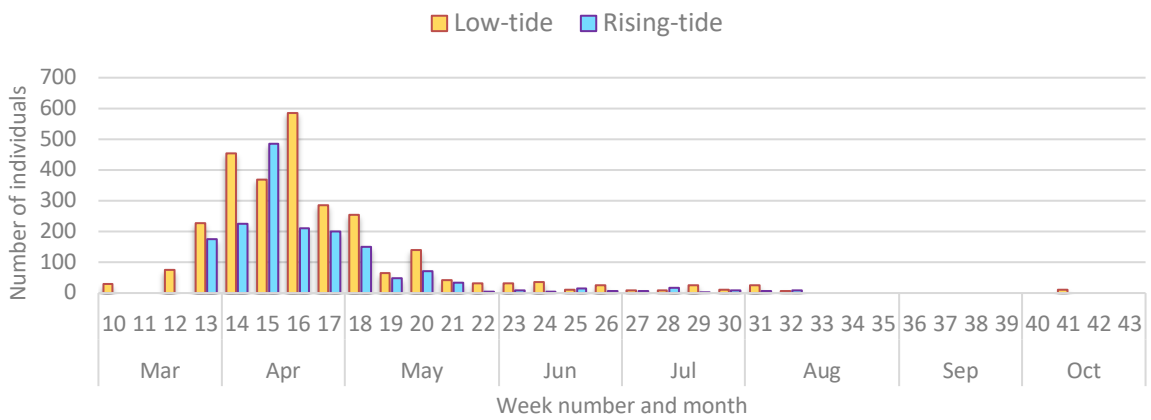

Figure 3-62. Number of *Haematopus ostralegus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

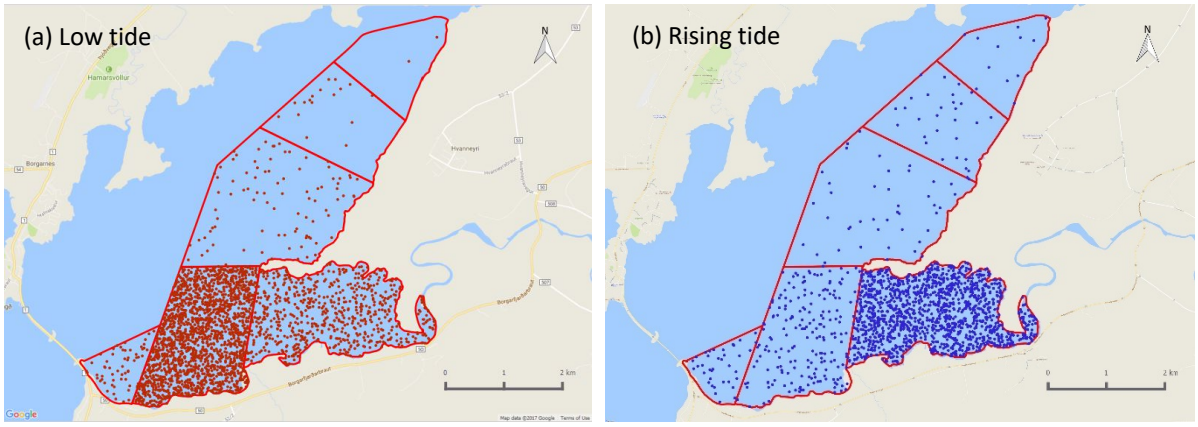

Figure 3-63. Relative abundance of *Haematopus ostralegus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

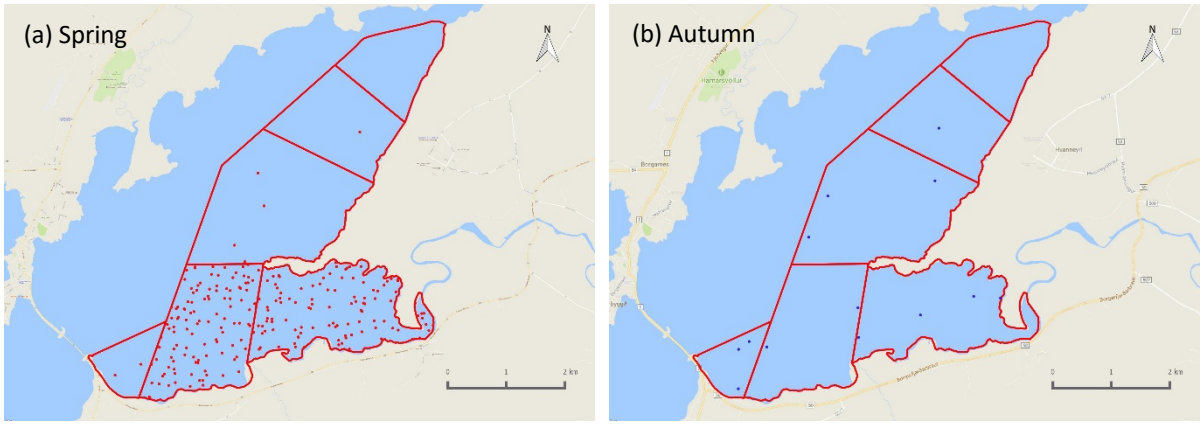

Figure 3-64. Relative abundance during (a) spring and (b) autumn of *Haematopus ostralegus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

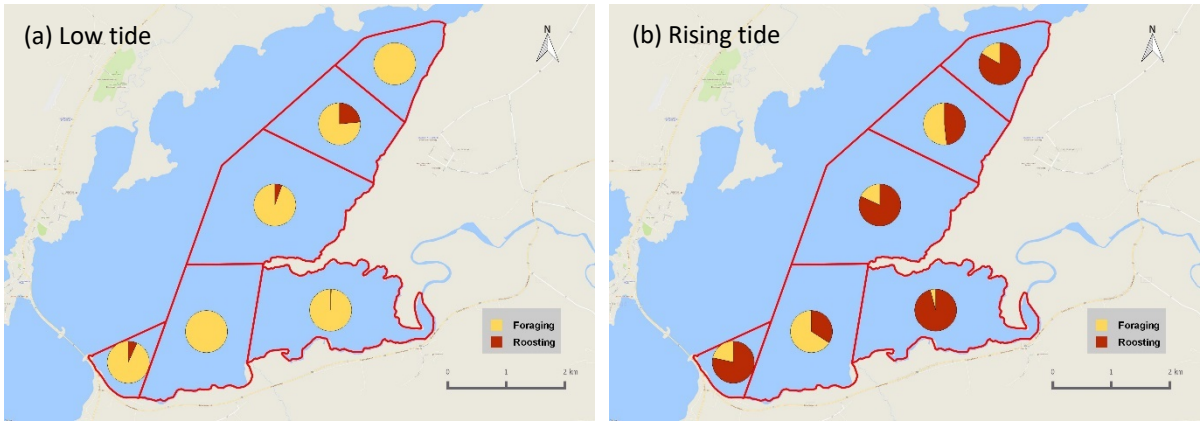

Figure 3-65. Proportion of foraging and roosting *Haematopus ostralegus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

European Golden Plover	*Pluvialis apricaria*	Heiðlóa

Golden Plover were present in the survey area on almost all surveys between 3rd April and 25th October, albeit in low numbers (< 50 birds) before 2nd August. During August, September and October, the mudflats were well used by Golden Plovers, especially during low tides – there were greater than 600 birds present on each low tide survey throughout September, and there was a peak of 950 birds on 9th October. Golden Plover were distributed throughout the six subsites, with largest numbers recorded in Kistufjörður (Est 2) and Grjóteyrarklakkur (Est 1) during low tides, and Ásgarðshöfði (Est 4) during rising tide surveys. The greatly reduced numbers during rising tide surveys suggest the birds must be exploiting terrestrial foraging areas at this tidal stage.

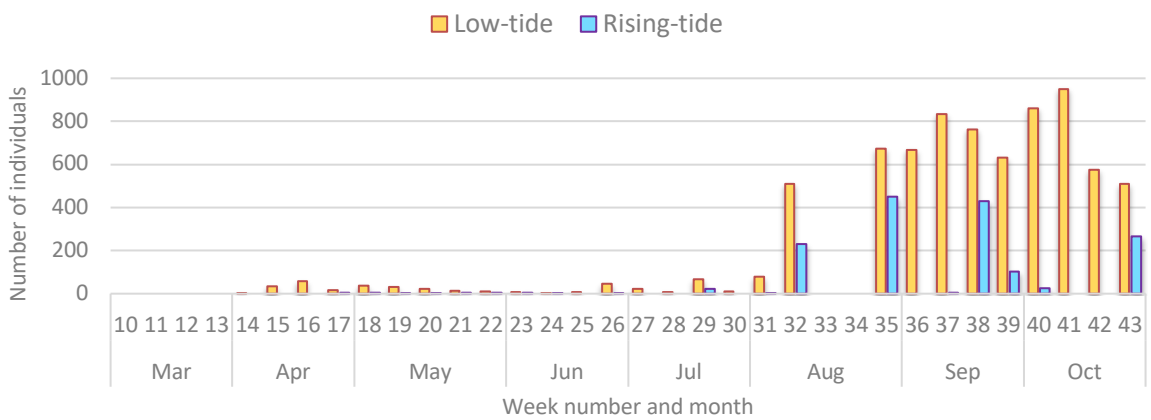

Figure 3-66. Number of *Pluvialis apricaria* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

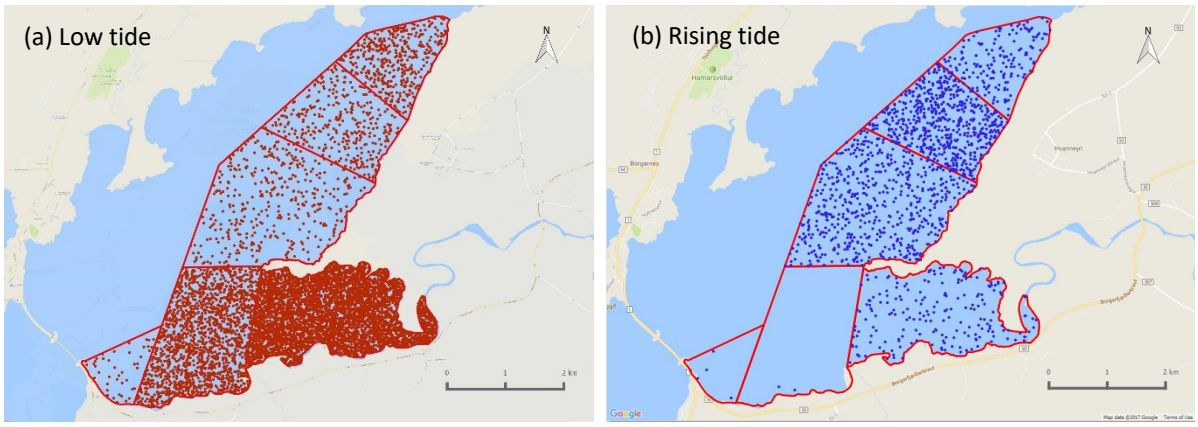

Figure 3-67. Relative abundance of *Pluvialis apricaria* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

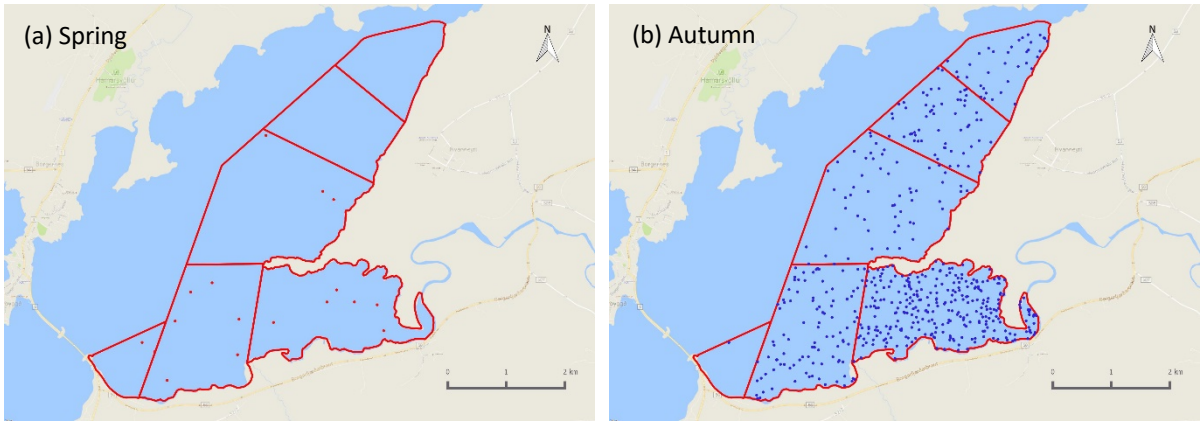

Figure 3-68. Relative abundance during (a) spring and (b) autumn of *Pluvialis apricaria* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

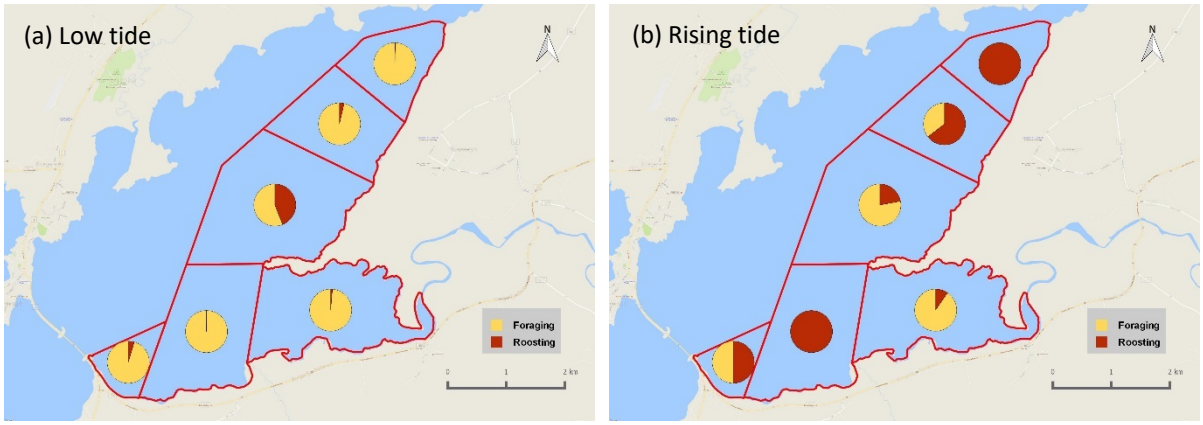

Figure 3-69. Proportion of foraging and roosting *Pluvialis apricaria* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Ringed Plover	*Charadrius hiaticula*	Sandlóa

Ringed Plovers were first recorded in the survey area on 18th April and were present in all weeks until 11th September. Birds were observed in greater numbers during low tide surveys than rising tide surveys, which suggests that the birds avail of high tide refuges outside the Andakíll Ramsar site. The first chicks were recorded on the 12th June. At least one pair nested close to the Arctic Tern colony adjacent to Flæðhöfðasker (Est 6). Highest counts occurred during low tide counts in July and August, with monthly peaks of 65 and 64 birds, respectively. During low tide surveys, birds displayed a preference for the three southernmost subsites (Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2), and Flæðhöfðasker (Est 6)), but were dispersed throughput the six subsites during rising tide surveys.

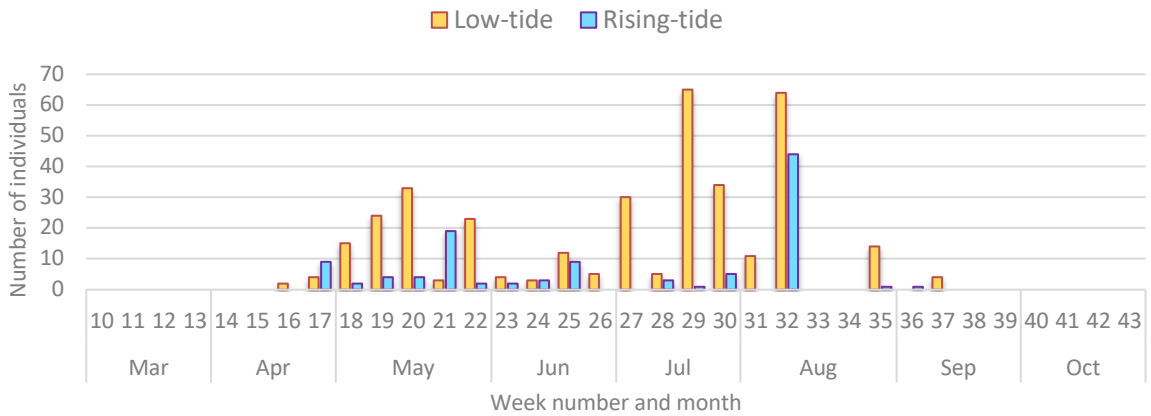

Figure 3-70. Number of *Charadrius hiaticula* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

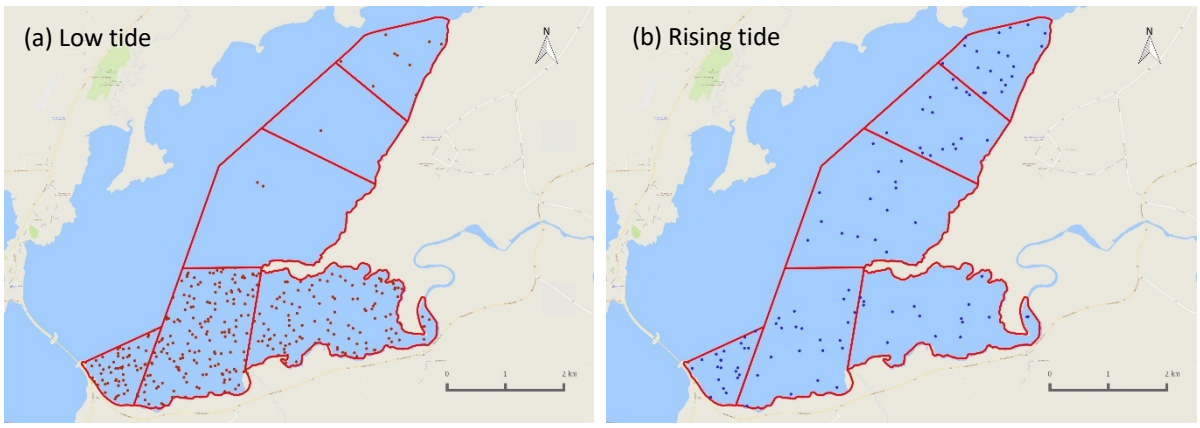

Figure 3-71. Relative abundance of *Charadrius hiaticula* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

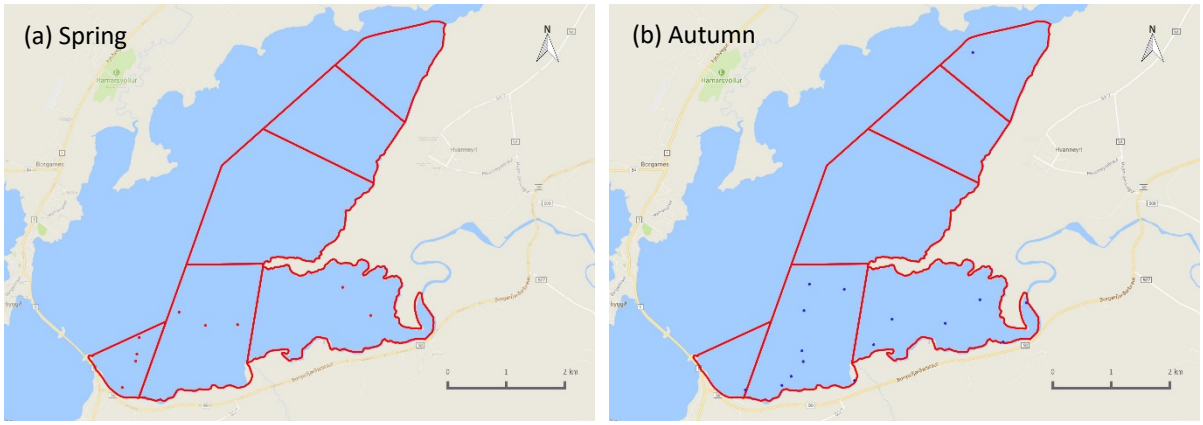

Figure 3-72. Relative abundance during (a) spring and (b) autumn of *Charadrius hiaticula* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

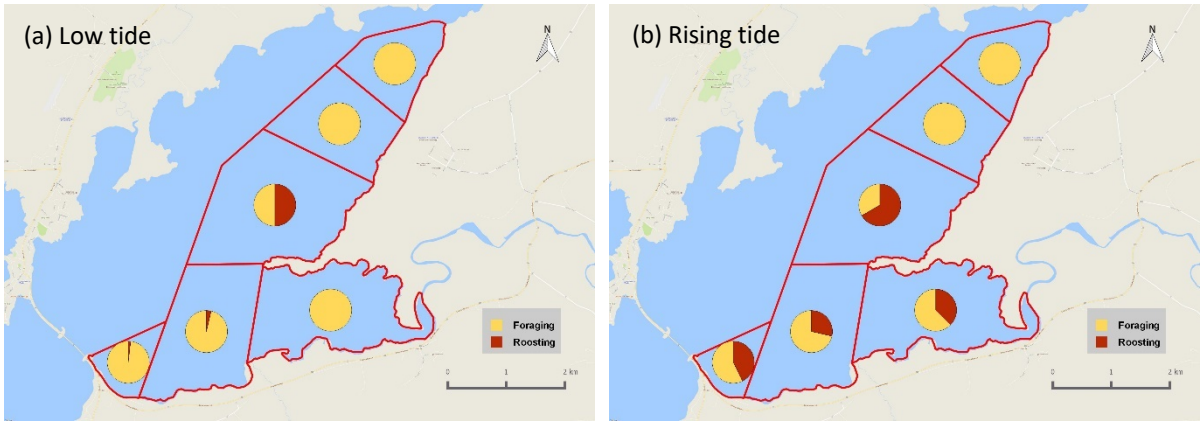

Figure 3-73. Proportion of foraging and roosting *Charadrius hiaticula* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Common Snipe	*Gallinago gallinago*	Hrossagaukur

While there was very little suitable habitat within the survey area, Snipe were recorded on two occasions. Six birds were observed foraging above the high tide line on 4th April, and a single bird was recorded on 31st July. Elsewhere in the Andakíll Ramsar site, they were the most abundant breeding wader (Tierney & Tierney 2020).

Black-tailed Godwit	*Limosa limosa*	Jaðrakan

Black-tailed Godwit were recorded in the survey area in all weeks between 24th April and 11th September, in most cases there were fewer than 50 birds. However, there were short-lived seasonal peaks: 122 birds on 24th April and 180 on 7th August. Birds were recorded in all subsites during low tide and rising tide surveys. During rising tide surveys, roosting aggregations occurred in Kistufjörður (Est 2), Kistuhöfðahólmar (Est 3) and Ásgarðshöfði (Est 4). They are common breeders within the Andakíll Ramsar site (Tierney & Tierney 2020)

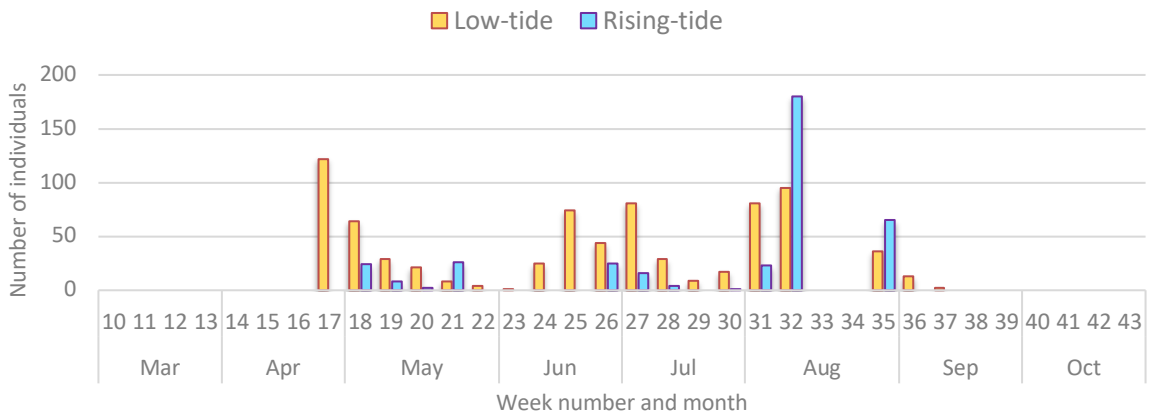

Figure 3-74. Number of *Limosa limosa* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

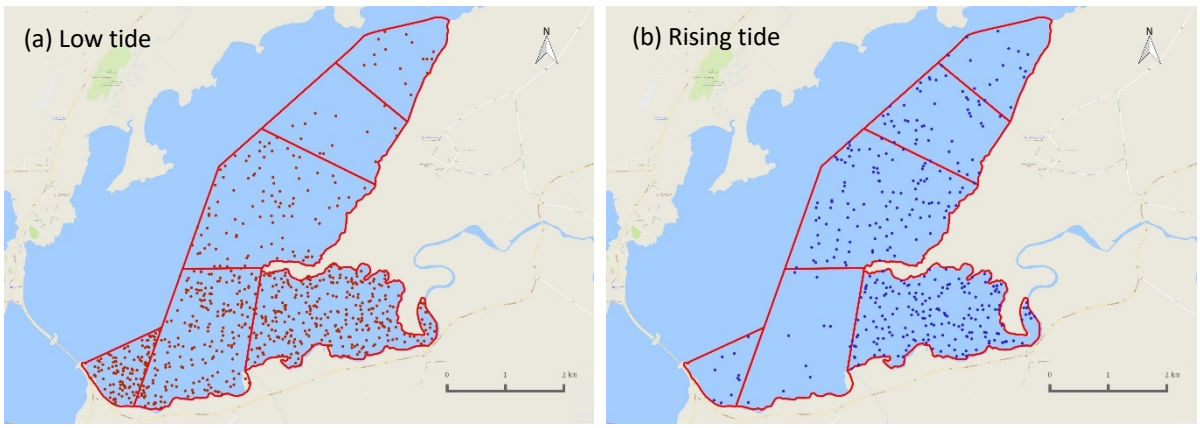

Figure 3-75. Relative abundance of *Limosa limosa* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

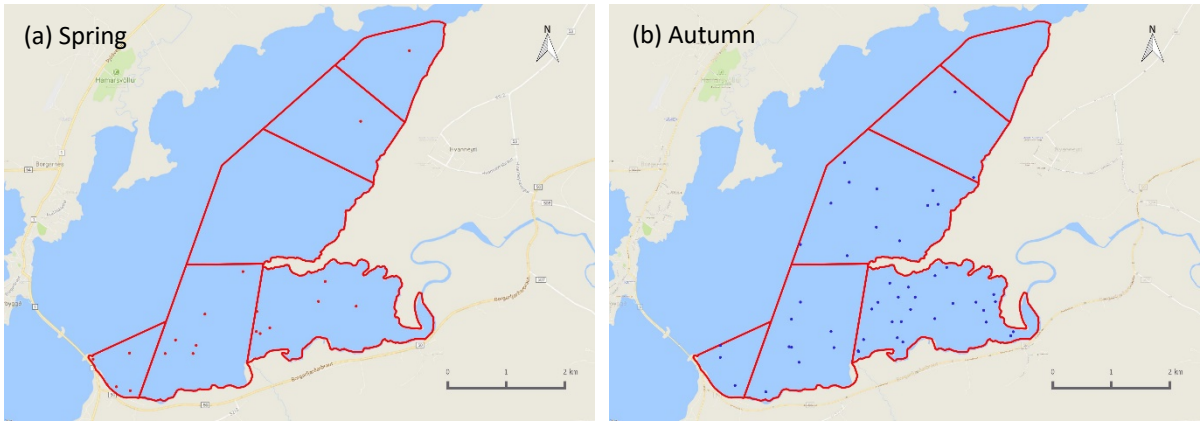

Figure 3-76. Relative abundance during (a) spring and (b) autumn of *Limosa limosa* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

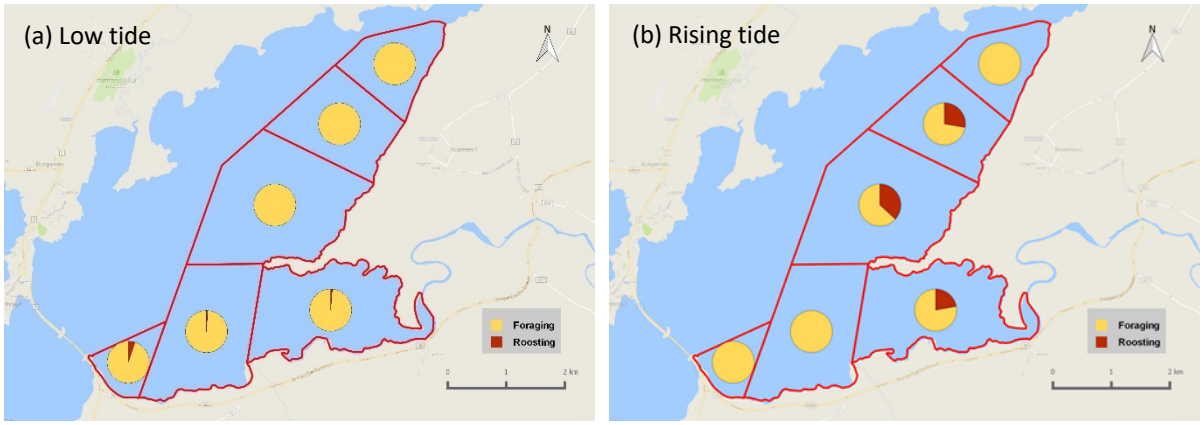

Figure 3-77. Proportion of foraging and roosting *Limosa limosa* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Whimbrel	*Numenius phaeopus*	Spói

Whimbrel were recorded in the survey area in two distinct peaks: from 3rd to 15th May; and19th July to 7th August. A peak count of 16 birds was recorded on 2nd August. Whimbrel showed a preference for the southernmost three subsites (Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2), and Flæðhöfðasker (Est 6)), and were recorded foraging when the sand and mudflats were exposed during low tide surveys and roosting on rising tide surveys. Whimbrel are common breeders within the Andakíll Ramsar site (Tierney & Tierney 2020).

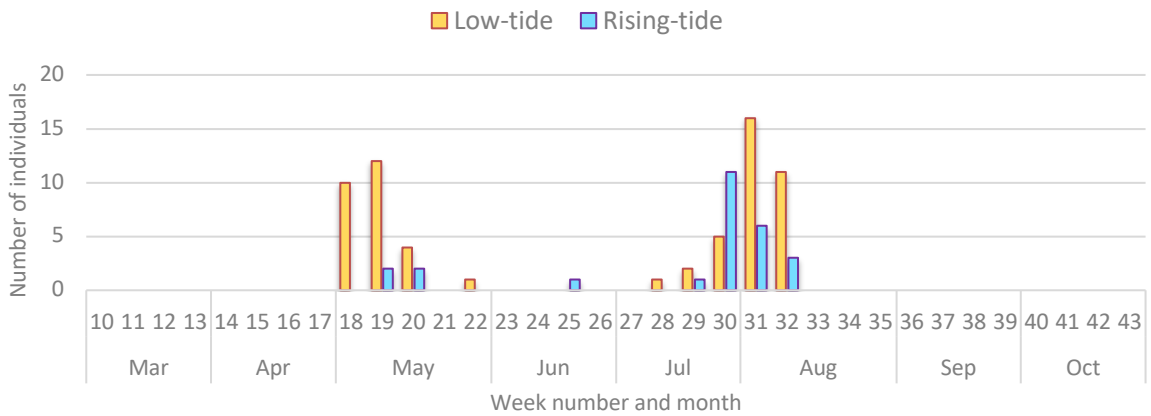

Figure 3-78. Number of *Numenius phaeopus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

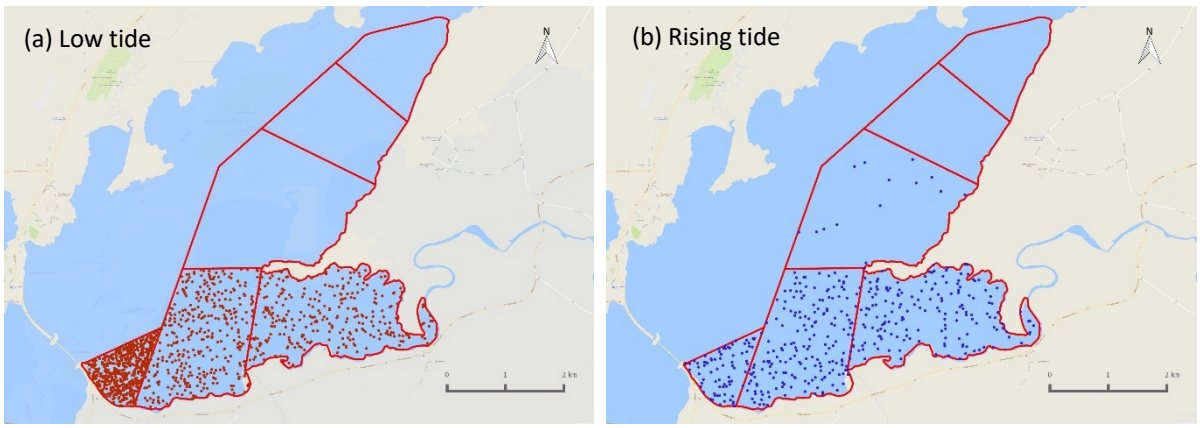

Figure 3-79. Relative abundance of *Numenius phaeopus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

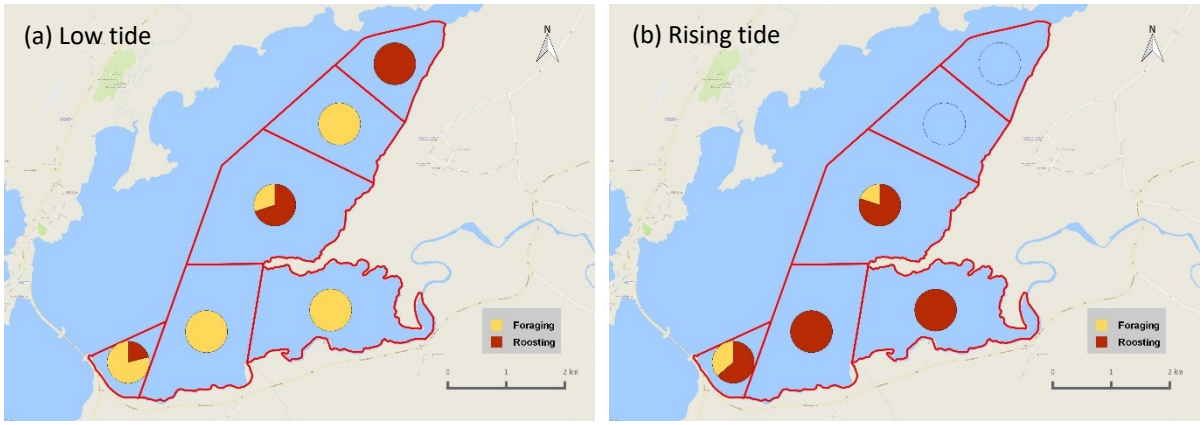

Figure 3-80. Proportion of foraging and roosting *Numenius phaeopus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Common Redshank	*Tringa totanus*	Stelkur

Redshank were recorded on almost every survey between 28th March and 25th September, and showed a bimodal peak, with a spring peak of 527 birds on 24th April, and an autumn peak of 1,206 on 24th July. There were fewer than 300 birds recorded on each survey during May and June before an influx on 6th July, when numbers rose to 821 birds. There followed a weekly increase in numbers until 24th July.

On 24th July, at 19:15, a flock of 270 Redshank were observed departing from a high tide roost, gaining considerable altitude and flying in a south easterly direction across the Brekkufjall mountain (*c.* 1.5 km away) and out of sight, presumably on migration.

Redshank were distributed throughout the survey area but favoured the southernmost three subsites during low tides (Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2), and Flæðhöfðasker (Est 6)), and Kistufjörður (Est 2) during rising tide surveys. While larger numbers occurred during autumn, the patterns of distribution during spring and autumn were broadly similar. Redshanks were almost exclusively recorded as foraging during low tide surveys, and were recorded as both foraging and roosting during rising tide surveys. Redshank were the second most numerous breeding wader (after Snipe) in the Andakíll Ramsar site (Tierney & Tierney 2020)

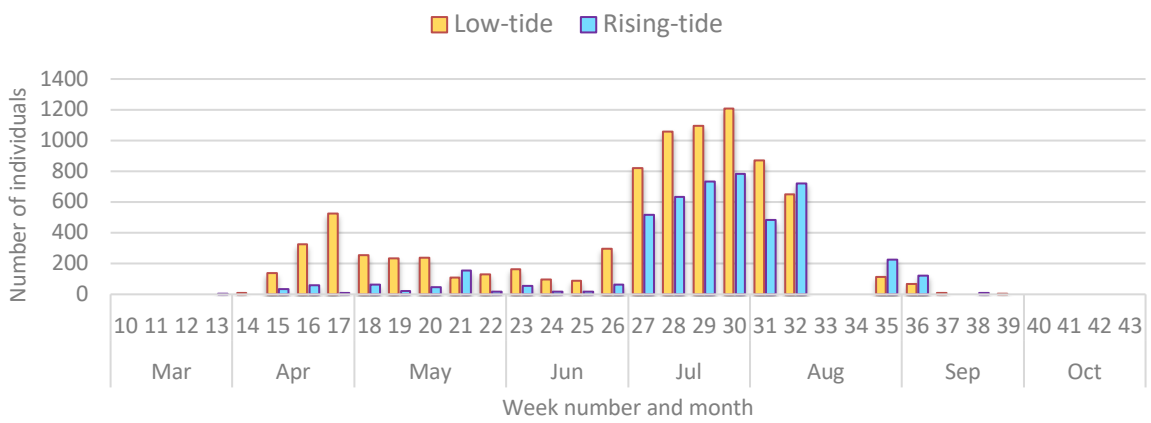

Figure 3-81. Number of *Tringa totanus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

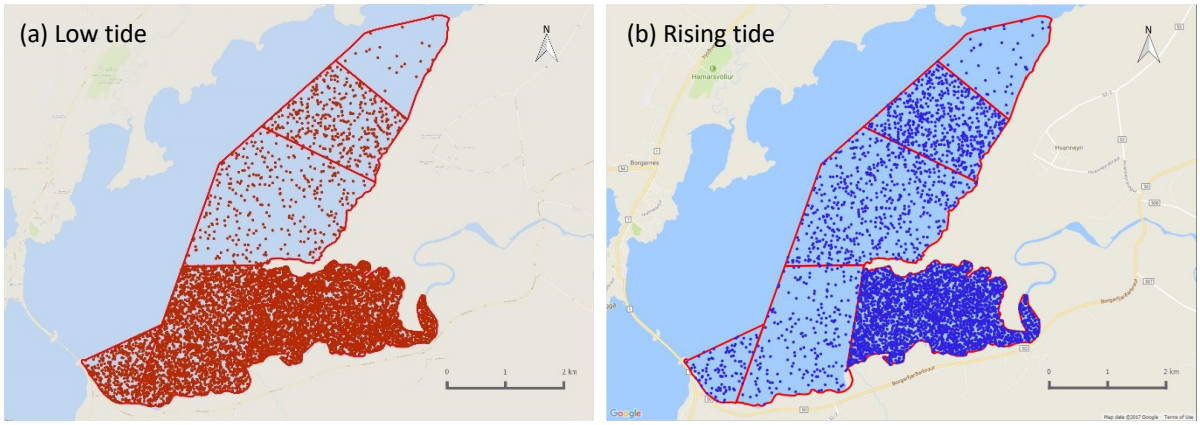

Figure 3-82. Relative abundance of *Tringa totanus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

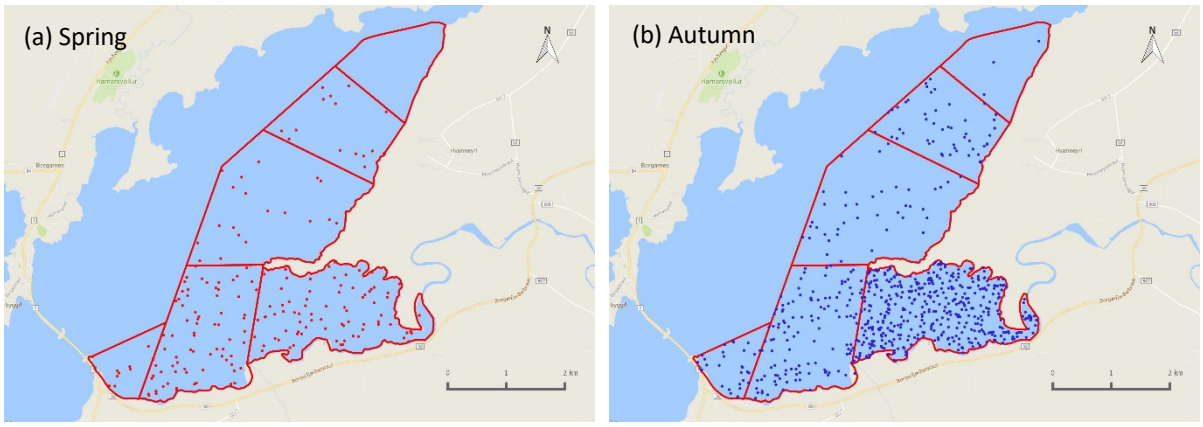

Figure 3-83. Relative abundance during (a) spring and (b) autumn of *Tringa totanus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

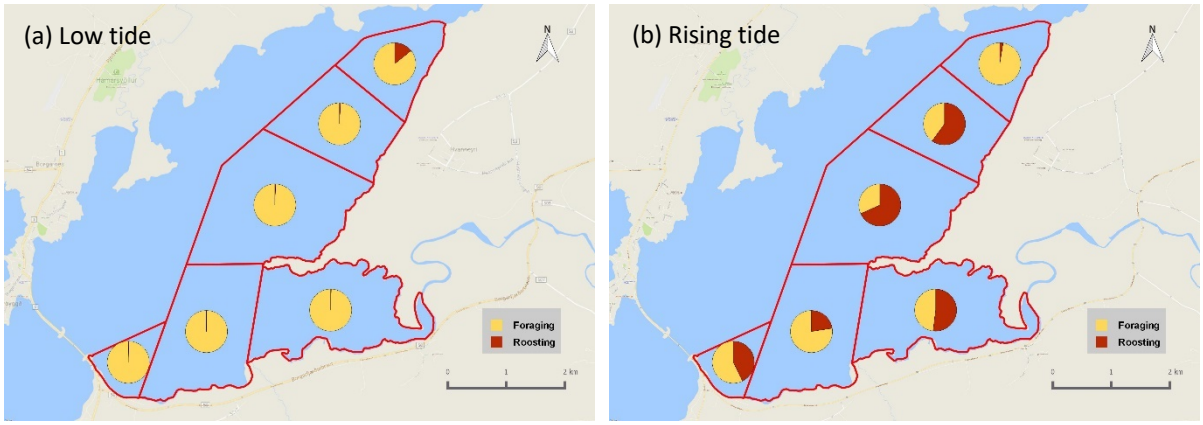

Figure 3-84. Proportion of foraging and roosting *Tringa totanus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Ruddy Turnstone	*Arenaria interpres*	Tildra

Turnstone was first recorded on 28th March, and the last record was on 9th October. Numbers in spring peaked at 112 birds on 24th April, but there were generally less than 50 birds per survey during April and May. The first record after the breeding season was of five birds on 10th July. Numbers increased from then onwards to peak at 218 on 6th August. Numbers during autumn low tide surveys were generally between 100 and 200. The number of birds recorded on rising tide surveys was generally lower than on low tide surveys, and no large high tide roosts were located, suggesting that at least some of the birds sought high tide refuges outside the Andakíll Ramsar site.

During both low tide and rising tide surveys, Turnstone displayed a preference for the three southernmost subsites: Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2), and Flæðhöfðasker (Est 6)). The general pattern is that the birds foraged during low tides and roosted during rising tides. Occasionally, *c.* 50 birds were recorded roosting on the promontory delineating the boundary between Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2), but as high tide observations were not conducted, it is not known whether this roost was used throughout the high tide period or if the rising water pushed the birds elsewhere.

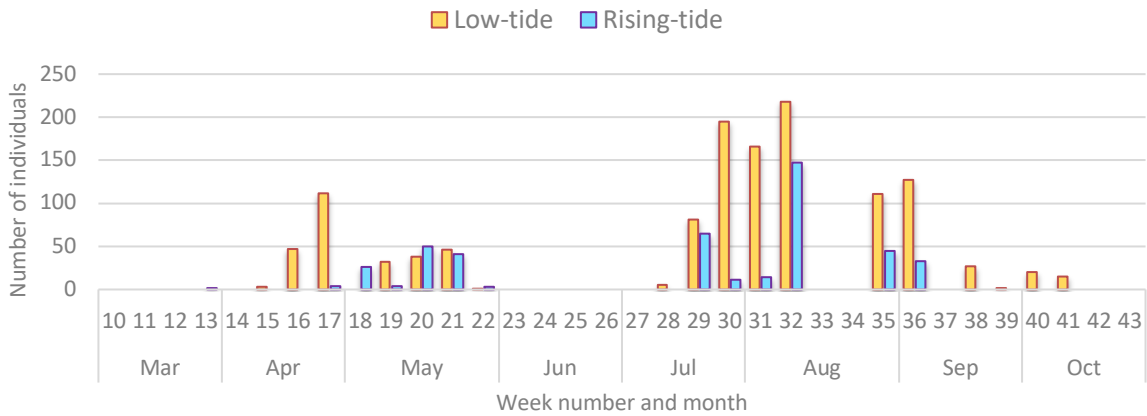

Figure 3-85. Number of *Arenaria interpres* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

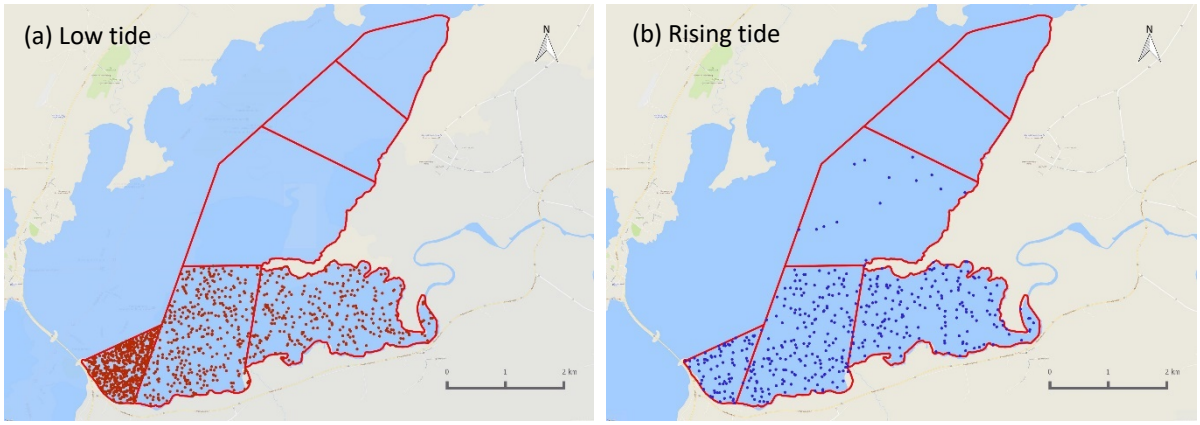

Figure 3-86. Relative abundance of *Arenaria interpres* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

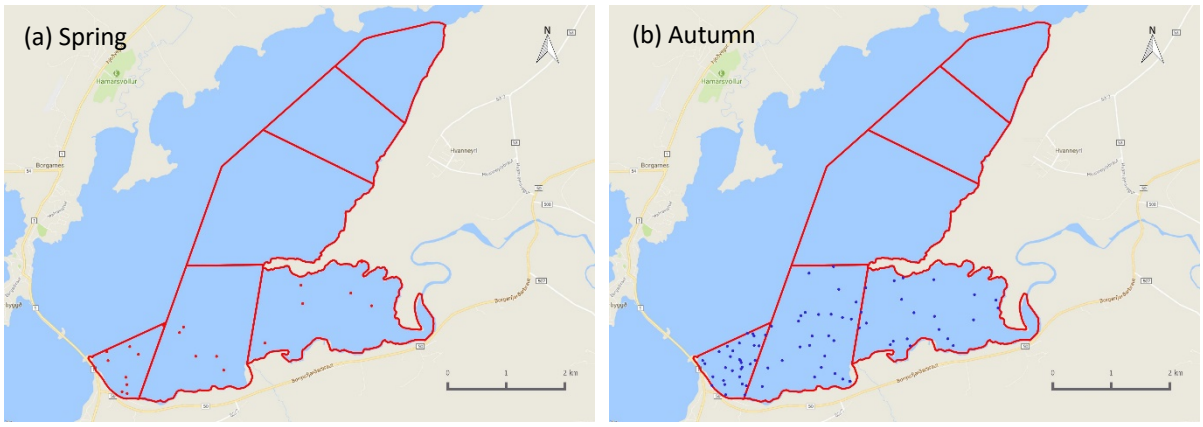

Figure 3-87. Relative abundance during (a) spring and (b) autumn of *Arenaria interpres* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

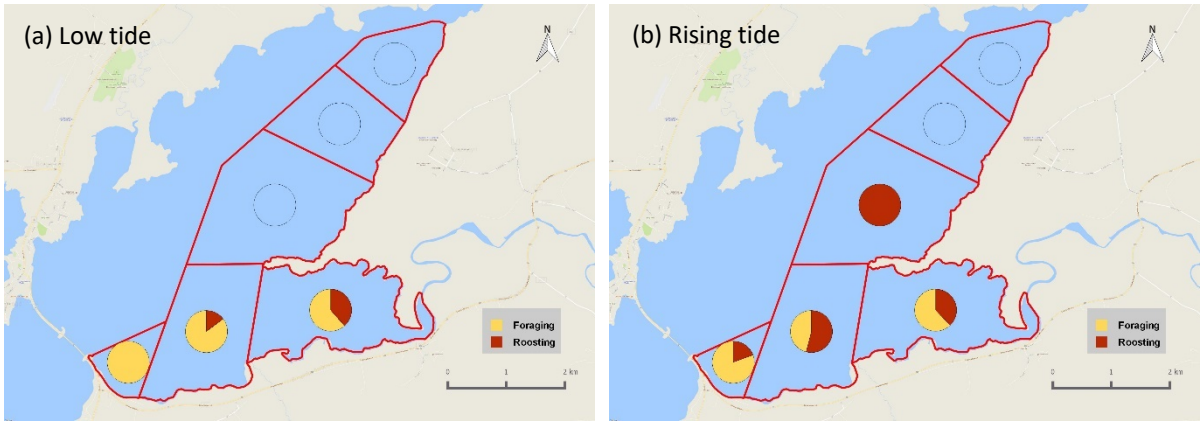

Figure 3-88. Proportion of foraging and roosting *Arenaria interpres* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Red Knot	*Calidris canutus*	Rauðbrystingur

During May, Knot occur along the west coast of Iceland, from Keflavik to the West Fjords while staging en route to arctic breeding grounds. In May 2017, a survey of seven areas known to be used by Knot in mid-western Iceland (Hvalfjordur to Stikkisholmur), resulted in a total of 37,000 Knot (J. Wilson, pers. comm.).

Despite the numbers of this species recorded in the vicinity of the Andakíll Ramsar site (the survey covered areas within 20 km to the north and south of the survey area), it is not used by large numbers of Knot. Knot were present in the survey area between 8th and 23rd May. Numbers built steadily and peaked at 145 birds on 23rd May. Two birds were recorded on 31st July. Knot were mainly recorded in the south of the survey area, in Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2).

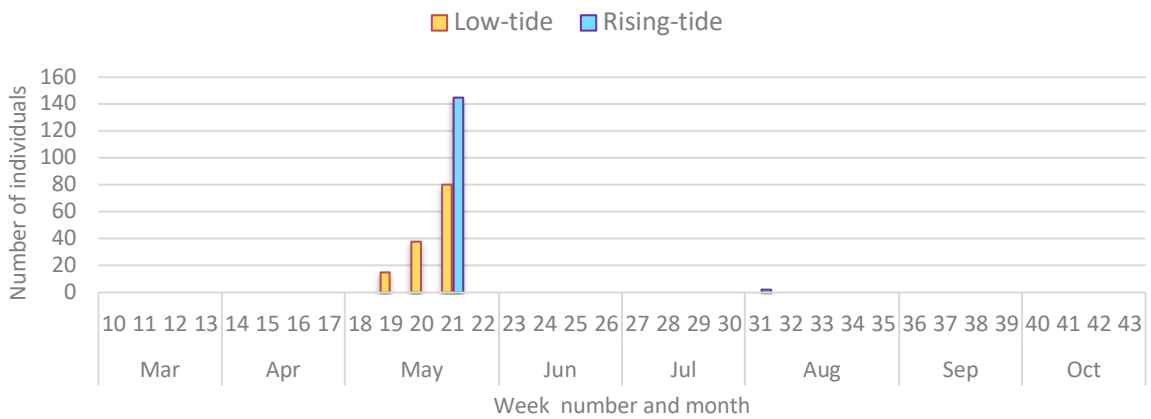

Figure 3-89. Number of *Calidris canutus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

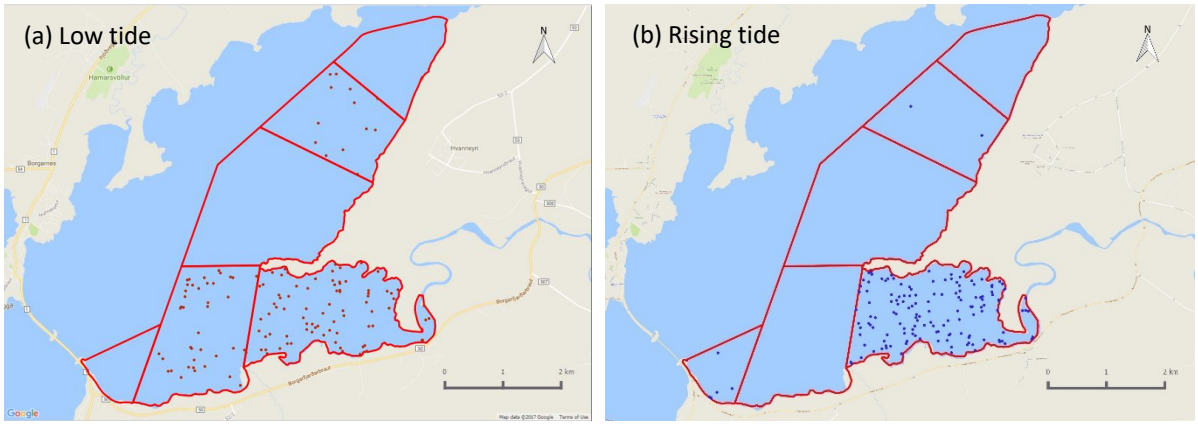

Figure 3-90. Relative abundance of *Calidris canutus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Dunlin	*Calidris alpina*	Lóuþræll

Dunlin were first recorded on 18th April and were present in the survey area until 25th September. During April and May, and for most of June there were fewer than 200 birds recorded on each survey. However, numbers rose from the second half of June onwards. In July, counts during low tide surveys were highest, suggesting that the birds used high tide refuges outside the survey area. There were between *c*. 750 and 1,000 birds during low tide surveys in July. A count of 1,478 was recorded during the rising tide survey on 7th August. By the last week August, and during September, the number of birds was *c*. 200 or less. During August, the number of birds recorded during rising tide surveys was higher than in low tide surveys, due to the formation of a new high tide roost in Kistuhöfðahólmar (Est 3). While Dunlin were distributed throughout the six subsites, they showed a preference for Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2) and Ásgarðshöfði (Est 4) during low tides, and Kistufjörður (Est 2), Kistuhöfðahólmar (Est 3), Ásgarðshöfði (Est 4) and Hvítárleirur (Est 5) during high tides. In all subsites except Kistuhöfðahólmar (Est 3), birds were most often recorded as foraging. Dunlin are common breeders within the Andakíll Ramsar site (Tierney & Tierney 2020)

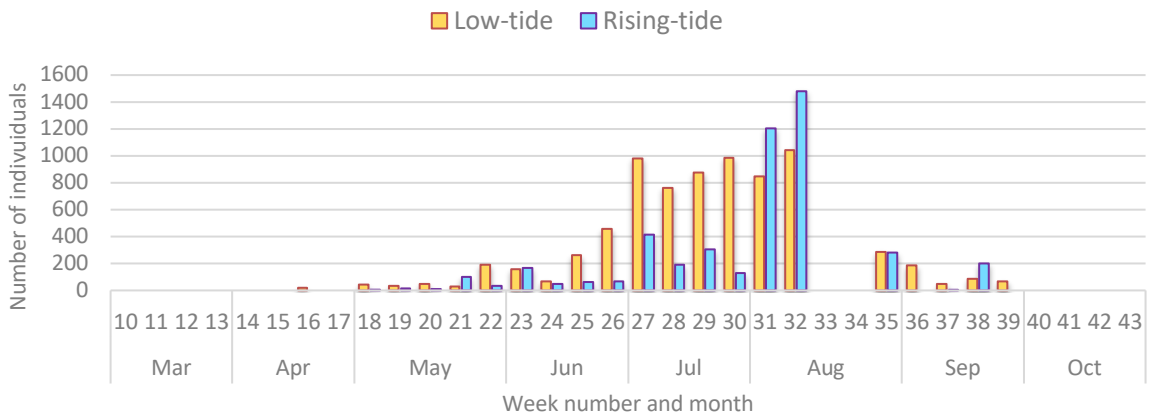

Figure 3-91. Number of *Calidris alpina* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

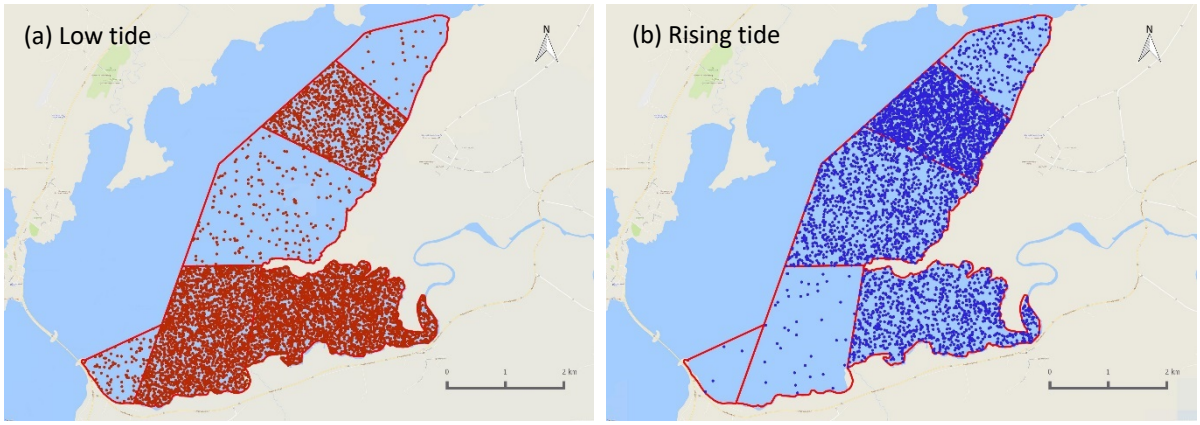

Figure 3-92. Relative abundance of *Calidris alpina* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

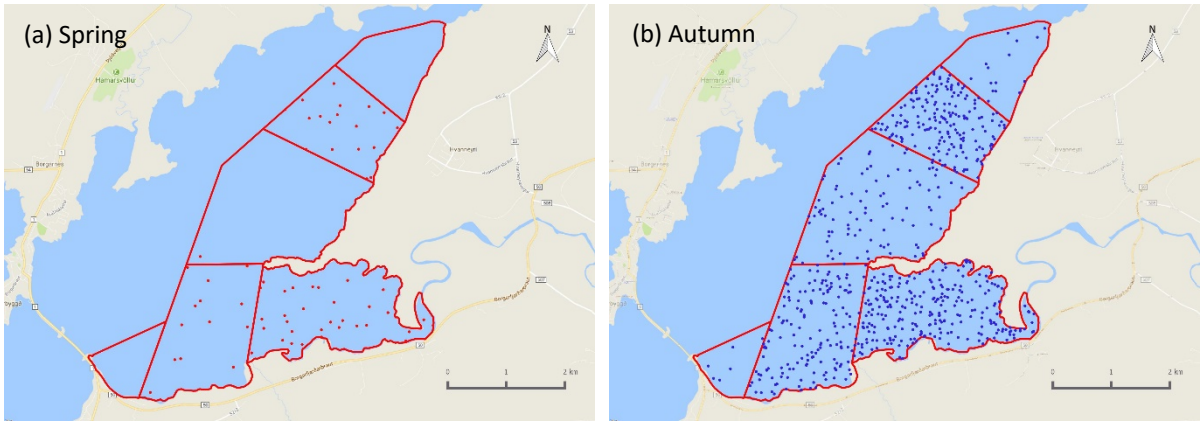

Figure 3-93. Relative abundance during (a) spring and (b) autumn of *Calidris alpina* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

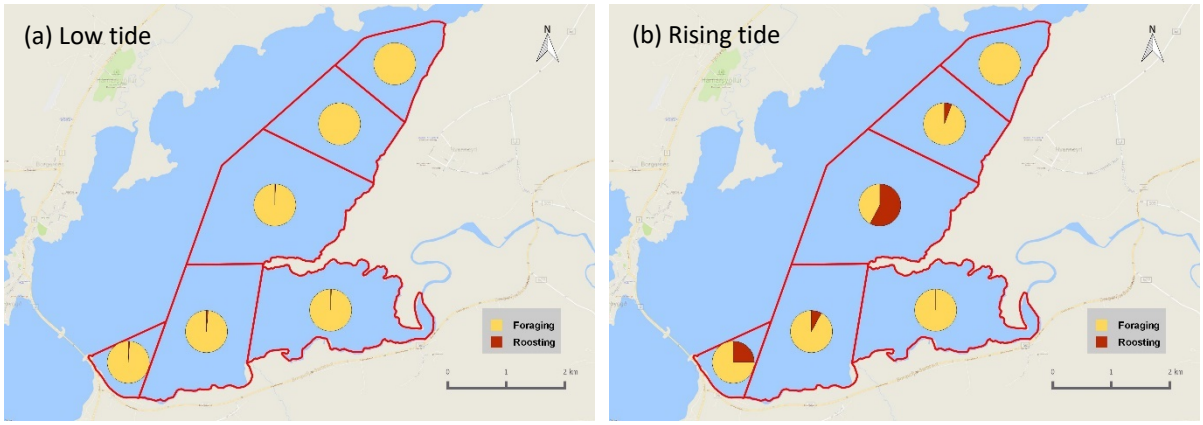

Figure 3-94. Proportion of foraging and roosting *Calidris alpina* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Purple Sandpiper	*Calidris maritima*	Sendlingur

The first Purple Sandpiper record within the survey area was on 20th March (114 birds had been recorded in Hvalfjordur (20 km to the south) on 4th March) (N. Tierney, unpublished dataset), and greater than 100 birds were recorded during all low tide surveys from then until the end of April. By 3rd May, numbers had reduced to 30 birds, and there were fewer than 15 birds recorded per survey until the first week of June. Small numbers of purple Sandpipers were recorded in late June, July and September, with the peak count in this period being 28 birds. Purple Sandpipers were recorded in the southern three subsites only: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2).

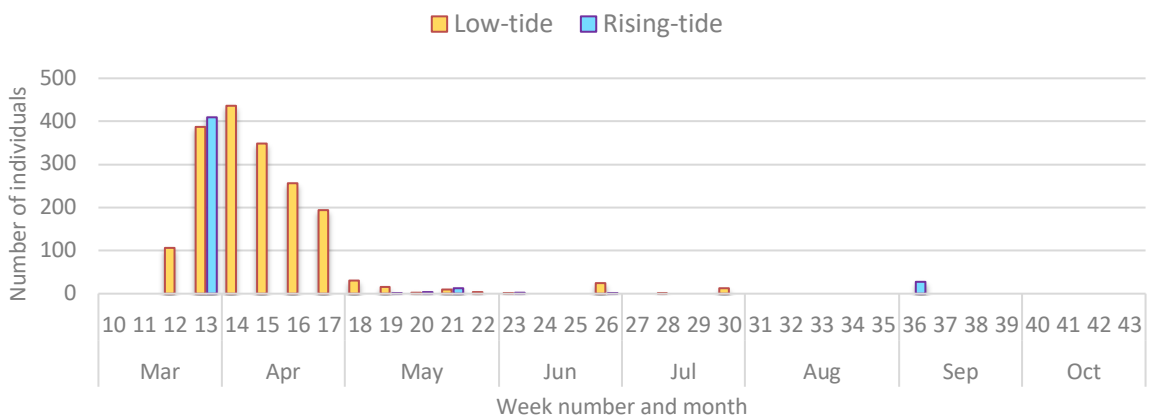

Figure 3-95. Number of *Calidris maritima* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

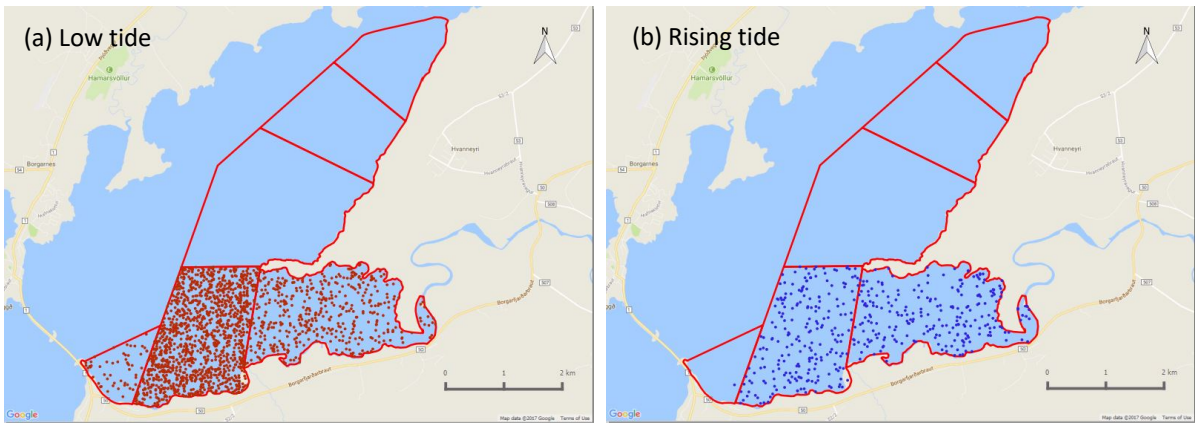

Figure 3-96. Relative abundance of *Calidris maritima* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

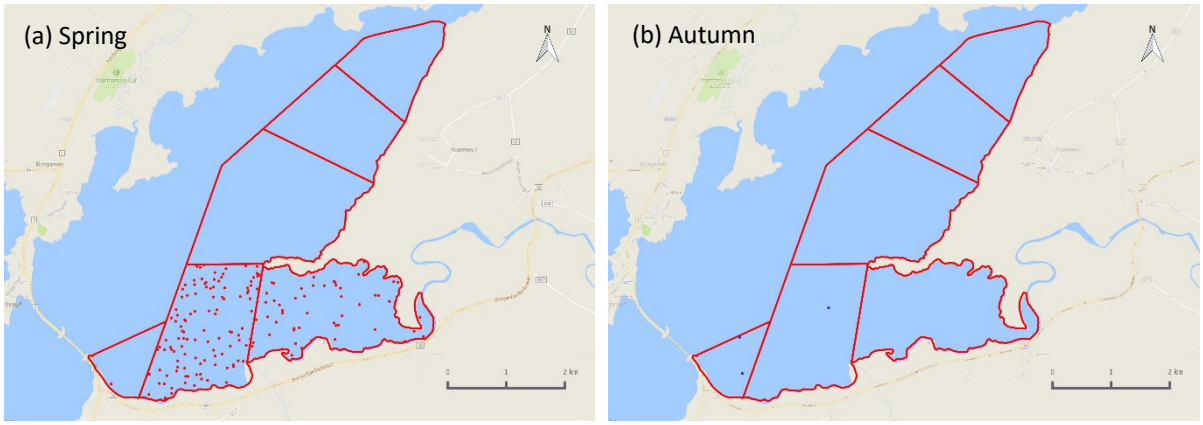

Figure 3-97. Relative abundance during (a) spring and (b) autumn of *Calidris maritima* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

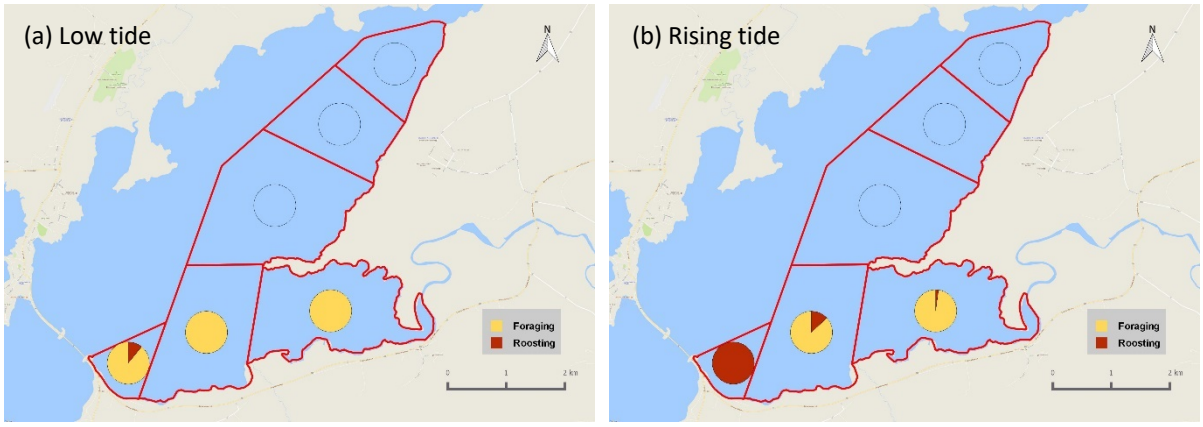

Figure 3-98. Proportion of foraging and roosting *Calidris maritima* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Red-necked Phalarope	*Phalaropus lobatus*	Óðinshani

The first Red-necked Phalarope record was on 24th May, and they were recorded in most weeks during June and July. The last record was on 6th August. A peak count of seven birds was recorded on 21st June. While the general timing of their arrival and departure was captured here, their habitat preference means the survey methodology employed here is not the optimal way to record Red-necked Phalaropes. Tierney & Tierney (2020) provide a better assessment of their abundance and distribution within the Andakíll Ramsar site.

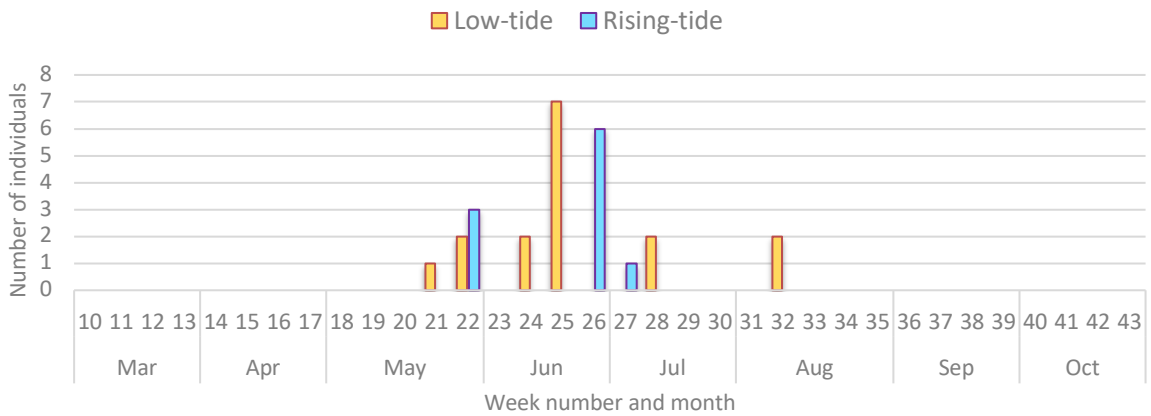

Figure 3-99. Number of *Phalaropus lobatus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Seabirds

There were two distinct peaks in the number of seabirds using the site; in late May, and during August and early September (Figure 3-100). The springtime peak is almost entirely explained by Arctic Terns, which were first recorded on 3rd May, and had largely passed through by the end of the month. Black-headed Gulls are responsible for the high counts of seabirds in August and September. There was a discrete influx of Glaucous (and/or Iceland Gulls) in October, which peaked at 262 birds in the second week of the month. Otherwise, the number of seabirds was approximately between 50 and 200 during each survey, usually with more birds recorded during low tide surveys.

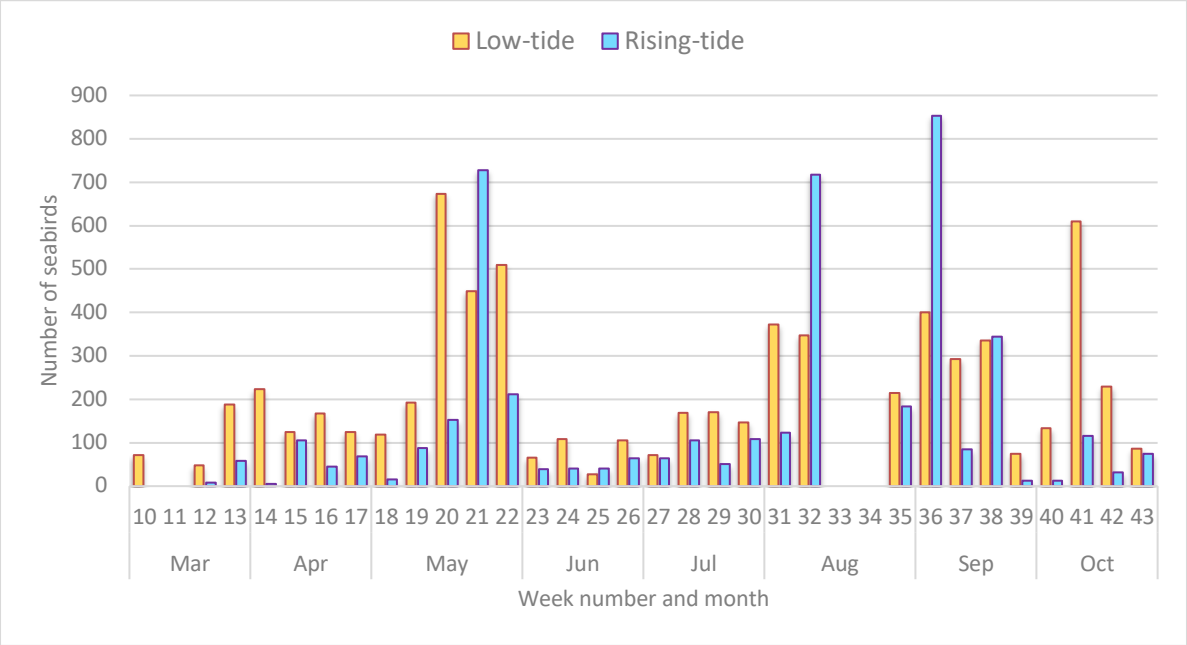

Figure 3-100. Number of seabirds recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Northern Fulmar	*Fulmarus glacialis*	Fýll

Northern Fulmars were recorded on most surveys between mid-April and mid-September. Usually birds were recorded commuting between the breeding colony at Brekkufjall (*c.* 1.5 km south of the survey area) and the open sea.

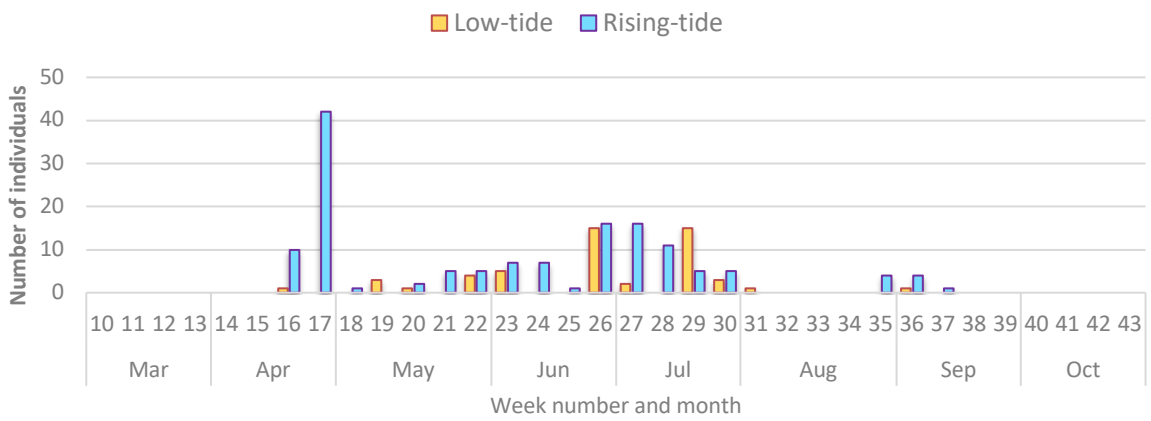

Figure 3-101. Number of *Fulmarus glacialis* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

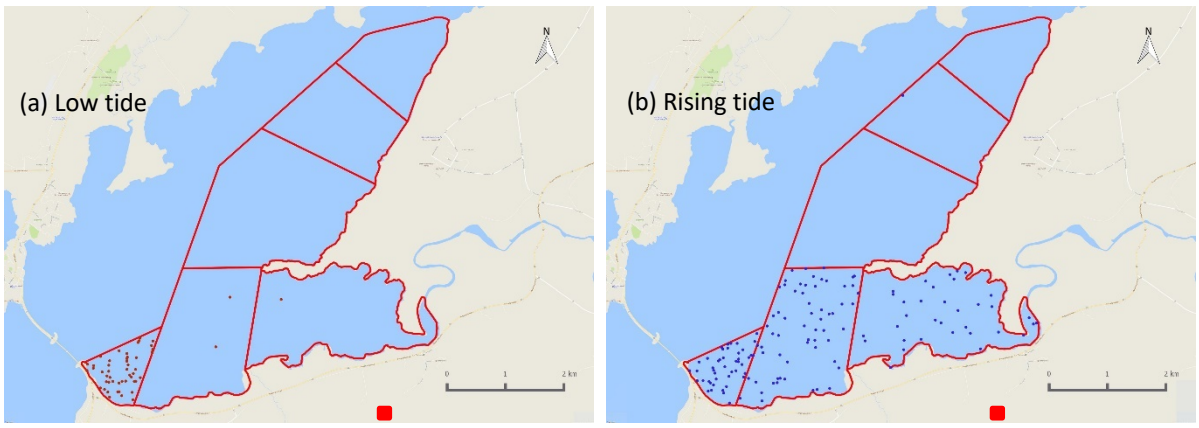

Figure 3-102. Relative abundance of *Fulmarus glacialis* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location. The red square represents the approximate location of the breeding colony at Brekkufjall.

Black-legged Kittiwake	*Rissa tridactyla*	Rita

Kittiwake was recorded on two surveys, with 26 birds on 17th April and a single bird on 24th April.

Black-headed Gull	*Chroicocephalus ridibundus*	Hettumáfur

Black-headed Gulls were recorded in low numbers (< 100 birds) in the survey area during late March, April and May, and were absent in June. Numbers gradually increased throughout July and August. Peaks of 626 and 778 were recorded on 7th August and 6th September, respectively, and then numbers declined during September and October. There were clear differences in distribution within the survey area between low tide and rising tide surveys. The birds showed a preference for the more southerly subsites during low tides, and exploited all subsites except Kistuhöfðahólmar (Est 3) during rising tides. During spring, the birds were mostly distributed in the three southernmost subsites (Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2)). In the autumn, they were more widely distributed and were recorded throughout the survey area. Birds were most often foraging during low tides and roosting during rising tides.

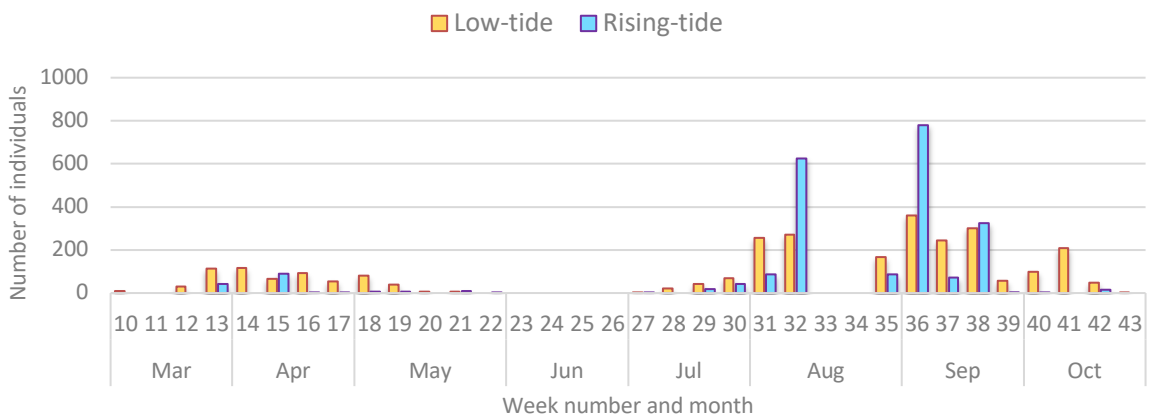

Figure 3-103. Number of *Chroicocephalus ridibundus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

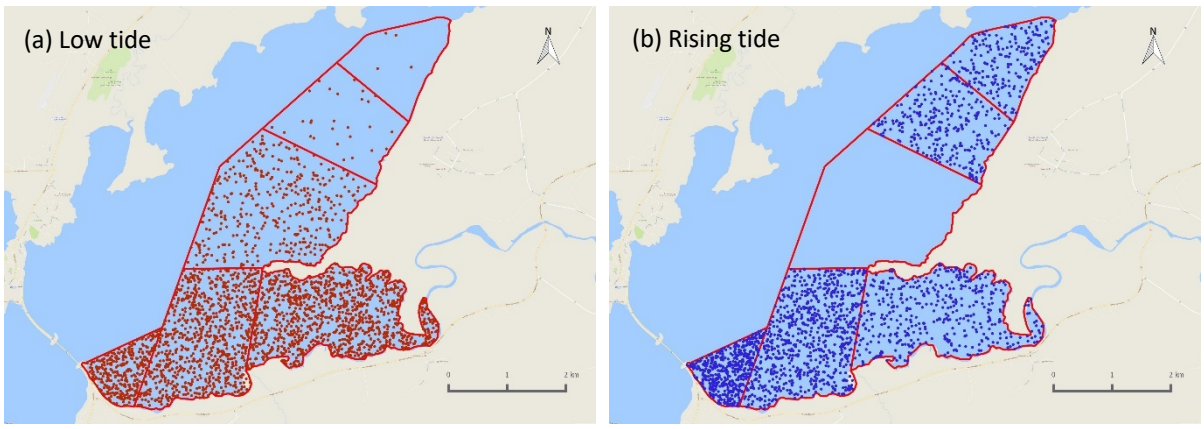

Figure 3-104. Relative abundance of *Chroicocephalus ridibundus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

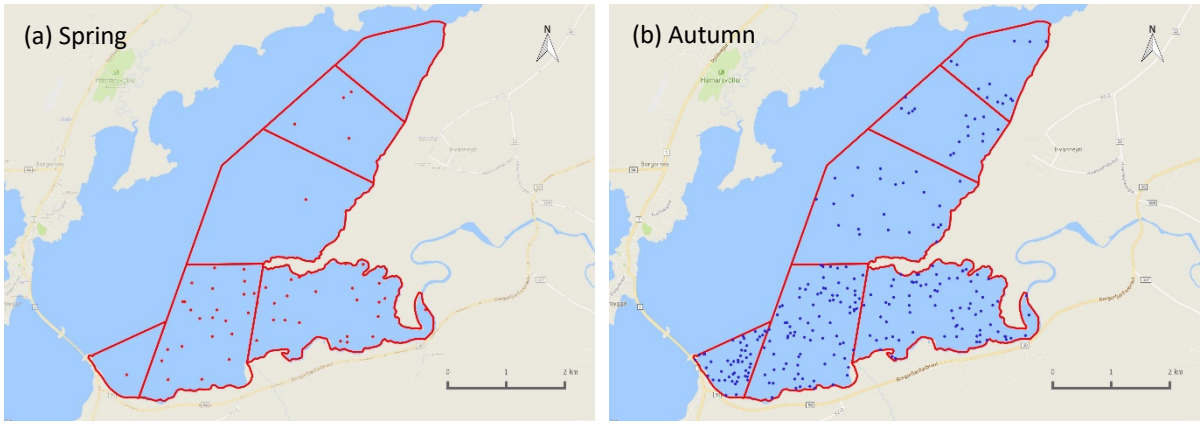

Figure 3-105. Relative abundance during (a) spring and (b) autumn of *Chroicocephalus ridibundus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

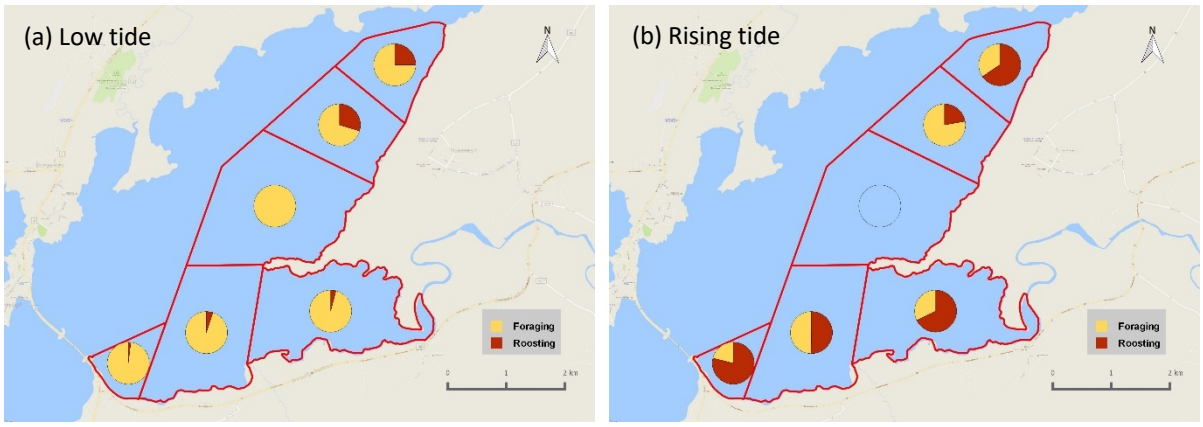

Figure 3-106. Proportion of foraging and roosting *Chroicocephalus ridibundus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Common Gull	*Larus canus*	Stormmáfur

Common Gulls were present in most surveys, with the exception of surveys in late-May, June and July, when almost no birds were recorded. In the spring, birds mainly used the survey area for foraging during low tides. A peak count of 83 birds was recorded on 3rd April. There was an influx from the last week of August onwards, when up to 65 birds were recorded, and Common Gulls were present on almost all of the surveys between then and the last survey on 25th October. In general, Common Gulls were present on the estuary in much greater numbers during low tide surveys, compared to rising tide surveys

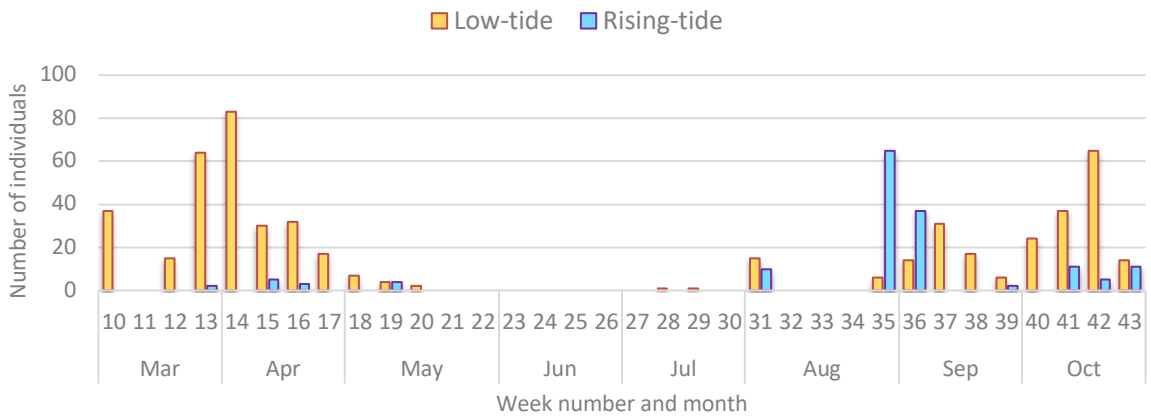

Figure 3-107. Number of *Larus canus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

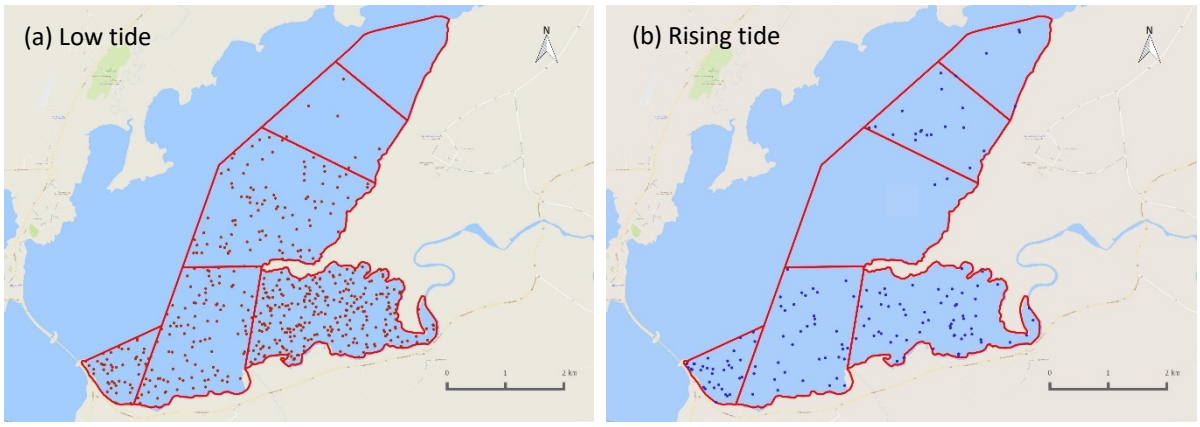

Figure 3-108. Relative abundance of *Larus canus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

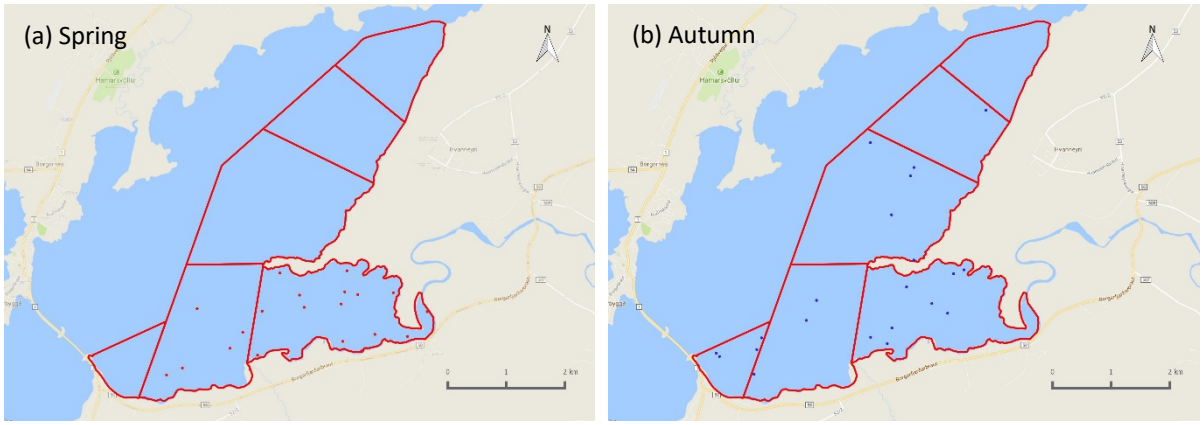

Figure 3-109. Relative abundance during (a) spring and (b) autumn of *Larus canus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

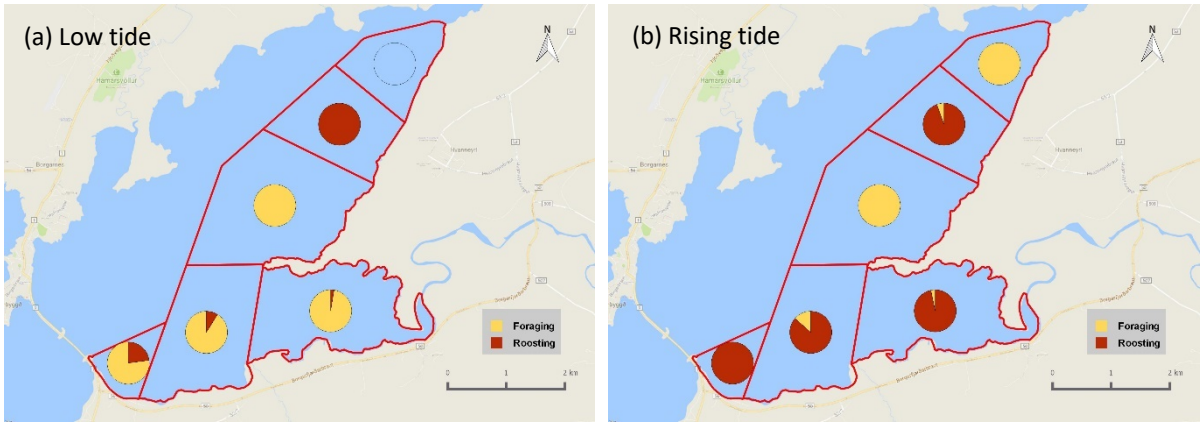

Figure 3-110. Proportion of foraging and roosting *Larus canus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Great Black-backed Gull	*Larus marinus*	Svartbakur

Great Black-backed Gulls were present in the survey area in almost all surveys, from the first one on 12th March until the final one on 25th October. Highest numbers were 20-27 birds in spring, and 31-33 in autumn. Adults were present on a small island in the middle of Ásgarðshöfði (Est 4), between 12th March and 18th September, and there were approximately 5 to 10 nests in May and June. At least two pairs reproduced successfully, as two broods of two large chicks were observed on 7th August. However, this must be considered a minimum, as the colony was not visited and observations were made from 1.5 to 2 km away. Due to the undulating topography of the island, and the cryptic nature of juvenile gull plumage, it is likely that other chicks were present and were not detected. There were an estimated 12-14 nests on Lake Vatnshamravatn, and chicks were observed on 9th July, but no concerted effort was made to accurately survey this colony. Throughout the survey period, the southernmost four subsites: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2) and Kistuhöfðahólmar (Est 3) were mostly used for foraging during low tides and for both roosting and foraging during rising tides.

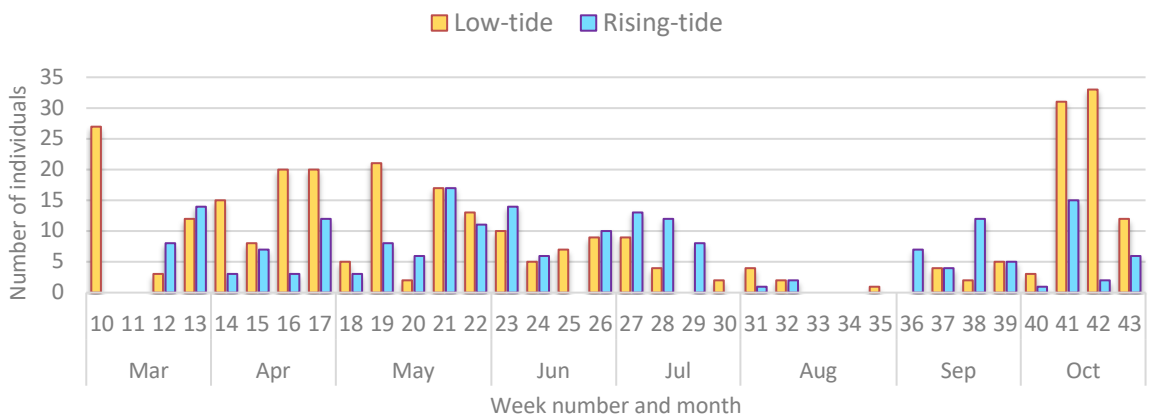

Figure 3-111. Number of *Larus marinus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

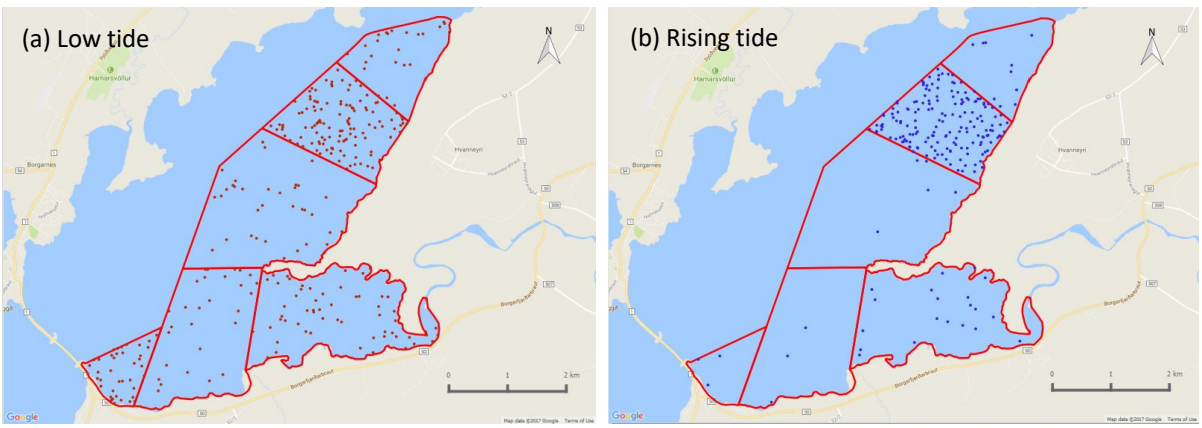

Figure 3-112. Relative abundance of *Larus marinus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

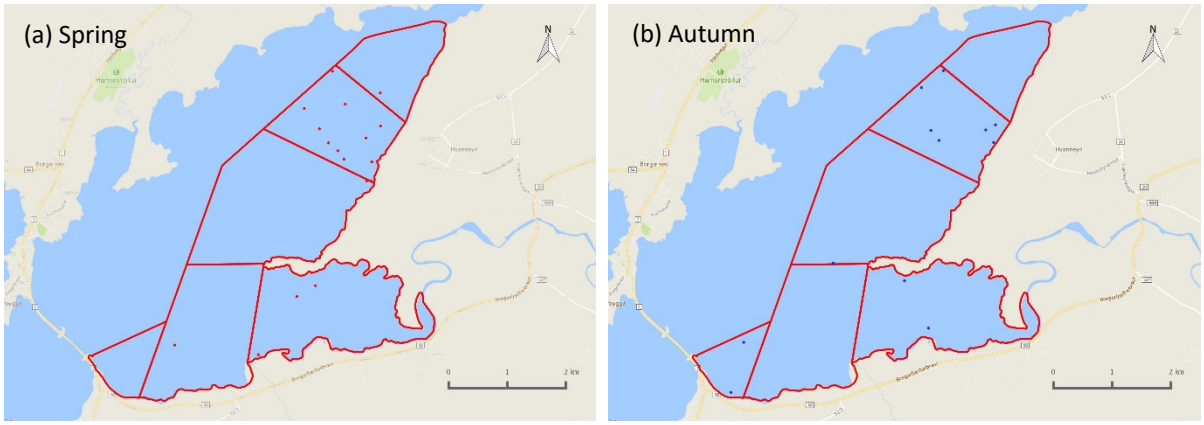

Figure 3-113. Relative abundance during (a) spring and (b) autumn of *Larus marinus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

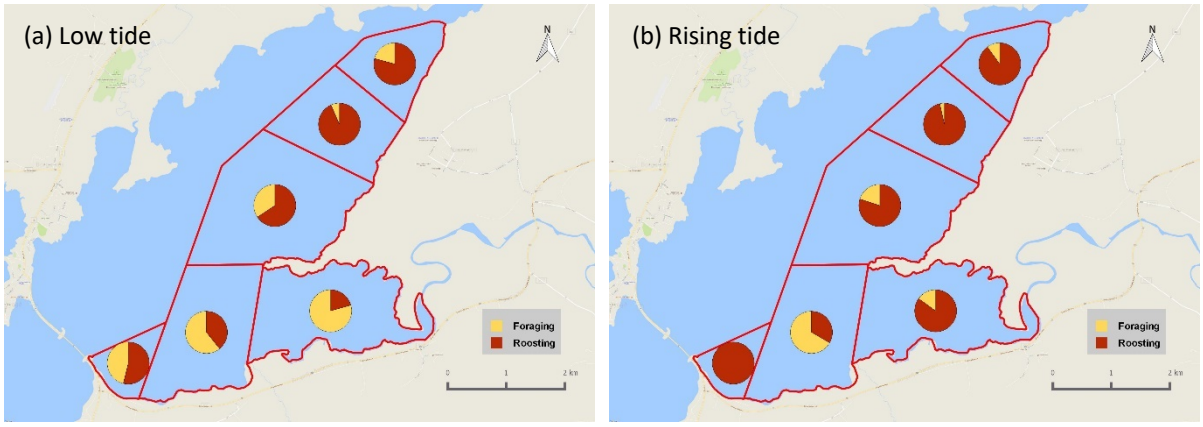

Figure 3-114. Proportion of foraging and roosting *Larus marinus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Glaucous Gull	*Larus hyperboreus*	Hvítmáfur

Glaucous Gulls occurred in single numbers in the survey area during April and May, and then were absent until 6th September. A peak count of 96 Glaucous Gulls was recorded on 9th October. However, due to difficulty accurately differentiating Glaucous and Iceland Gulls (which share identical plumage characteristics and differ only in body proportions), during surveys when observation conditions were suboptimal or when the birds were being observed at considerable distance, these two species were recorded as 'Unidentified Glaucous /Iceland Gull' (see below).

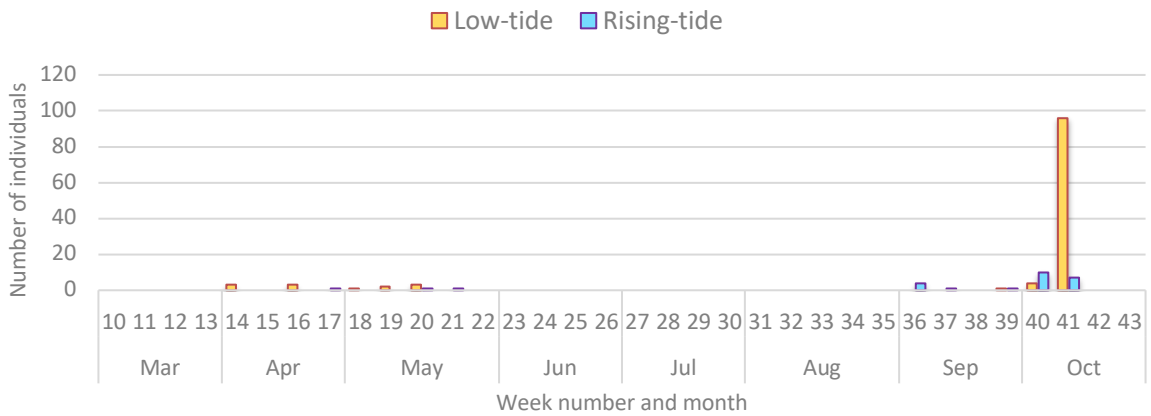

Figure 3-115. Number of *Larus hyperboreus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

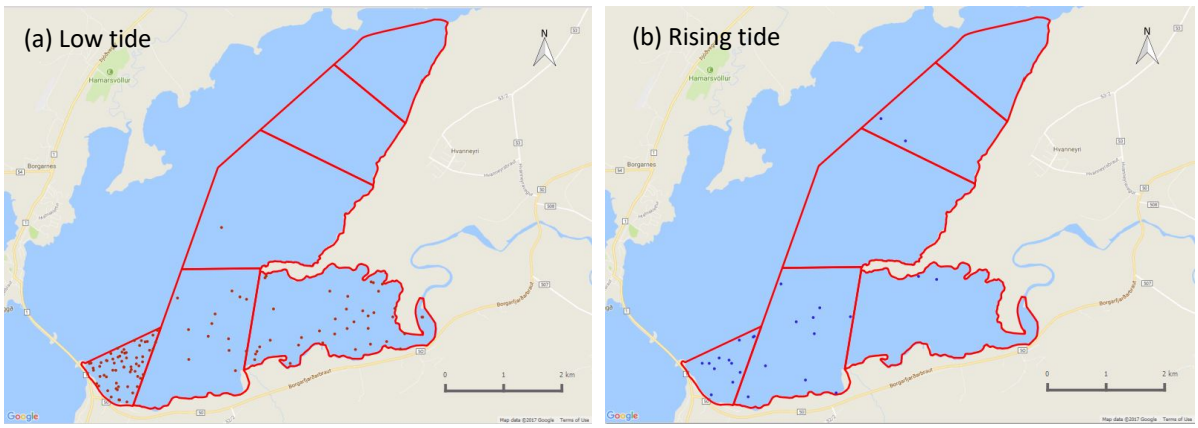

Figure 3-116. Relative abundance of *Larus hyperboreus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

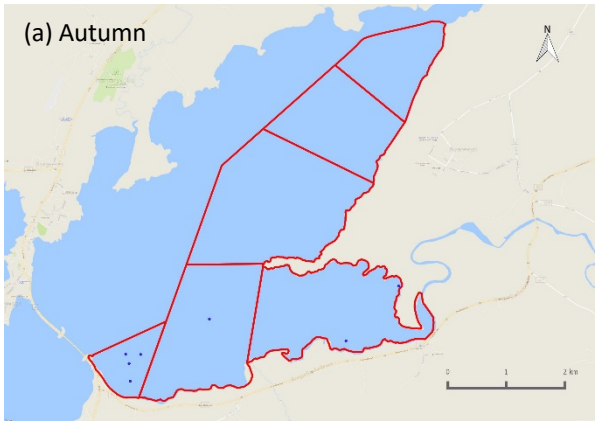

Figure 3-117. Relative abundance of *Larus hyperboreus* during autumn (6th September– 25th October), counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. No map is provided for spring due to the low numbers recorded. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys), and reflects the species' abundance, not the specific location of birds.

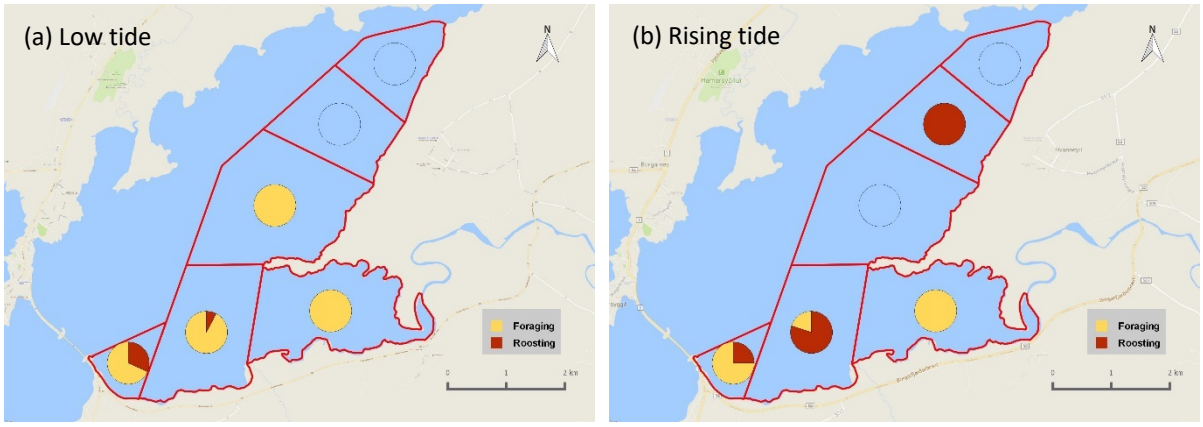

Figure 3-118. Proportion of foraging and roosting *Larus hyperboreus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Iceland Gull	*Larus glaucoides*	Bjartmáfur

Iceland Gulls were present in single numbers in April, September and October. Due to difficulty accurately differentiating Iceland and Glaucous Gulls (which share identical plumage characteristics), during surveys when observation conditions were suboptimal or when the birds were being observed at considerable distance, these two species were recorded as 'Unidentified Glaucous /Iceland Gull' (see below).

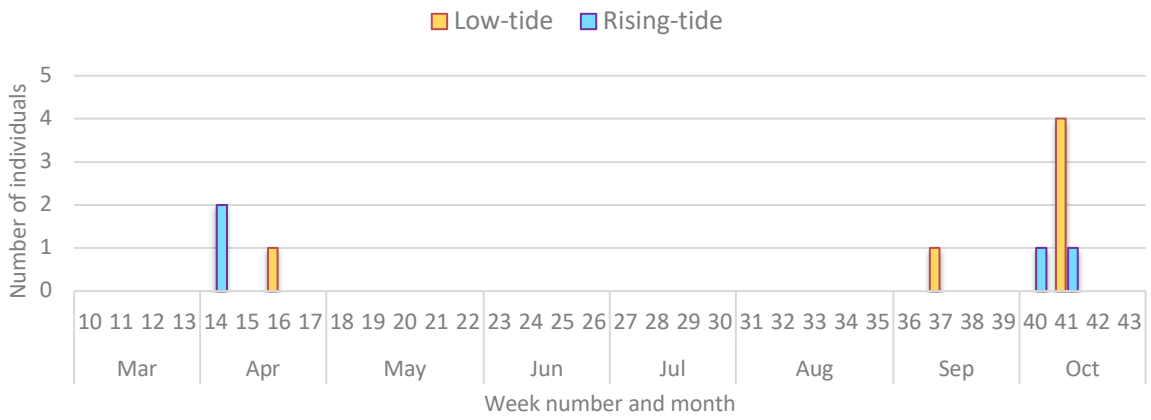

Figure 3-119. Number of *Larus glaucoides* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

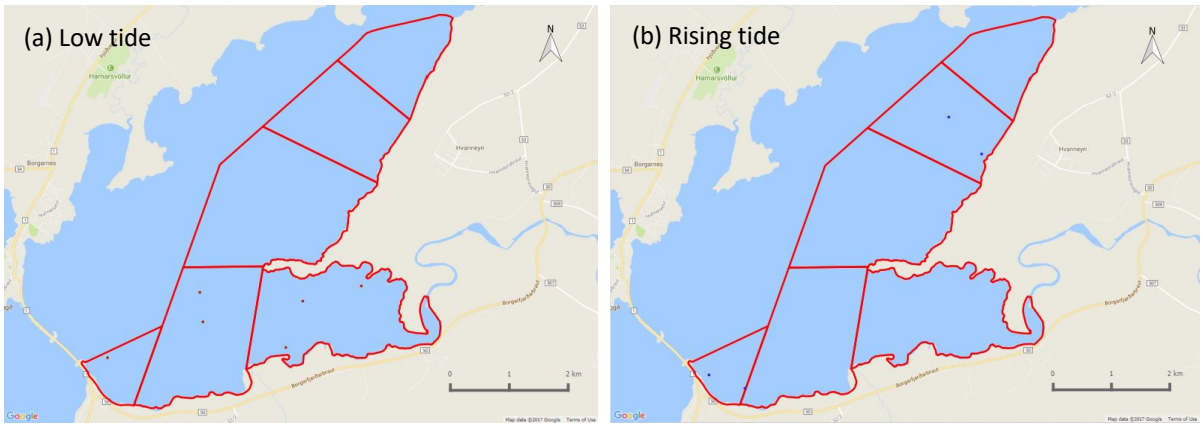

Figure 3-120. Relative abundance of *Larus glaucoides* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Unidentified Glaucous/Iceland Gull Larus hyperboreus/glaucoides Hvítmáfur/Bjartmáfur

As Glaucous and Iceland Gulls share identical plumage characteristics and differ only subtly in proportion, it is often difficult to differentiate the two species in the field, especially at distance, or when visibility is suboptimal. Therefore, the two species were grouped in October, when several tens of birds were present, and differentiating each individual bird in a flock was not practical. There was an influx of Glaucous /Iceland Gulls during October, and a peak count of 162 birds were recorded during the low tide survey on 9th October. These birds were distributed throughout the survey area, with the exception of Hvítárleirur (Est 5).

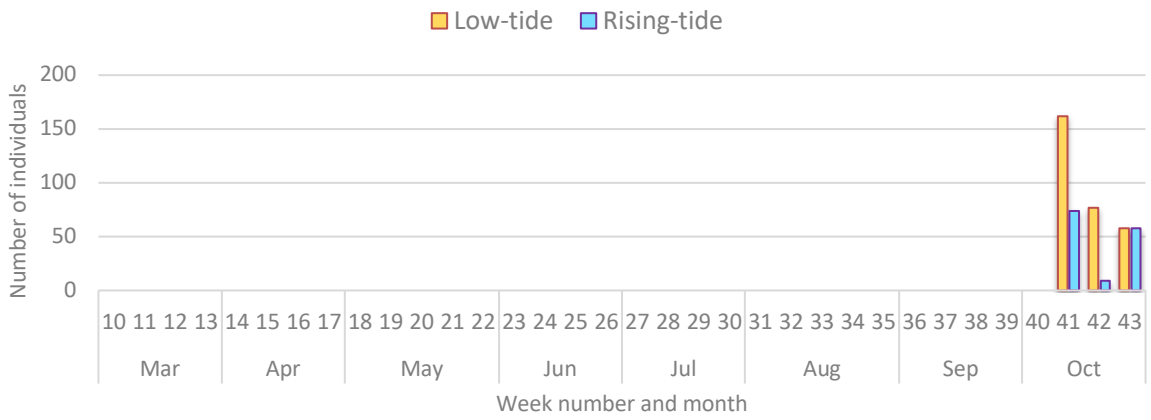

Figure 3-121. Number of *Larus hyperboreus/glaucoides* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

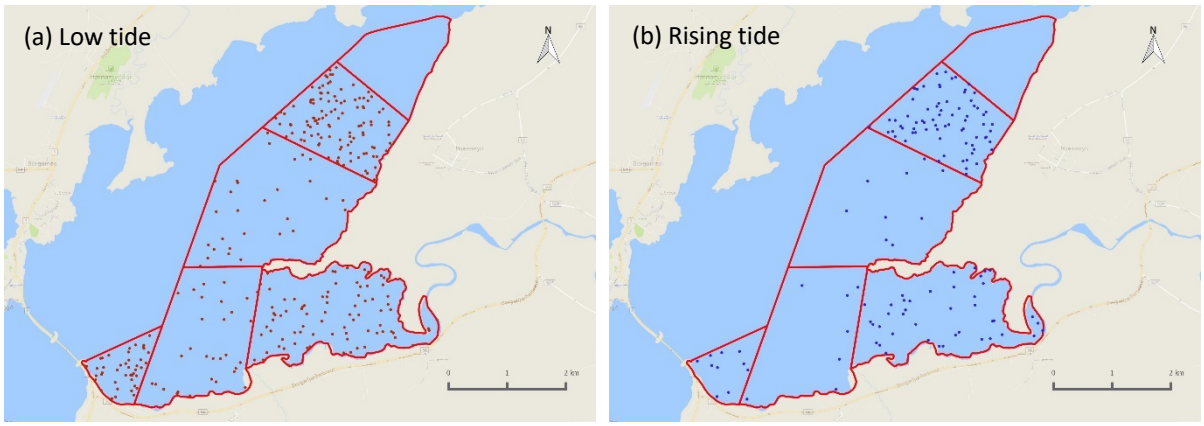

Figure 3-122. Relative abundance of *Larus hyperboreus/glaucoides* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

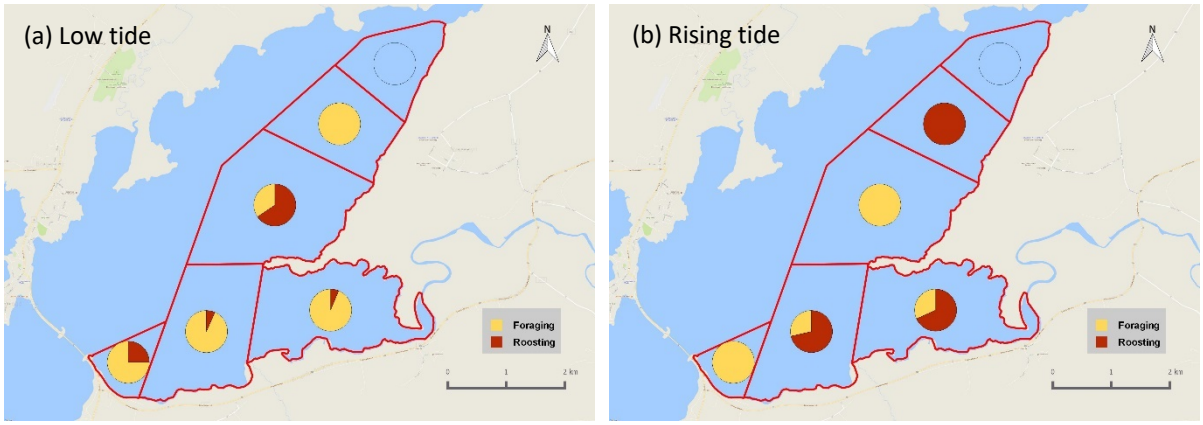

Figure 3-123. Proportion of foraging and roosting *Larus hyperboreus/glaucoides* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Herring Gull	*Larus argentatus*	Silfurmáfur

Small numbers of Herring Gulls (< 10) were present in the survey area in spring and autumn, and were absent between late-May and September.

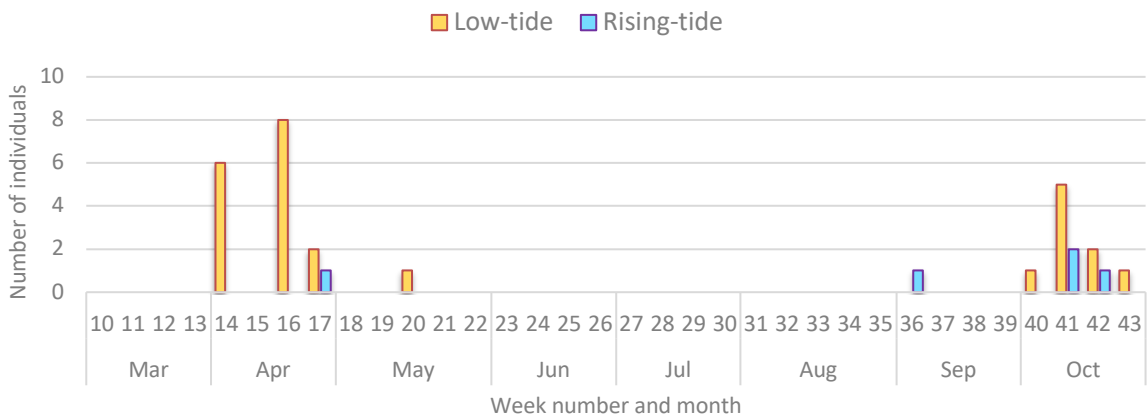

Figure 3-124. Number of *Larus argentatus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

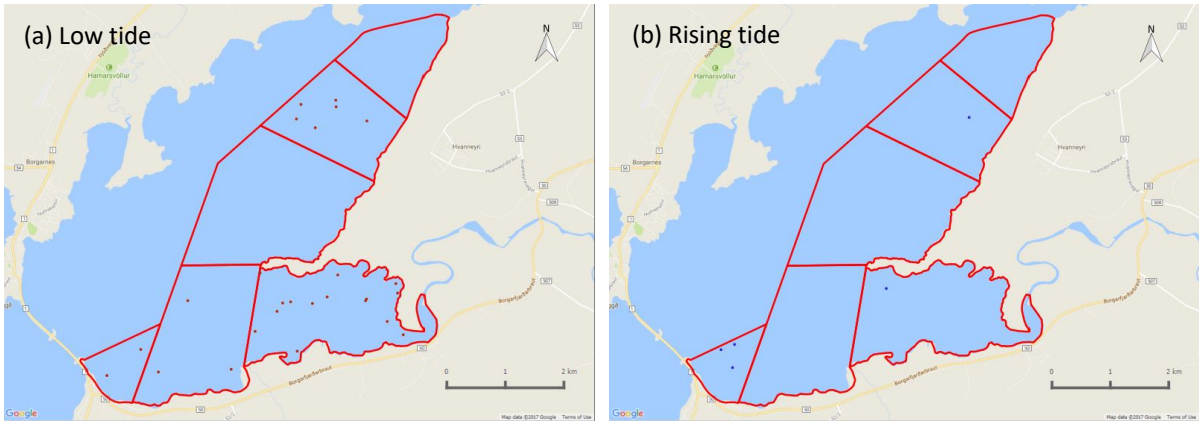

Figure 3-125. Relative abundance of *Larus argentatus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

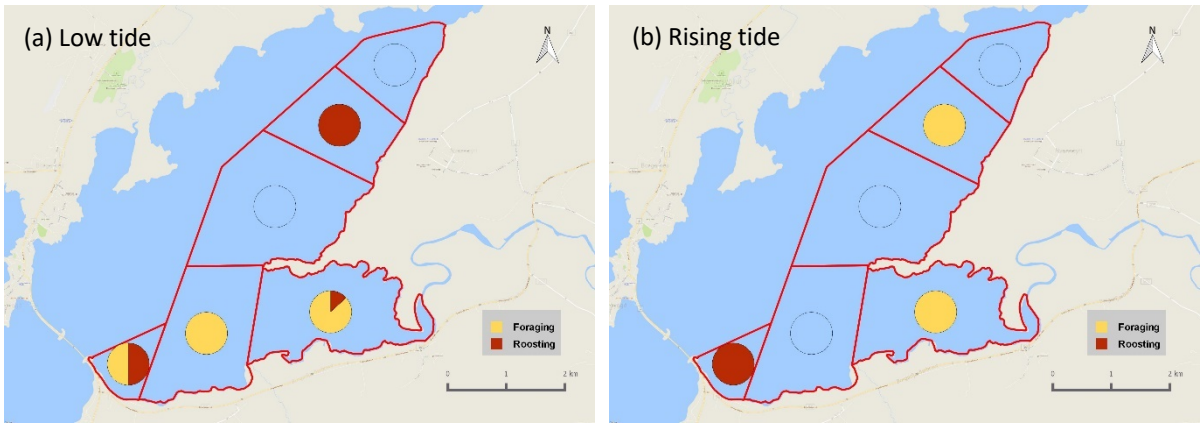

Figure 3-126. Proportion of foraging and roosting *Larus argentatus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Lesser Black-backed Gull	*Larus fuscus*	Sílamáfur

Two Lesser Black-backed Gulls were observed in the fjord on the 1st March, at a time when it was still frozen, and before this survey had formally started. Between April and October, in the region of 10 – 30 birds were recorded in the survey area on each survey, but there were several surveys when much larger numbers (60 – 100 birds) were recorded. The reasons for these influxes, which occurred mainly during low time surveys, is not known.

Two to three pairs of Lesser Black-backed Gull were present at the Great Black-backed Gull colony in Ásgarðshöfði (Est 4) during the summer months, but it is not known whether they nested successfully or not, as the island was not visited and observations were made from the closest elevated vantage points 1.5 to 2 km away. Due to the undulating topography of the island, and the cryptic nature of juvenile gull plumage, it was not possible to ascertain the presence of incubating adults or chicks. Similarly, Lesser Black-backed Gulls were present on the island on Lake Vatnshamravatn during April, where Great Black-backed Gulls nested, but no dedicated survey was undertaken to ascertain breeding status.

Lesser Black-backed Gulls were distributed throughout the survey area during low tide and rising tide surveys. The four southernmost subsites: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1), Kistufjörður (Est 2) and Kistuhöfðahólmar (Est 3), were mainly used for foraging during low tides and for both roosting and foraging during rising tides.

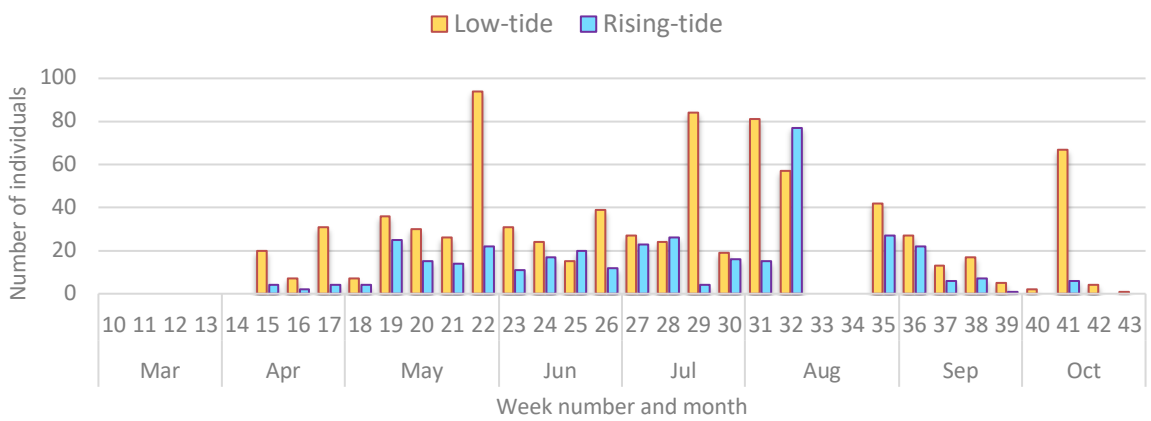

Figure 3-127. Number of *Larus fuscus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

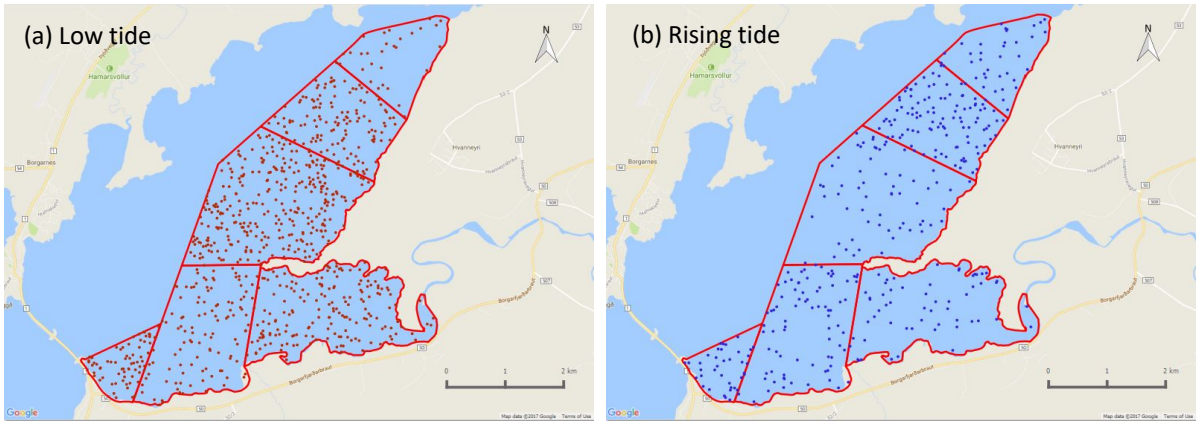

Figure 3-128. Relative abundance of *Larus fuscus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

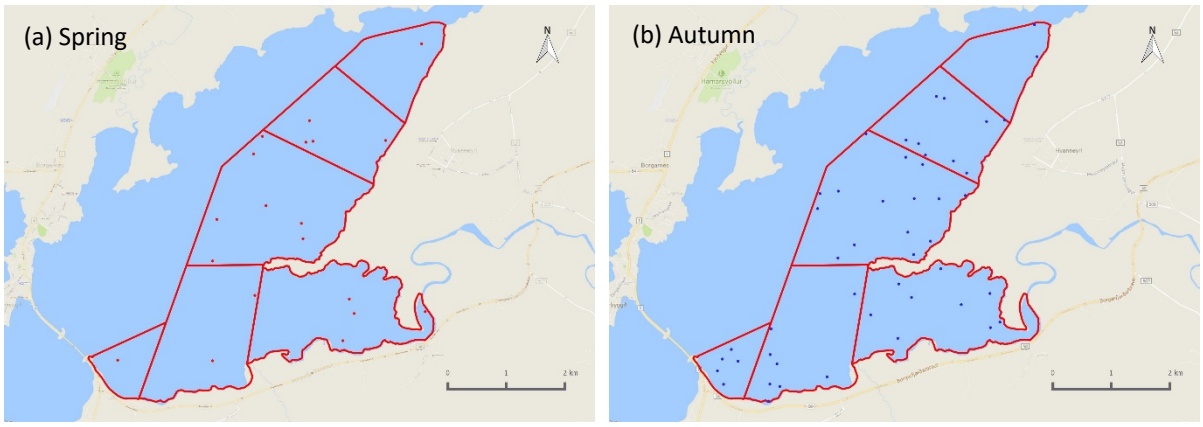

Figure 3-129. Relative abundance during (a) spring and (b) autumn of *Larus fuscus* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

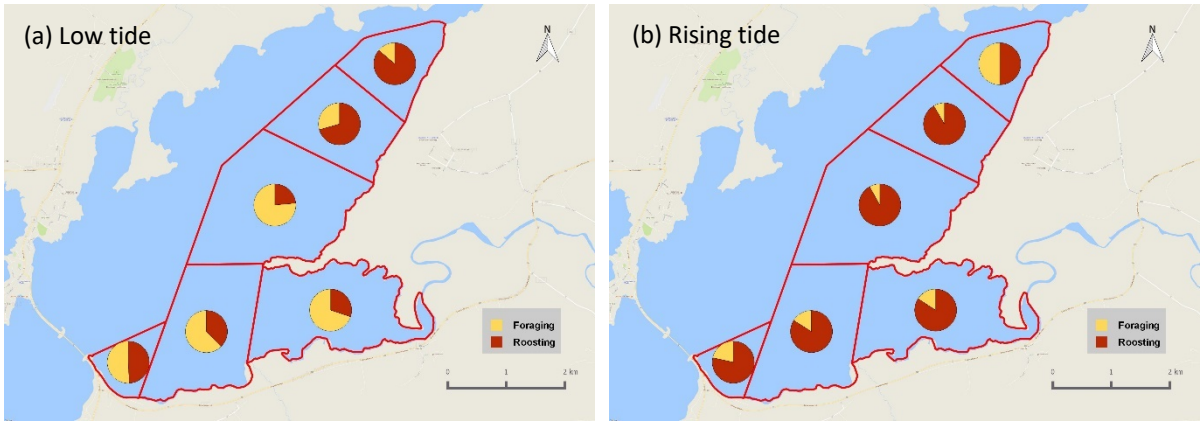

Figure 3-130. Proportion of foraging and roosting *Larus fuscus* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Arctic Tern	*Sterna paradisaea*	Kría

Arctic Terns were first recorded on 3rd May, and peaks of 627 and 682 were recorded on 15th and 23rd May, respectively, as birds moved through the site. Smaller numbers, *c*. 30-50 birds were present throughout June, July and the beginning of August, with the last record being on the 7th August. Birds were mostly observed foraging or loafing in the southernmost three subsites: Flæðhöfðasker (Est 6), Grjóteyrarklakkur (Est 1) and Kistufjörður (Est 2).

There was a breeding colony adjacent to Flæðhöfðasker (Est 6) at 64.527617, -21.882915. No dedicated nest count was undertaken, so no information on colony size or productivity cannot be provided. However, there were 53 and 45 individuals present in the colony on 5th and 7th June, respectively, several unfledged chicks were observed on 10thand 24th July. There was considerable disturbance to the colony throughout the breeding season, as the area is used as a car park for recreational activities such as fishing and dog-walking. Furthermore, several piles of gravel, and occasionally road maintenance machinery, were stored at this location. Such machinery was present on 19th July, and there was loading/unloading of gravel in the colony in the days before and after this. As this colony is directly adjacent to two roads, it is expected that the nesting terns are relatively resilient to vehicular disturbance, but their nests and flightless chicks are at risk from trampling by humans or vehicles.

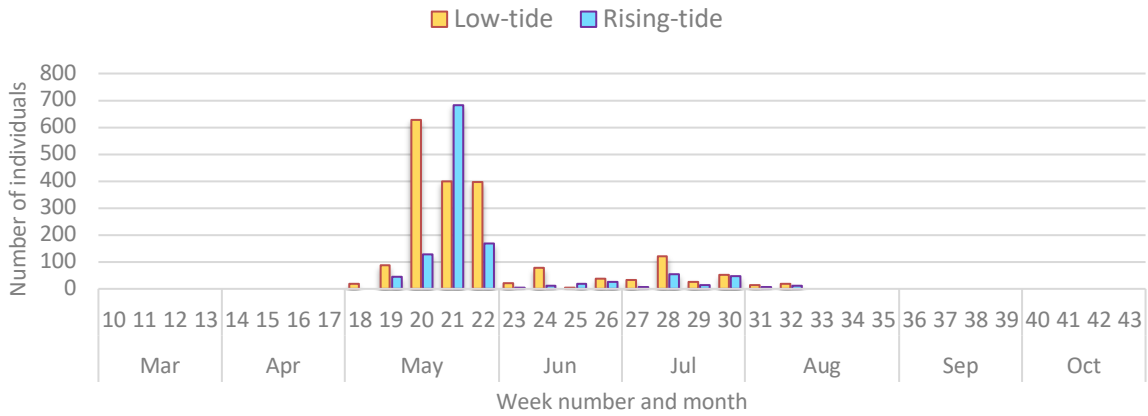

Figure 3-131. Number of *Sterna paradisaea* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

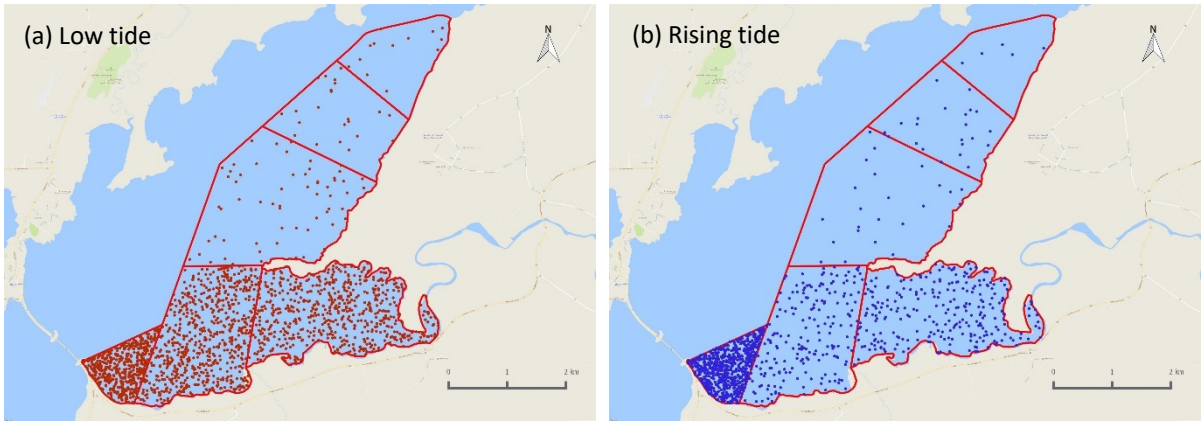

Figure 3-132. Relative abundance of *Sterna paradisaea* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

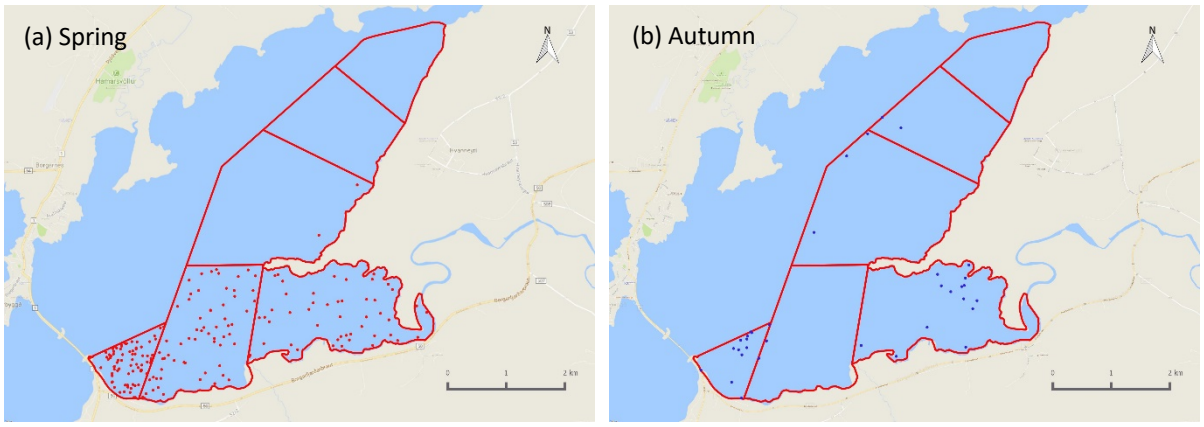

Figure 3-133. Relative abundance during (a) spring and (b) autumn of *Sterna paradisaea* counted on twice-weekly estuarine surveys in the Andakíll Ramsar site in 2017. Spring = 12th March - 7th June; Autumn = 12th June - 25th October. The number of dots in each subsite refers to the total number of bird-records (from weekly low tide and rising tide surveys) in spring and autumn, adjusted for the length of the season, and reflects the species' abundance in that season, not the specific location of birds.

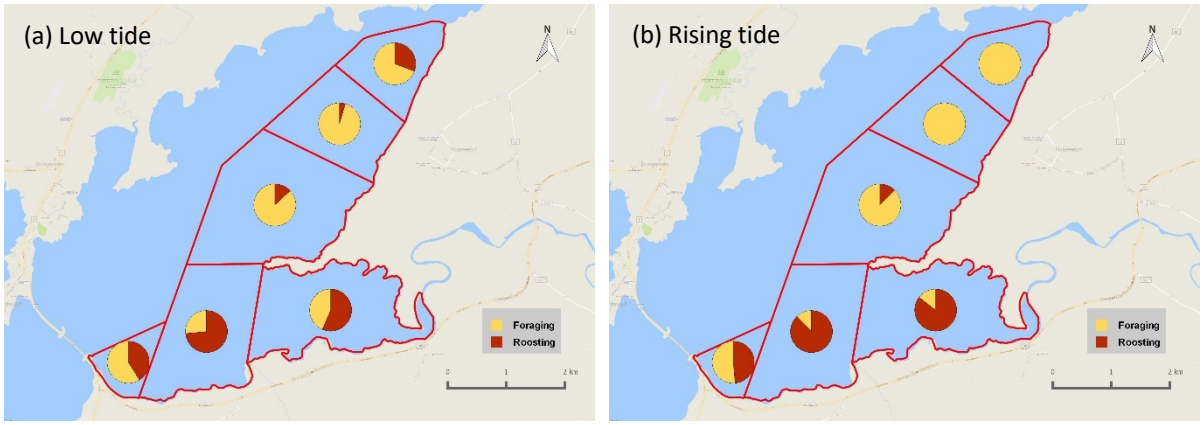

Figure 3-134. Proportion of foraging and roosting *Sterna paradisaea* during weekly (a) low tide and (b) rising tide estuarine surveys in six subsites in the Andakíll Ramsar site between 12th March and 25th October 2017.

Parasitic Jaeger / Arctic Skua	*Stercorarius parasiticus*	Kjói

Arctic Skuas were recorded in most surveys between 18th April and 31st July, and records were distributed throughout the survey area. Several nesting territories were recorded within the Andakíll Ramsar site (Tierney & Tierney 2020).

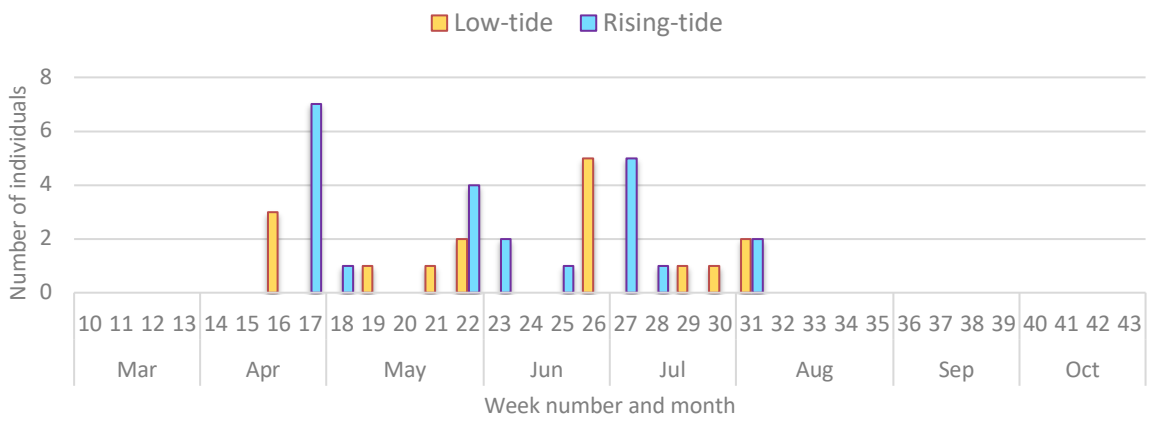

Figure 3-135. Number of *Stercorarius parasiticus* recorded during weekly low tide and rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

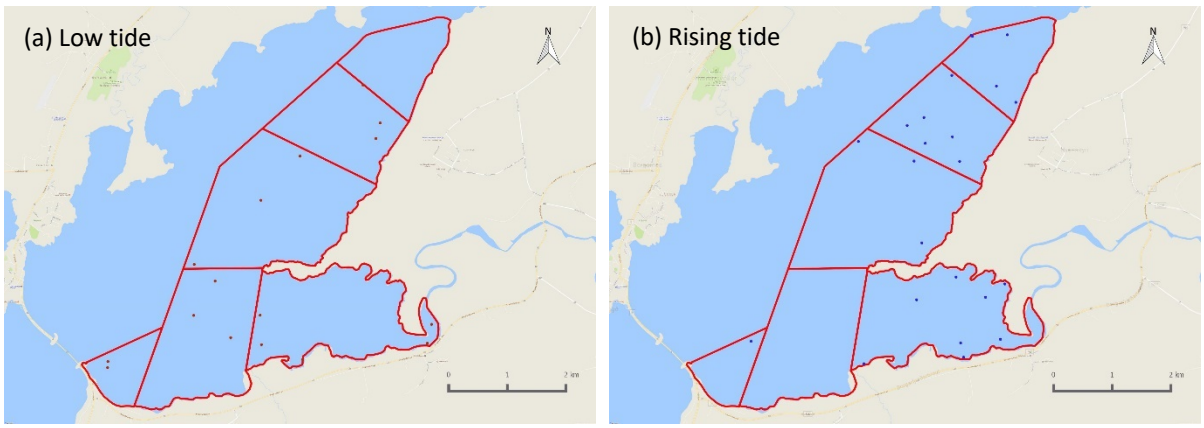

Figure 3-136. Relative abundance of *Stercorarius parasiticus* during weekly (a) low tide and (b) rising tide estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017. Dots are randomly positioned within each subsite. While each dot refers to a single bird, it refers to the bird's presence in that subsite only, and not the bird's actual location.

Other species

Several other species were observed during low tide and rising tide surveys, but are not covered here as they do not rely on estuarine habitat. A White-tailed Eagle *Haliaeetus albicilla* territory was occupied, and one or both of the pair were recorded on most surveys between 12th March and 16th October. However, no breeding activity was detected. A Gyrfalcon *Falco rusticolus* was recorded during the low tide survey on 2nd October.

4. Recommendations

4.1 Uses of the dataset

These data are of value for the conservation of estuarine habitats and estuarine birds in Andakíll, and should act as a foundation for more pure research into particular species or patterns. These data are potentially useful for conservation casework, and could be used for objective decision-making on (changes to) land management, or to avert or mitigate against potentially damaging activities or developments. These data can be used, or built upon, for research purposes, e.g. to investigate how waterbird distributions vary according to prey densities or to look at species' habitat use and preferences. Or at a larger spatial scale, to investigate variation in the density of waterbirds between estuaries in relation to variables like estuary location or sediment type.

4.2 Monitoring and research in the future

We have been successful in gathering baseline data on the waterbirds in the Andakíll Ramsar site, and the data recorded is likely to be a reasonably predictor of longer-term distributions. However, it would be short-sighted to consider this as a completed undertaking. Changes in invertebrate distribution or abundance, or increases in external pressures (e.g. human activities) could result in broad-scale changes in waterbird usage of the site. Long-term monitoring schemes have many advantages compared to once-off or reactive surveys. A long-term scheme, with regular surveys and standardised methodology will yield data of a consistent nature. Surveys carried out on an *ad hoc* basis, instigated as and when a need arises, are unlikely to be consistent, which makes comparisons and assessments of population trends difficult. Furthermore, carrying out short-term *ad hoc* surveys can only address short-term issues. And some important questions can only be answered using a suite of consistent surveys carried out at regular intervals over a longer time period. These include the effects of climate change or sea-level rise or gradual changes in pollution levels or disturbance. Waiting for a problem to be identified before carrying out a survey can greatly reduce the chance of being able to measure its impact.

Therefore, it is recommended that some form of repeat surveys are conducted, ideally at regular intervals. Potential approaches to scaling back on the amount of time or effort required, while still ensuring comparable data include: covering a smaller area (provided the areas surveyed allow comparison with the existing subsite boundaries), surveying at a reduced frequency, or focusing on particular species or species groups. Suggested approaches, instructions and field recording materials are provided in Stroud & Tierney (2017). Nonetheless, some modifications and developments could be introduced to add value to the process.

Aside from regular monitoring, targeted research could be undertaken to scrutinise some of the patterns of waterbird presence in the estuary such as, for example, between-site movements, or investigations into prey distribution and abundance. Colour-ringing would elucidate patterns and timing of movements; facilitate the calculation of survival rates; and expand on knowledge of staging, moulting and wintering areas.

Jónsson (2011) and Tierney *et al*. (2020) investigated Shelduck use of the site and estimated the number of breeding pairs. However, further exploration into this expanding population would undoubtedly be enlightening. Colour-ringing would be especially pertinent as a means to determine their wintering areas. The use of geolocators or GPS devices would provide such information quicker,

as well as arrival and departure dates; the proportion of migratory and sedentary birds in the population; and fine-scale investigation of habitat use.

5. Acknowledgements

We are extremely grateful to Dr. Björn Þorsteinsson, Dr. Hlynur Óskarsson, Ragnhildur Jónsdóttir and Ragnar Frank Kristjánsson for seeing the value in this work, and for helping us to get the project up and running. We thank Náttúruverndarsjóður Pálma Jónssonar, who funded part of this work.

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7. Appendices

7.1 Appendix 1 – Survey dates and details

Table 7-1. Low tide and rising tide survey dates of estuarine surveys in the Andakíll Ramsar site between 12th March and 25th October 2017.

Month	Week	Survey type	Date
March	10	Low tide	12-Mar
	12	Low tide	20-Mar
	12	Rising tide	21-Mar
	13	Low tide	27-Mar
	13	Rising tide	28-Mar
April	14	Low tide	03-Apr
	14	Rising tide	04-Apr
	15	Rising tide	11-Apr
	15	Low tide	12-Apr
	16	Rising tide	17-Apr
	16	Low tide	18-Apr
	17	Low tide	24-Apr
	17	Rising tide	26-Apr
May	18	Low tide	03-May
	18	Rising tide	03-May
	19	Low tide	08-May
	19	Rising tide	08-May
	20	Low tide	15-May
	20	Rising tide	15-May
	21	Rising tide	23-May
	21	Low tide	24-May
	22	Low tide	31-May
	22	Rising tide	31-May
June	23	Rising tide	05-Jun
	23	Low tide	07-Jun
	24	Low tide	12-Jun
	24	Rising tide	12-Jun
	25	Rising tide	19-Jun
	25	Low tide	21-Jun
	26	Low tide	26-Jun
	26	Rising tide	26-Jun
July	27	Low tide	06-Jul
	27	Rising tide	07-Jul
	28	Low tide	10-Jul
	28	Rising tide	10-Jul
	29	Rising tide	17-Jul
	29	Low tide	19-Jul
	30	Low tide	24-Jul
	30	Rising tide	24-Jul
	31	Rising tide	31-Jul
August	31	Low tide	02-Aug
	32	Low tide	06-Aug
	32	Rising tide	07-Aug
	35	Low tide	30-Aug
	35	Rising tide	30-Aug
September	36	Low tide	04-Sep
	36	Rising tide	06-Sep
	37	Low tide	11-Sep
	37	Rising tide	12-Sep
	38	Rising tide	18-Sep
	38	Low tide	19-Sep
	39	Low tide	25-Sep
	39	Rising tide	26-Sep
October	40	Low tide	02-Oct
	40	Rising tide	02-Oct
	41	Low tide	09-Oct
	41	Rising tide	11-Oct
	42	Low tide	16-Oct
	42	Rising tide	17-Oct
	43	Low tide	23-Oct
	43	Rising tide	25-Oct

7.2 Appendix 2 – Field recording forms

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Start: _____ **End:** _____

Tide Focus: Rising / Low

Coverage: Full / Partial

Ice Cover: _ % **Cloud:** _ /8 **Rain:** None / Showers / Drizzle / Heavy

Wind: F _____ **Visibility:** Good / Moderate / Poor

Data entry date:
Initials:
Location:

Subsite: **Est_6**

* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Intertidal**, **Subtidal**, **Supratidal**, **Terrestrial**

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_6**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____ **Ice Cover:** __ % **Cloud:** __ /8 **Rain:** None / Showers / Drizzle / Heavy

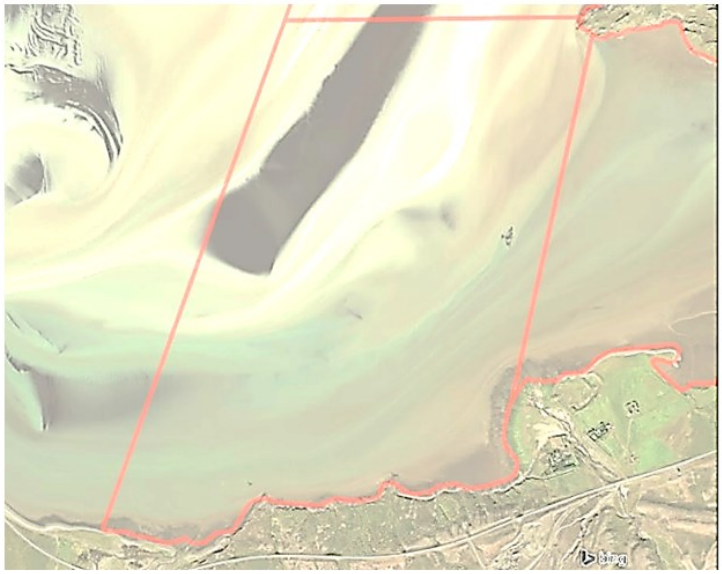
Start: _____ **End:** _____ **Wind:** F ____ **Visibility:** Good / Moderate / Poor

Tide Focus: Rising / Low

Coverage: Full / Partial

Data entry date:
Initials:
Location:

Subsite: **Est_1**



* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Int**ertidal, **Sub**tidal, **Sup**ratidal, **Ter**restrial

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_1**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____ **Ice Cover:** __ % **Cloud:** __ /8 **Rain:** None / Showers / Drizzle / Heavy

Start: _____ **End:** _____ **Wind:** F ____ **Visibility:** Good / Moderate / Poor

Tide Focus: Rising / Low

Coverage: Full / Partial

Data entry date:
Initials:
Location:

Subsite: **Est_2**

* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Int**ertidal, **Sub**tidal, **Sup**ratidal, **Ter**restrial

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_2**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____ **Ice Cover:** __ % **Cloud:** __ /8 **Rain:** None / Showers / Drizzle / Heavy

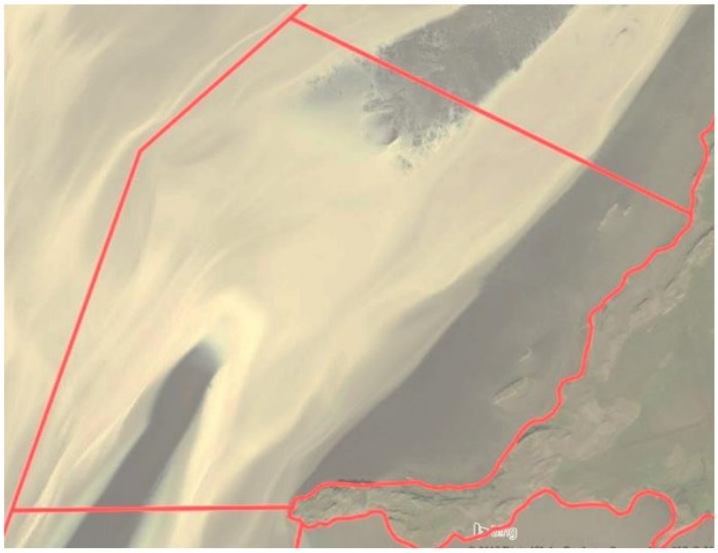
Start: _____ **End:** _____ **Wind:** F ____ **Visibility:** Good / Moderate / Poor

Tide Focus: Rising / Low

Coverage: Full / Partial

Data entry date:
Initials:
Location:

Subsite: **Est_3**



* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Int**ertidal, **Sub**tidal, **Sup**ratidal, **Ter**restrial

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_3**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____ **Ice Cover:** __ % **Cloud:** __ /8 **Rain:** None / Showers / Drizzle / Heavy

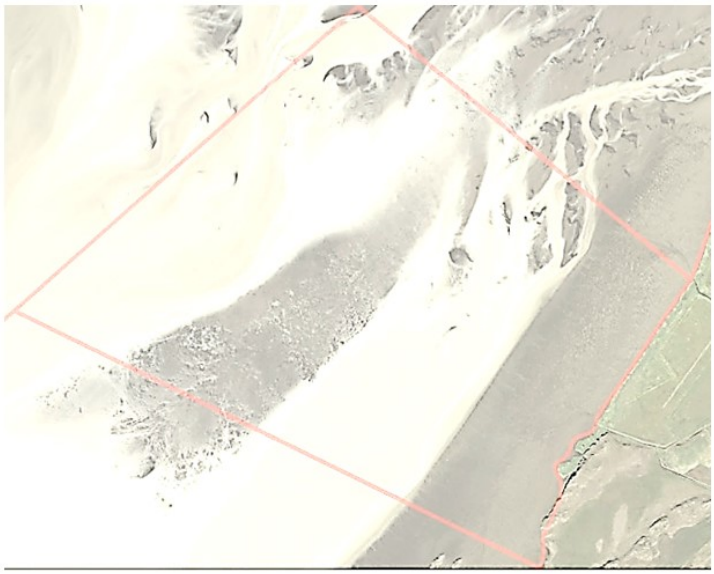
Start: _____ **End:** _____ **Wind:** F ____ **Visibility:** Good / Moderate / Poor

Tide Focus: Rising / Low

Coverage: Full / Partial

Data entry date:
Initials:
Location:

Subsite: **Est_4**



* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Int**ertidal, **Sub**tidal, **Sup**ratidal, **Ter**restrial

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_4**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____ **Ice Cover:** __ % **Cloud:** __ /8 **Rain:** None / Showers / Drizzle / Heavy

Start: _____ **End:** _____ **Wind:** F ____ **Visibility:** Good / Moderate / Poor

Tide Focus: Rising / Low

Coverage: Full / Partial

Data entry date:
Initials:
Location:

Subsite: **Est_5**

* Sp	** Count	*** Behav	**** Sub	* Sp	** Count	*** Behav	**** Sub

*BTO Species Code
**Count: Number, (100) Estimate, NC (Not counted)
***Behaviour: F (Foraging), R (Roosting/Other,) FO (Flying over)
****Substrate: **Int**ertidal, **Sub**tidal, **Sup**ratidal, **Ter**restrial

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Date: _ _ / _ _ / _ _ _ _ **Observers:** _____

Tide Focus: Rising / Low

Data entry date:
Initials:
Location:

Subsite: **Est_5**

Time	Disturbance Type *(0-12)*	Disturbance Duration *(0-2)*	Response *(0-3)*	Notes *Include quantity of disturbance (i.e number of walkers/kite-surfers etc.)*

Disturbance Type

0 - No disturbance
1 - Humans (on foot)
2 - Dogs
3 – Bait diggers
4 - Non-powered watercraft
5 – Powered watercraft
6 - Wind/kite-surfers
7 – Horse riding
8 - Aircraft
9 - Shooting
10 – Farm Vehicles
11 - Raptor
12 – Other - specify in Notes

Disturbance Duration

0 - Discrete (short lived disturbance event)
1 - Prolonged
2 - Ongoing (disturbance started before survey, continues throughout and afterwards)

Bird Response

0 - No apparent response from birds
1 - Birds relocate to subsite
2 - Some birds leave subsite
3 - All/most (90%) birds leave subsite

Landbúnaðarháskóli íslands Andakill Protected Habitat Area Monitoring 2017
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