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Important bird areas in the southern part of West Iceland

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Umhverfiseild



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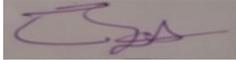
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Yfirlýsing

Hér með lýsi ég því yfir að verkefni þetta er byggt á mínum eigin athugunum, er samið af mér og að það hefur hvorki að hluta né í heild verið lagt fram áður til hærri prófgráðu.



Pavle Estrajher

Abstract

To determine the species composition and fluctuation in bird numbers through the most part of one breeding season, birdlife was observed weekly in three Important Bird Areas* in the southern part of West Iceland during late spring and early summer of 2016. These areas, within the town of Akranes, and the municipalities Hvalfjarðarsveit and Borgarbyggð were subdivided into 15 individual sites.

The ecosystems in these sites were often a combination of freshwater, brackish, or marine environments. Bird species composition in different areas depended mainly on the habitat type of the area, and the characteristics of specific sites. Most abundant species were ducks, geese and swans (Anatidae) **, followed by waders, gulls and relatives. Passerine birds and raptors were present in low numbers. Most of the recorded species breed and nest in Iceland, but some passage migrants, vagrants and wintering guests were also seen. A total of 21,687 birds were seen and 49 species were recorded, of them 43 breeds regularly in Iceland. The numbers of birds were slightly lower in early June than in late May and late June.

All areas were well accessible. Roads are either paved or gravel, and offer in most areas relatively good infrastructure for motorized birding. Walking is also possible in some areas where traffic is low, but getting to a starting point by car is still necessary. Most areas have the potential for increase in bird watching visitors, but some would require adaptations or conservation measures.

The results bring valuable insight into the species composition and distribution in several very important bird habitats in Iceland. Because some of the sites have previously been little studied, the obtained data has value for further studies and gives grounds for recreational birdwatching.

*Classification by the Icelandic Institute for Natural History

**the taxonomy is explained in the Methods chapter

Þakkir

Mig langar að byrja á að þakka konunni minni Sonju og börnunum Dagmar og Emil fyrir stuðningu í þessu langdregna verkefni. Þetta var góður tími.

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1. Introduction

Icelandic bird species

Being an isolated island high in the North Atlantic Ocean, Iceland depends greatly on the sea currents and temperate air from the South. In the last ice-age period, the Pleistocene, Iceland was covered by ice and most species of both flora and fauna started the colonization 10,000 years ago. It is believed that the island was greatly deforested due to excessive lumber exploitation and intense grazing after the Norse Settlement around the year 870 CE. In this process, the highlands were almost completely desertified, and the lowlands were also nearly deforested (Arnalds, 2015).

Abundant in both freshwater and saltwater, the coastal areas of Iceland make a habitat of choice for many aquatic bird species. Their populations are often large and make for great parts of global populations of some species. Terrestrial species are much fewer, but their populations are also often large and some species are extensively distributed.

Mobility allows the birds to reach isolated areas before other species. At the same time the birds facilitate the colonization of some species of plants. Mobility could also explain the relatively high number of bird species compared to species of other animals and plants (Snorri Baldursson, 2014). Midway between two continents, North America (Nearctic) and Europe (Palearctic), the species composition is a blend of the Nearctic and Palearctic species, but the latter dominate, mainly because of Greenland which isolates the island from North America (Snorri Baldursson, 2014). Very few Icelandic species are Holarctic, found both in Europe and North America (Jóhann Óli Hilmarsson, 2000).

Around 75 species nests in the country regularly (Snorri Baldursson, 2014). The scientific community's opinion is that the number of breeding bird species is low, which could be partially true due to extensive deforestation, and the lack of terrestrial species. If compared to the other neighbouring islands, like Greenland, which is much larger both in size and by the habitable area, the number of species found in both islands are not so surprising (BirdLife International, 2018; BirdLife International, 2018). The checklist of seen species seen in Iceland is about 410 (Gunnlaugur

Pétursson, 2014). In Newfoundland, which is similar size to Iceland, less densely populated, closer to the mainland and further away from the Arctic Circle, the checklist of species is only slightly smaller, 398 species (B. Mactavish, J. Clarke et als, 2016). Iceland's glaciers, which make around 10% of the landmass, contribute by making it less inhabitable.

While some Icelandic bird species have been studied relatively well, very little is known about the population ecology of many other species, and only several species are monitored regularly (Guðmundur A. Guðmundsson & Kristinn Haukur Skarphéðinsson, 2012). There are no endemic bird species in Iceland, but the endemic subspecies are important as they maintain the biodiversity and could make the link for the evolution of new species.

All Icelandic wild birds are protected by law and any wildlife disturbance outside the permitted periods (Icelandic Environmental Agency, 2017) and/or within the restricted areas is forbidden (Alþingi, 2013). A report by the Icelandic Institute for Natural History (Guðmundur A. Guðmundsson & Kristinn Haukur Skarphéðinsson, 2012) classifies the species based on the importance of their monitoring. Nonetheless, for many of these species the ban is lifted either throughout the whole year or only partially, and they are either being commercially exploited or exterminated. Eggs are taken for food from 30 species, hatchlings or birdlings from 16 species, 18 species are shot for consumption (of which some are showing a population decline) and another nine species are shot as damage prevention (Menja von Schmalensee, 2015). Species which enjoy special protection and whose sale and handling is prohibited are 9 (along with all stray birds), and for seven of these species no disturbance is allowed in nesting periods (Menja von Schmalensee et als, 2017).

The breeding habitats of many migratory birds which nest in Iceland maintain their populations worldwide. The staging habitats for species which travel through Iceland but breed elsewhere (passage migrants) are equally important and help them recover the energy loss during the long flights and species breeding at high latitudes need energy reserves to be able to tolerate the first few weeks of the nesting season. Some (predominantly) non-migratory species populations are very large – the Eiders (*Somateria mollissima*) are estimated to make up to 35% of the world's population (Guðmundur A. Guðmundsson & Kristinn Haukur Skarphéðinsson, 2012). The Icelandic populations of many other species make a large part of the global population, like the Pink-footed goose (*Anser brachyrhynchus*), Golden plover

(*Pluvialis apricaria*), Whimbrel (*Numenius phaeopus*) and many seabird species (Kristinn Haukur Skarphéðinsson et al, 2016). Some species' populations are much smaller, and count only several hundred pairs, like the Great northern diver (*Gavia immer*) (Kristinn Haukur Skarphéðinsson et al, 2016).

Habitat characteristics

Habitats like marine littoral mudflats, lakes and wetlands, and sea skerries are abundant in the southern part of West Iceland. Mudflats are important as feeding grounds (especially in the spring while the terrestrial plants are sparse) in which the birds recover their energy after the long flights, or feed extensively to collect the nutrients for their flight overseas. Lakes, wetlands and skerries are important breeding and nesting grounds for many of these species. The importance of these ecosystems as bird habitats is one of the reasons for their special status. Icelandic Nature Conservation Act in its Article 61 states that „ ... *freshwater lakes and pools, 1000 m² or more in area, bogs and fens 20,000 m² or more in area, all salt marshes and mudflats ... shall enjoy special protection. Their disturbance should be avoided if at all possible*” (Alþingi, 2013).

Drainage of wetlands

Wetlands, which globally cover a relatively small area (3%), store 20 to 30% of total organic carbon (TOC) on Earth. When submerged in water, in oxygen-depleted environment, and in low temperature, organic matter decays much slower. The CO₂ emissions from the drained wetlands, however, make for by far the largest part of the total greenhouse gas emissions in Iceland (Samráðshópur um endurheimt votlendis, 2016).

Agricultural land exploitation in Iceland during the mid-20th century included extensive drainage of wetlands. The drainages were made to improve the land use, but it had severe consequences to both wildlife and the amount of greenhouse-gas emissions (Samráðshópur um endurheimt votlendis, 2016). Peaking in intensity around 1965-70, when the digging ranged in the yearly amount of drainages from 1200 to 1600 km. The total drained area today is around 4,200 km² or approximately 46% of all wetlands (Samráðshópur um endurheimt votlendis, 2016).

The first wetlands reclamation efforts began in 1996 with the formation of the Wetland Committee, which was functional for 10 years (Samráðshópur um endurheimt votlendis, 2016). During the ten-year period the Committee coordinated 35 wetlands reclamation projects, several of these areas in the close vicinity of this research. In Hvanneyri, around 800 meters of ditches was filled and some drainages were changed to ponds (Samráðshópur um endurheimt votlendis, 2016), while in Mýrar area two ponds and one lake were reclaimed by blocking the drainages (Samráðshópur um endurheimt votlendis, 2016). A total of 6, 8 km² was reclaimed in all 35 projects the Committee coordinated, which makes a very small part of the total drained area (4,200 km²), but at the same time marks the beginning of the land reclamation.

Hey fire in Mýrar

On 30 March 2006 a fire spread over a 73 km² area in Mýrar, burning most vegetation (68 km²) on its way. The fire went over seven of nine areas researched in this study - only Nýlenduvatn's and Lambasker's surroundings weren't physically reached by it. In a research shortly after the fire, much higher density of both bird and insect species was recorded in the fire affected areas than the ones unaffected by it consequently, which showed a short-term positive effect (María Ingimarsdóttir et al, 2007). The fire, which is one of the largest fires by size in the Icelandic history, was extinguished by mutual effort of the locals and the Borgarbyggð Fire Brigade, on 1 April 2006, after almost three days.

Importance of habitats and measures of their preservation

Being predominantly wetland species, or connected in some way to water, most of Icelandic bird species live in similar natural habitats. These habitats are often easy to access and close to the main roads. Signs or notifications are raised in most of the areas, but the profiling of the natural reserves in Iceland is in general discreet. Urban areas in the country are also relatively few, but human activity still had a negative effect on many species in the past. Some species ceased to nest in Iceland completely, like the Water rail (*Rallus aquaticus*) (Snorri Baldursson, 2014), or partially, like the Horned grebe (*Podiceps auritus*) (Kristinn Haukur Skarphéðinsson , 2000). Other

species became almost extinct in the country and are recovering, like the White-tailed eagle (*Haliaeetus albicilla*) (Kristinn Haukur Skarphéðinsson, 2011).

The research in these areas should show what the best ways are to adapt to the challenges that come with the increased human population and the evolving industries like tourism. The results should keep maintain these habitats and the bird populations healthy, at the same time having the growth trends in touristic industry and the increase of visits to the country in mind. To do that we tried to understand the behavioral patterns which different species express in their habitats.

2. Methods

The number of birds and species composition was monitored and recorded at three main areas divided into fifteen study sites in southern part of West Iceland during the end of May, the whole June and the first days of July 2016.

Habitat types

Many Icelandic bird species live in vicinity of fresh water, the ocean, or both. Their feeding areas are often coastal littoral zones. *Arenicola* and *Hediste (Nereis)* type mudflats, rich in life, make for 27% of the total littoral shore. (Gunnhildur I. Georgsdóttir et al, 2016). These types of mudflats often found in southern part of West Iceland 's littoral zones are an important food source for many bird species. Wetlands make about 10% of all Icelandic vegetated land (Snorri Baldursson, 2014). Rocky littoral habitats, where several seaweed types (*Fucus vesiculosus*, *Ascophyllum nodosum*) prevail, are found in intertidal rocky zones (Náttúrufræðistofnun Íslands, 2017). These areas are important for the birds both as food sources and nesting areas. The wetlands have earned a significant role in ecosystems by handling the water budget, filtering nutrients and binding CO₂ in the soil (Snorri Baldursson, 2014). This study was conducted in littoral and wetland areas (littoral mudflats, lakes, ponds or river estuaries). Most waterfowl, waders, gull, terns and skuas, land birds and passerines either breed, feed or frequently visit littoral and wetland habitats (Jóhann Óli Hilmarsson, 2000). Cultivated agricultural fields, found in most of the studied sites (or close to them), and the activity around them also attract many studied bird species. For this study, fifteen sites with good accessibility and birding conditions in three coastal areas of South-western Iceland, **Akranes**, **Borgarnes-Hvanneyri** and **Mýrar**, including a part of two Ramsar sites, were selected and monitored in late spring and early summer of 2016. All areas are categorized as Important Bird Areas by the Icelandic Institute for Natural History (Náttúrufræðistofnun Íslands, 2017)

Study areas

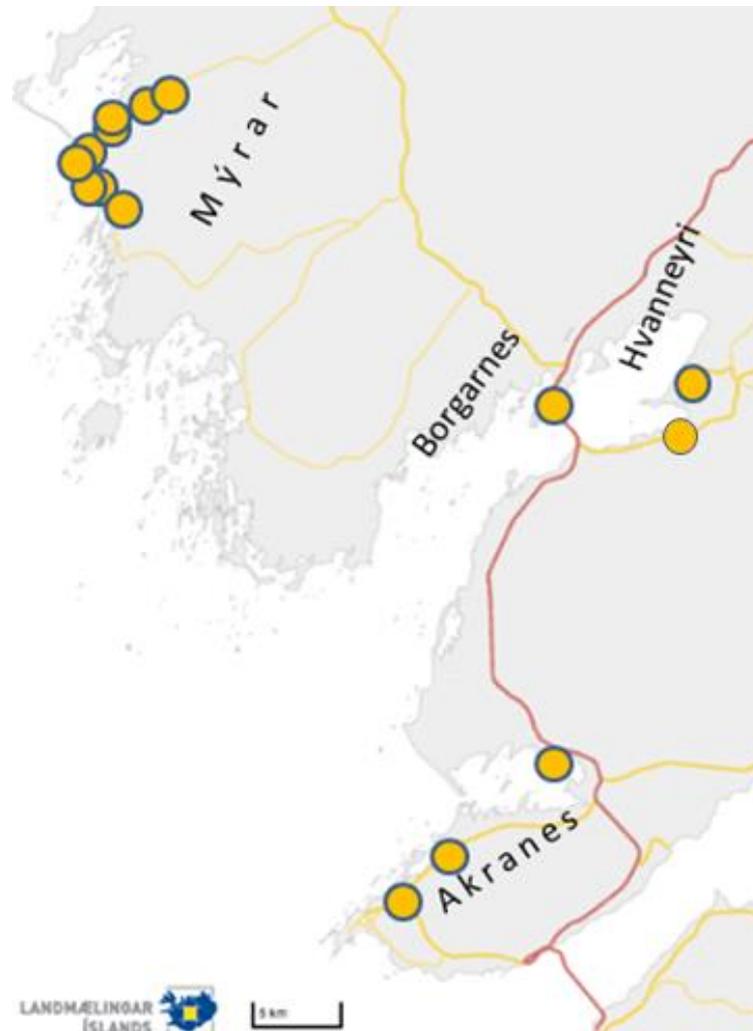


Figure 1: The three main areas, Akranes, Borgarnes and Hvanneyri and Mýrar (which was further divided into Mýrar A, B and C, not shown here)

Akranes

Kalmansvík (64.3267, -22.0670) cove, about 0.1 km², is located within Akranes town limits, at the camping area. Rocky littoral zones and littoral sediment prevail in the observed area (Náttúrufræðistofnun Íslands, 2017). The tidal zone is noticeable by the abundant seaweeds exposed in low tide. Few surrounding fields are used for agriculture. A sewage or industrial outlet leading directly to the sea west of the cove attracts many birds and likely fertilizes the area. The view from the gravel road inside the camping area reaches over the cove and skerries at sea around it, giving a good



Figure 2: Akranes area, the three sites are Kalmansvík, Blautós and Grunnafjörður

overview. Kalmansvík is the only site not on the protected areas list and is also poorly researched.

Blautós (64.3459, -22.0102), the estuary of the river Blautá, is few minutes away from Akranes. In the estuary which stretches a little over 1 km² the littoral mud is prevalent (Náttúrufræðistofnun Íslands, 2017). The area of observation is relatively small (compared to previous spot, Grunnafjörður), and it wasn't too difficult to find the best position next to the road from a small grassy plateau opposite to the peninsula at the estuary. The view from there reaches easily over the whole estuary and to the majority of the skerries out at sea. Agricultural and industrial activity is present in the neighboring fields, while the uncultivated land consists of grass meadows, moss heaths and fens, moss and lichen fields (Náttúrufræðistofnun Íslands, 2017). Blautós is a protected area which is an important staging site for the Brent goose (*Branta bernicla*), and an area rich in birdlife (Kristinn Haukur Skarphéðinsson et al, 2016).

Grunnafjörður (64.3955, -21.9076) is a shallow cove rich in *Arenicola* type mudflats and is also an important staging site for both Brent goose and Red knot (*Calidris canutus*). Other species like Sanderling (*Calidris alba*), and Oystercatcher (*Haematopus ostralegus*) were previously recorded in Grunnafjörður in large numbers, along with duck species like Red-breasted merganser (*Mergus serrator*) which moult there (Kristinn Haukur Skarphéðinsson et al, 2016). Grunnafjörður has

been nationally protected since 1994 and in 1996 it was designated a Ramsar site (Umhverfisstofnun, 2013; RAMSAR, 2015). It is located approximately thirty kilometers from Hvanneyri and Borgarnes, and fifty kilometers from Reykjavík. The protected area includes the fjord Grunnaufjörður along the River Leirá estuary, a total of 14 km², of which km 12.5 km² are mudflats. Agricultural activity is present in the area. The access point to Grunnaufjörður was in Skipanes farm, whose owner allowed the use of his premises for bird watching. After a few tries with different positions, the field near the farm was found most suitable, as it offered a good view over the fjord. The elevation is some twenty meters above sea level, on the edge of a sandy cliff above the shore.

Borgarnes and Hvanneyri

Andakílsós (64.5345, -21.7727) is in Borgarfjörður southeast of Borgarnes at the Andakílsá estuary, a couple of kilometers away from Hvanneyri. Littoral sediments are abundant around the estuary, with grasslands, moss fens and heaths surrounding, and agricultural activity in the surrounding fields (Náttúrufræðistofnun Íslands, 2017). Andakíll area is a protected natural habitat and a Ramsar site (RAMSAR, 2015). The view from under Andakílsós allowed for watching over a good part of the estuary and

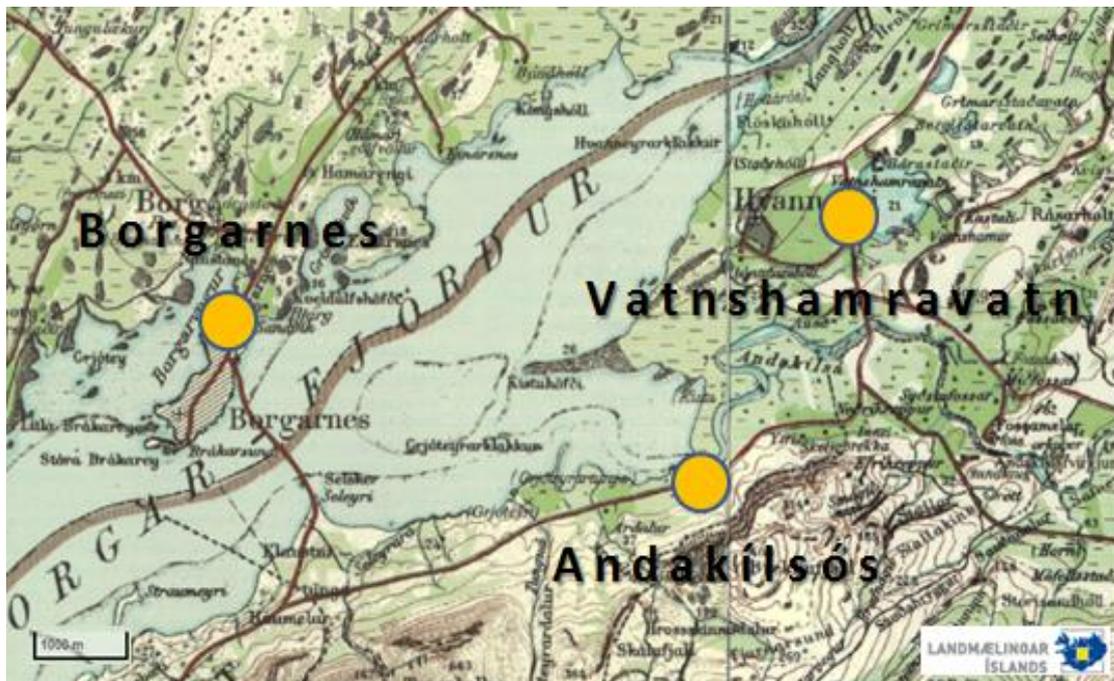


Figure 3: Borgarnes, Hvanneyri and Andakílsós

the rest of the fjord. Andakíll, as another of the six Ramsar sites in Iceland (RAMSAR, 2015), is an important staging site for the Greenland white-fronted goose (*Anser albifrons flavirostris*) (Fox et als, 2010), a moulting site for the Whooper swan (Kristinn Haukur Skarphéðinsson et als, 2016), a nesting site for Shelducks (*Tadorna tadorna*) (Jón Einar Jónsson, 2011), and an important food source for many other species (Kristinn Haukur Skarphéðinsson, 2000; Kristinn Haukur Skarphéðinsson et als, 2016).

Vatnshamravatn lake (64.5670, -21.7313) is a 40 ha lake with several islets in its western part. The lake's yearly water budget fluctuates slightly, and water levels differ accordingly. Grasslands, mires, fens, sedges, heaths and rooted floating vegetation are the habitat types (Náttúrufræðistofnun Íslands, 2017). The area is agricultural; the Agricultural University of Iceland is in Hvanneyri and has cultivated the fields around Vatnshamravatn since the late 20th century (Ragnhildur Helga Jónsdóttir, personal communication). A spot next to the lake, in the vicinity of the old agricultural premises, was ideal for the study as it gave a good view of the lake. Vatnshamravatn lake is also an area important for the Greenland white-fronted goose because of the surrounding agricultural fields where the birds feed (Fox et als, 2010).

Birdlife in **Borgarnes** depends greatly on the mudflats and river estuaries. Some data exists on the number of Shelducks in the coves of Borgarvogur and Grímólfsvík and Langárós estuary (Jón Einar Jónsson, 2011), and the arrival periods of the waders in the same areas (Svanhvít Lilja Viðarsdóttir, 2017), but the last substantial researches have been done almost 20 years ago (Kristinn Haukur Skarphéðinsson, 2000). In Borgarnes, the main study area was **Borgarvogur** (64.5504, -21.9174). Borgarvogur is a 2 km² bay on the north and west outskirts of Borgarnes, composed mainly of littoral sediment. The surrounding areas are grasslands, moss heaths and fens, cotton grass fens and meadows (Náttúrufræðistofnun Íslands, 2017). Urban areas also make a good part of shoreline in Borgarvogur, the town of Borgarnes is located on its south-eastern bank. Several sites were used in Borgarnes depending on the weather and tidal conditions, as birds moved with the tide in and out of the bay. On low tide it was best to be somewhere inside the Borgarnes camping site (64.5525, -21.9099), moving with high tide southwest to a spot below the Borgarnes sports hall (64.5410, -21.9222) and further to Englendingavík cove (64.5376, -21.9274). Sometimes the harbor facilities were also used (64.5336, -21.9318) to observe the surrounding islets and skerries.

Mýrar

Mýrar is a lowland wetlands area around 25 km from Borgarnes rich in birdlife. It is important moulting area for Eider ducks and Whooper swans, as well as a staging area for Red knot, Brent goose, Sanderling, Black-tailed godwit (*Limosa limosa*), and a nesting area for Red-throated diver (*Gavia stellata*), Great northern diver, Eider duck, Great black-backed gull (*Larus marinus*), Arctic tern (*Sterna paradisea*) and Puffin (*Fratercula artica*) (Kristinn Haukur Skarphéðinsson et als, 2016). The skerries around Akrar area in Mýrar are a nesting area for Shags (*Phalacrocorax aristotelis*) (Arnþór Garðarsson & Ævar Petersen, 2009) and Cormorants (*Phalacrocorax carbo*) (Arnþór Garðarsson, 2008). White-tailed eagles are found there too, and some 10% of the known Short-eared owls (*Asio flammeus*) nest in the wider Borgarfjörður-Mýrar-Löngufjörur area (Kristinn Haukur Skarphéðinsson et al, 2016).

In Mýrar, nine sites were used for the study. The area was divided into three subdivisions, **Mýrar A (Bæjartjörn, Hólmavatn, and Akraós)**, **Mýrar B (Bergsteinsvatn, Bergsteinsvatn II, and Nýlenduvatn)** and **Mýrar C (Lambasker, Sandvatn and Laxárholtsvatn)**. Of them, seven are lakes, one is a river estuary with mudflats (Akraós) and one a rocky littoral area with sandbanks (Lambasker). The



Figure 4: Mýrar area was subdivided into three areas, Mýrar A - Bæjartjörn, Hólmavatn, Akraós; Mýrar B - Bergsteinsvatn, Bergsteinsvatn II, Nýlenduvatn, and Mýrar C - Lambasker, Sandvatn and Laxárholtsvatn

lakes are inland and coastal with wetland vegetation consisting mainly of rooted floating plants, reed beds and helophytes and some grasslands and cultivated agricultural fields (Náttúrufræðistofnun Íslands, 2017). The area suffered from extensive wither fires in 2006, which was thoroughly researched and likely had a temporary positive effect on bird life, through increased nutrient supply caused by fires (María Ingimarsdóttir; Guðmundur A. Guðmundsson & Erling Ólafsson, 2007). Many lakes contain small islets and the area is extensively water-drained for agricultural use. Road 54 from Borgarnes was driven to the west, and after 22 km the turn was taken to Hraunhreppsvegur (540, gravel road) leading to Akrar. From there the Akrar area was circled by turning to the road 533 and back to road 54. Regardless to the division of the area into three subdivisions, Mýrar will be referred to as an area in whole, if not stated otherwise.

Bæjartjörn (64.6676, -22.2981) is a 0.5 ha pond opposite to the Stóri Kálfalækur farm, with agricultural fields north and west, grass heaths, sedge and moss fens and rooted floating vegetation around the pond (Náttúrufræðistofnun Íslands, 2017). The pond is easy to scan, stopping at the road next to it.

Hólmavatn (64.6644, -22.3145) is surrounded by sedge and moss fens, lichen heaths, cotton-grass fens, sedge mires, moss and lichen fields and rooted floating vegetation (Náttúrufræðistofnun Íslands, 2017). This 21 ha lake is close to the road (ca 80 m) but the ground elevation doesn't give a good overview (the lake lies at approximately the same level as the road) and the observation can take longer time and require a position change. The overview is still good, and the lake was well worth the stopping.

Bergsteinsvatn (64. 6559, - 22. 3479) lake is surrounded by moss, sedge and cotton grass-fens, lichen fields, grasslands and heaths, salt meadows and shore vegetation with some glacial moraines that contain no vegetation, and in the Southwest part some agricultural fields (Náttúrufræðistofnun Íslands, 2017). The lake is about 130 ha and has some water level fluctuations due to sea level change.

Akraós is a brackish coastal lagoon at the Hítará river estuary. This habitat also has a littoral sediment area and is surrounded by cotton-grass and moss fens, some grassland and agricultural-cultivated fields (Náttúrufræðistofnun Íslands, 2017). The view from the side of the road contains the whole estuary and the littoral sand shore.

Bergsteinsvatn 2 (64. 6462, -22. 3610) is another site which monitored the lake Bergsteinsvatn from a different position. The site offered a good view to a nesting colony of Common eiders.

Nýlenduvatn (64.6307, -22.3750) is a coastal lake with reedbeds and tall halophytes surrounded by cotton-grass, sedge and moss fens and grasslands (Náttúrufræðistofnun Íslands, 2017). This 6.5 ha lake's shores lie a few steps away from the road and the whole lake is easily monitored.

Lambasker (64.6263, -22.3719) is a 35 ha sparsely vegetated sand shore with littoral sediment surrounded by moss and lichen fields (Náttúrufræðistofnun Íslands, 2017). From an elevated bank in the moss field, the view opens to the shore and some of the nearby skerries.

Sandvatn (64.6260, -22.3674) is a 37 ha coastal lake with typical water-fringing reedbeds and tall halophytes, divided by a narrow sandbank from lake Nýlenduvatn. It is surrounded by moss, sedge and cotton-grass fens (Náttúrufræðistofnun Íslands, 2017). The view from the road reaches well over the lake.

Laxárholtsvatn (64.6012, -22.3393) is a 24 ha lake near Laxárholt farm. It is surrounded by cotton-grass, sedge and moss fens, sedge heaths, cultivated agricultural fields and some forest plantations (Náttúrufræðistofnun Íslands, 2017). There is no parking area and the lake was monitored by stopping the car on side of the road without difficulties thanks to low traffic.

Counting

The sites were visited once weekly during May and June 2016, with a goal of seven counts per site. In five sites the results weren't obtained at all counts, while Grunnafjörður is missing two individual counts while Andakílsós, Bergsteinsvatn and Laxárholtsvatn are missing one individual count each. In Grunnafjörður it happened because it was difficult to determine the exact count positions (it required contacting the landowner in Grunnafjörður) and the count was attempted but omitted because of a low number of birds seen - a better site was selected next time. At Bergsteinsvatn and Laxárholtsvatn the results are missing because of excessive wind. This could be misleading when interpreting the results as it shows a lower number of birds than if all seven counts were performed.

The research area couldn't be covered in one day because of other obligations, and the count dates between individual areas vary sometimes for as much as five days (count seven at Vatnshamravatn was 28 June and in Akranes 3 July), but for the individual areas the dates are in better accordance and the difference is one day at most. This is because Borgarnes was the starting point for both the Akranes and Hvanneyri areas, and the count was then combined with the tidal conditions for best results. If the tide was low and groups of birds were seen in Borgarnes then the count was done right away, while at high tide it was either omitted in Borgarnes and most often the destination was Mýrar. If the tide was lowering, either Hvanneyri or Akranes were chosen depending on the time remaining until the low tide in Borgarnes. Vatnshamravatn in Hvanneyri isn't affected by tide, while Akranes is half an hour distant - since Kalmansvík isn't rich in mudflats but both Grunnafjörður and Blautós are, (as well as Andakílsós in Borgarnes/Hvanneyri area) combining the stops at these sites was a good option.

For better understanding, all the dates are listed and the counts referred by the individual dates. Count one was 18 May at all sites, except the ones with insufficient data. Count two was 23 May in Akranes and Borgarnes and Hvanneyri areas, and 24 May in Mýrar A, B, and C. Count three was 1 June (Akranes, Borgarnes and Hvanneyri) and 31 May (Mýrar). Count four is 9 June (Mýrar), 10 June (Akranes) and 11 June (Borgarnes, Hvanneyri). Count five was 14 June (Borgarnes, Hvanneyri & Mýrar, all) and 18 June (Akranes). Count six was 21 June (Mýrar, all), 23 June (Hvanneyri) and 25 June (Borgarnes and Akranes). Count seven was 28 June (Hvanneyri), 29 June (Borgarnes and Mýrar, all) and 3 July (Akranes).

Birds were counted using Williams Optics 17x80 monocular with a tripod and an 8x20 Nexus binocular. Binocular was used to determine where the birds' position and the monocular mounted onto the tripod to scan the area. Approximations were made to the number of birds in a group by count tens of birds together, both to avoid excessive time consumption and because of the possibility of losing count due to flock mobility. Remarks were made about the sex, couples with young birds or bird lying on the nest if the weather and visibility distances allowed. Individual birds were counted if flocks were less than 50 birds, depending on present conditions. If the groups were larger, tens of birds were counted by approximation. Most count times were in the morning and early afternoon and some in the evening. The count wasn't

directly related to tidal changes, but a website (tides.mobilegraphics, 2016) was often consulted before the count in the littoral areas and the routes decided according to it.

Data analysis

All data regarding species, numbers, and, if possible, sex of birds, dates and times of day, and positions were recorded at count sites, and later transferred to Microsoft Excel which was used for all calculations and charts. Few remarks were made about the weather conditions if the count was affected by them (heavy wind, evaporative mist). Birds seen while driving between sites weren't recorded, except in the case the short-eared owl, because it was the only specimen seen during the observation. Some birds were seen either in flight or earthbound. This is especially true for areas abundant in agricultural fields like Mýrar and Hvanneyri. Ducks, (often seen in roadside ditches), swans and geese (in fields), landbirds (in trees or bushes), seagulls (while driving in marine areas), Shags and Cormorants (while driving in marine areas), and Ravens (*Corvus corax*) (in all the mentioned occasions) were the most common species seen between sites.

The cumulative number of birds was calculated in Excel for all species by placing all birds counted in all counts into a singular chart. From this chart, all other charts and tables were extracted.

The composition of species was compared to the overall composition of species in the country. As the observed spots stretch over a much larger area than the study sites included, calculating density or distribution for the whole area would be difficult with precision. The results show the number of birds present at each time within the range of study, but the total number of birds present in the areas could be higher – the observational methods didn't include any changes in position, and it was always monitored from the same spot (except for Borgarnes, where the positions were somewhat adjusted within the Borgarvogur bay). It means that groups of birds were possibly present but not recorded, either because of too long distances (when it was impossible to recognize them) or because the flocks weren't seen entirely (the positioning used in count didn't have full coverage of the area).

Bird species' classification

Six main groups of birds are divided according to their habitat, resembling habits or evolutionary connection. It was a practical simplification taken directly from the book Icelandic bird guide (Jóhann Óli Hilmarsson, 2000), because sometimes only one species from a larger group of birds were seen, and instead of classifying it as a separate group, this kind of grouping gave a better overview. **Seabirds** (fulmars, paddlefeet and auks) and waders and herons are grouped together because they share similar habit patterns. **Gulls and relatives** from all three families (Laridae, Sternidae and Stercoriidae) are closely related. The group called **Waterbirds** gathered ducks and their relatives (swans and geese) but also three species unrelated to the group - two species from Gaviidae family, (the Great northern diver and the Red-throated diver) and one from Podicipedae family, the Horned grebe. All these birds share similar habitats and behavior patterns (during the breeding season). **Landbirds** (Rock ptarmigan, Short-eared owl and White-tailed eagle) share the same habitat, while **Passerines** (songbirds) make a separate group to which no changes were made. Landbirds and Passerines were grouped together in the study (except in the main chart), their cumulative numbers were low and it seemed more practical to group them together.

3. Results

The number of birds counted in all counts and all study sites was 26,189. The largest number of birds in one count (4,863) was recorded on third count (31 May in Mýrar and 1 June in Borgarnes/Hvanneyri and Akranes). The smallest number of birds (2,385) was recorded in the fourth count (9 June in Mýrar, 10 June in Borgarnes/Hvanneyri and 11 June in Akranes) (Figure 5). The complete chart with all the species and all individual counts is attached (appendix 1).

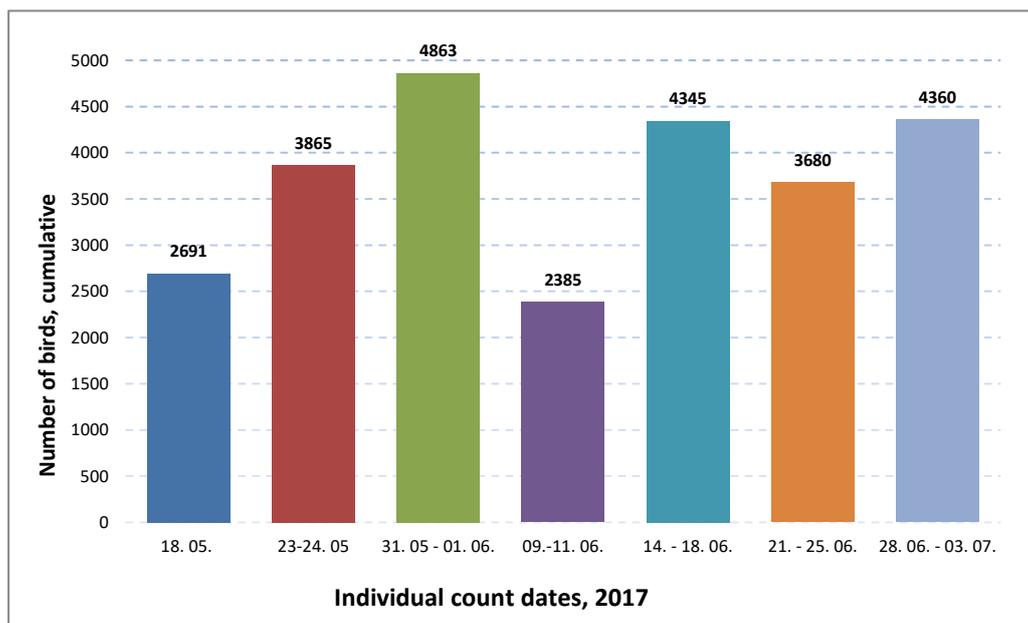


Figure 5: Cumulative number of birds in all study sites in each count.

The number of recorded species was 49 - fifteen species of waterbirds, thirteen species of waders and herons, nine species of gulls, skuas and terns, five species of passerines, four species of landbirds and four species of seabirds (Figure 3). Forty-three of these species nest in Iceland, four are passage migrants - Red knot, Ruddy turnstone (*Arenaria interpres*), Sanderling, and Brent and two wintering guests, Iceland gull (*Larus glaucooides*) and Grey Heron (*Ardea cinerea*).

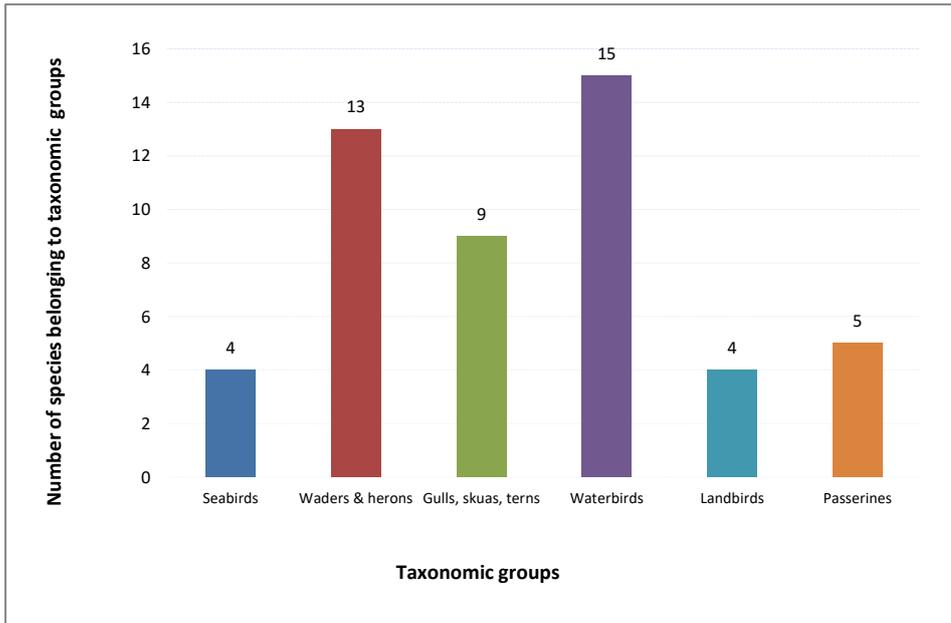


Figure 6: Number of species in each area

In Borgarnes and Hvanneyri, the number of species seen was 39, in Akranes 36, in Mýrar A 26, in Mýrar B 28 and Mýrar C 33 (Figure 3).

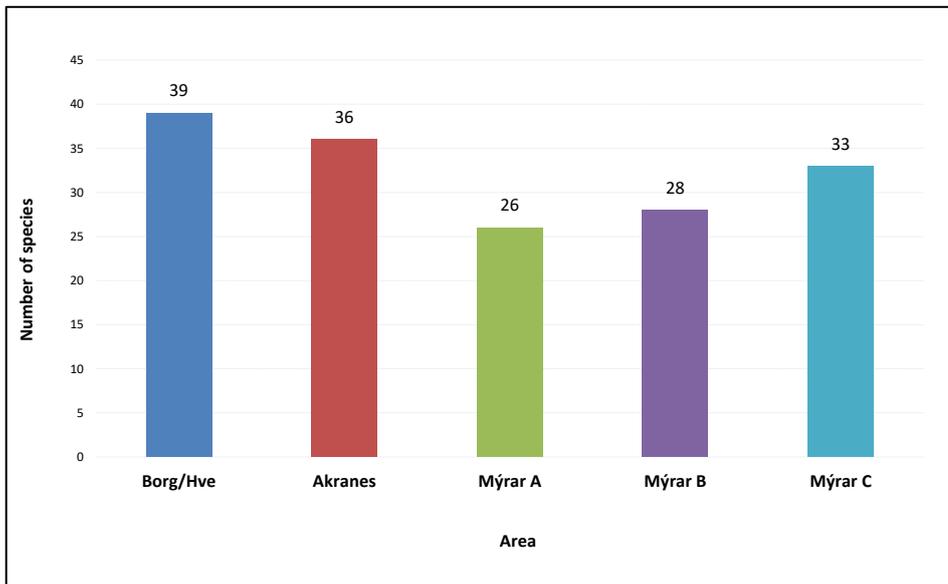


Figure 7: Number of species by area.

Eiders and Northern fulmars (*Fulmarus glacialis*) were the most numerous birds, followed by Lesser black-backed gulls (*Larus fuscus*), Arctic terns, Greylag geese (*Anser anser*), and Shelducks (Figure 4):

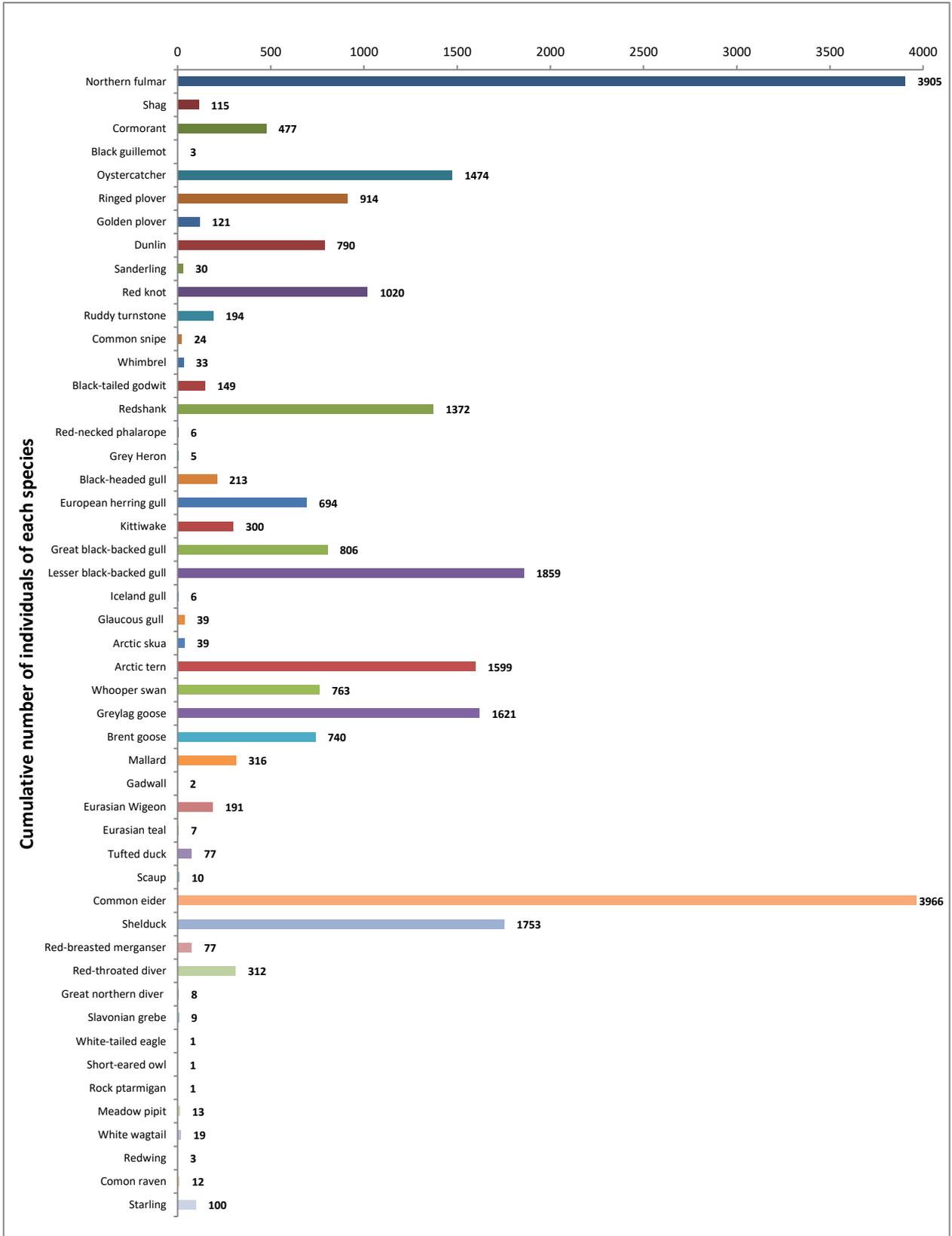


Figure 8: Cumulative numbers of all individuals by species

Most bird species preferred the mudflats to the other habitats (Figure 9):

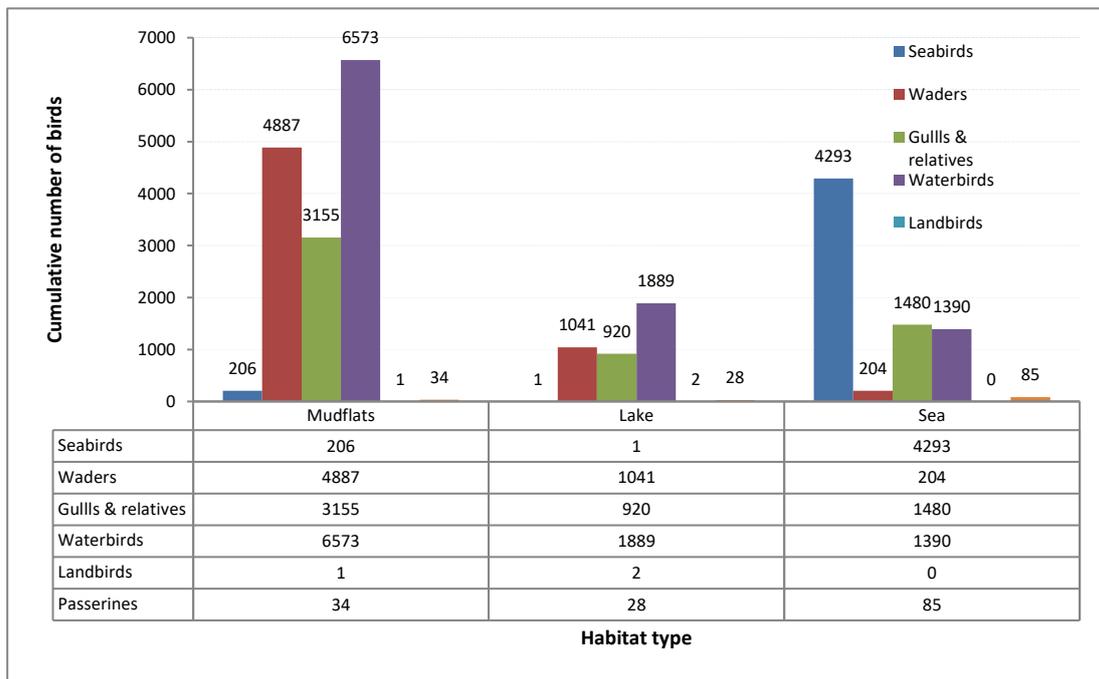


Figure 9: Mudflats were a favourite ecosystem of all bird species except the seabirds and landbirds

Seabirds

Most Northern fulmars were seen in Kalmansvík (ca. 1,000 birds on two occasions, 23 May and 18 June), where they fed on a sewage let-out. The Northern fulmars were seen only three times elsewhere than in Kalmansvík. Shags and Cormorants were often seen in the skerries in Blautós and Lambasker. The area around Lambasker is a known long-term colony for both species. (Arnþór Garðarsson, 2008; Arnþór Garðarsson & Ævar Petersen, 2009) The Cormorants were seen either at open sea or close to the shore, resting, drying their wings, or in search of food. The largest group of Shags (40 birds) was seen at Lambasker on 31 May. The Cormorants were most numerous at Lambasker on 14 June, when appx. 150 individuals were seen resting on the skerries. Black Guillemots (*Cephus grylle*) were seen fishing twice in Borgarvogur.

Waders and herons

Most waders were seen in areas rich in mudflats during low tide and ranged from one or several individuals to groups of ca. 400 birds. In other areas, they were less present, but their numbers were none the less high, both in individual counts and as species. The species of waders were Oystercatcher, Redshank (*Tringa totanus*), Red knot, Ringed plover (*Chariadris hiaticula*), Dunlin (*Calidris alpina*), Ruddy turnstone, Black-tailed godwit, Golden plover, Whimbrel, Sanderling, Common snipe (*Gallinago gallinago*) and Red-necked phalarope (*Phalaropus lobatus*). Grey Heron was the only recorded heron species.

Oystercatchers were both numerous and frequent in all areas. Their largest

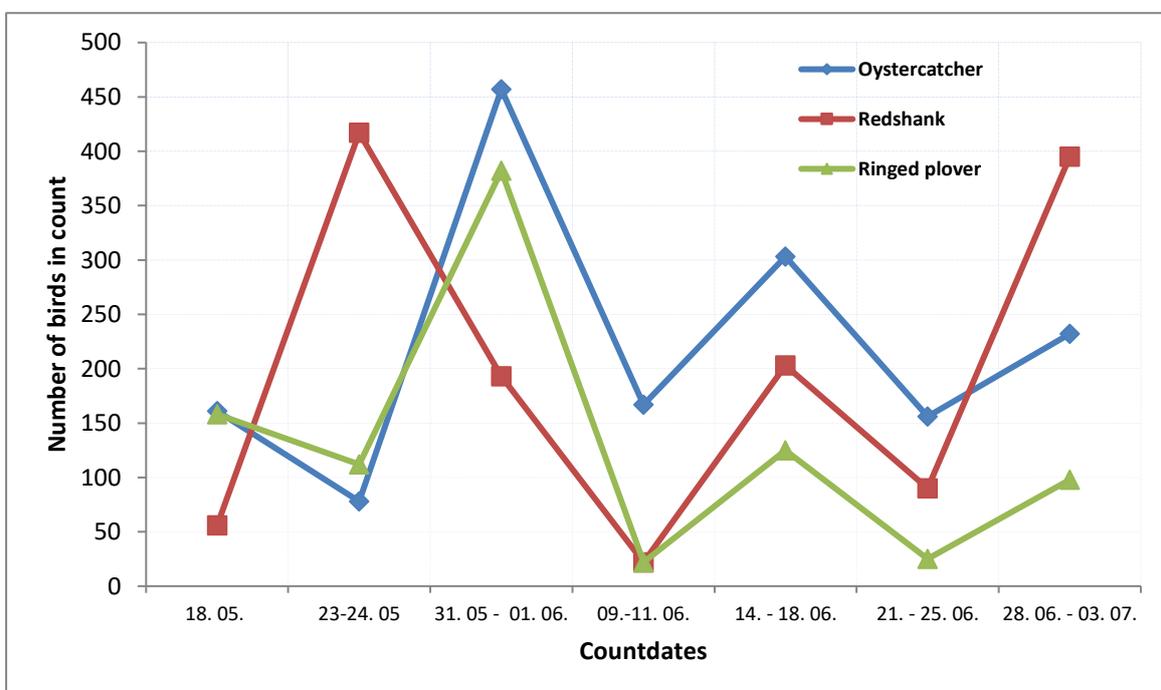


Figure 10: Oystercatchers, Redshanks, and Ringed plovers in individual counts (cumulative numbers for all areas)

groups were recorded at Akraós (200, 14 June), Grunnafjörður (150, 1 June), Bergsteinsvatn 2 (150, 31 May and 112, 9 June) and Blautós (100, 1 June). The first two counts for Grunnafjörður were incomplete and their results are omitted, which affects the final results. The number of Oystercatchers increased slightly in the count in the beginning of June, then dropped and increased again in late June and early July. The chart with cumulative numbers divided by individual counts is made for Oystercatchers, Redshanks and Ringed plovers (Figure 5).

Redshanks were also very frequent, most (400) were seen at Andakílsós on 23 May, Borgarvogur (250 on 29 June) and Blautós (100, 1 June) (Figure 5). On other

occasions, the groups ranged from 20-70 birds, and individual birds were also often seen. They showed similar oscillation in numbers as the Oystercatchers, but without the increase in July. The first count at Andakílsós was omitted because the position was not determined until 23 May.

Ringed plovers were most numerous at Akraós (250, 31 May), Grunnafjörður (100, 1 June - first two counts missing) and Bergsteinsvatn (100, 21 June) (Figure 5). The oscillation in numbers of Ringed plovers was very similar to the pattern shown by the Redshanks. Data for the first count at Bergsteinsvatn is missing because the count was omitted due to lowered visibility because of wind.

Dunlins, Ruddy turnstones, Black-tailed godwits, Golden plovers and Whimbrels were recorded in moderate numbers. Sanderlings, Common snipes, and Red-necked phalaropes had smallest records.

The Grey Heron was seen at Vatnshamravatn Lake at several counts.

Gulls and relatives

A total of nine species in the study were gulls and relatives. The most often seen species were the Lesser black-backed gulls which were mainly recorded in groups of 10-150 birds close to urban areas (Borgarnes and Akranes). These gulls were present in most of counts in all areas and at most sites.

Arctic terns were often seen fishing or in flight, but the designated research areas did not include any of their nesting colonies. The largest group of terns (350 birds) was seen feeding in Grunnafjörður, but most commonly the groups ranged from several birds to groups of 20-30 individuals. At landlocked lakes, their numbers were very low or none. Arctic terns are the only terns successfully nesting in Iceland, both in vegetated and barren areas (Jóhann Óli Hilmarsson, 2000). They were seen in all areas of the research.

Great black-backed gulls were seen in smaller groups (5-25 birds), or as pairs in their nesting colonies (lakes Vatnshamravatn, Hólmavatn, and Bergsteinsvatn). They were seen both in marine and freshwater habitats, nesting both in skerries and small islands within lakes.

Herring gulls (*Larus argentatus*), Kittiwakes (*Rissa tridactyla*), Black-headed gulls (*Croicocephalus ridibundus*), and Arctic skuas (*Stercorarius parasiticus*) were

less numerous. Glaucous gulls (*Larus hyperboreus*) and Iceland gulls were seen occasionally.

Waterbirds

Waterbirds were the most numerous taxa (15 species). Common eiders were the most abundant birds, while the other waterfowl were Shelducks, Greylag geese, Whooper

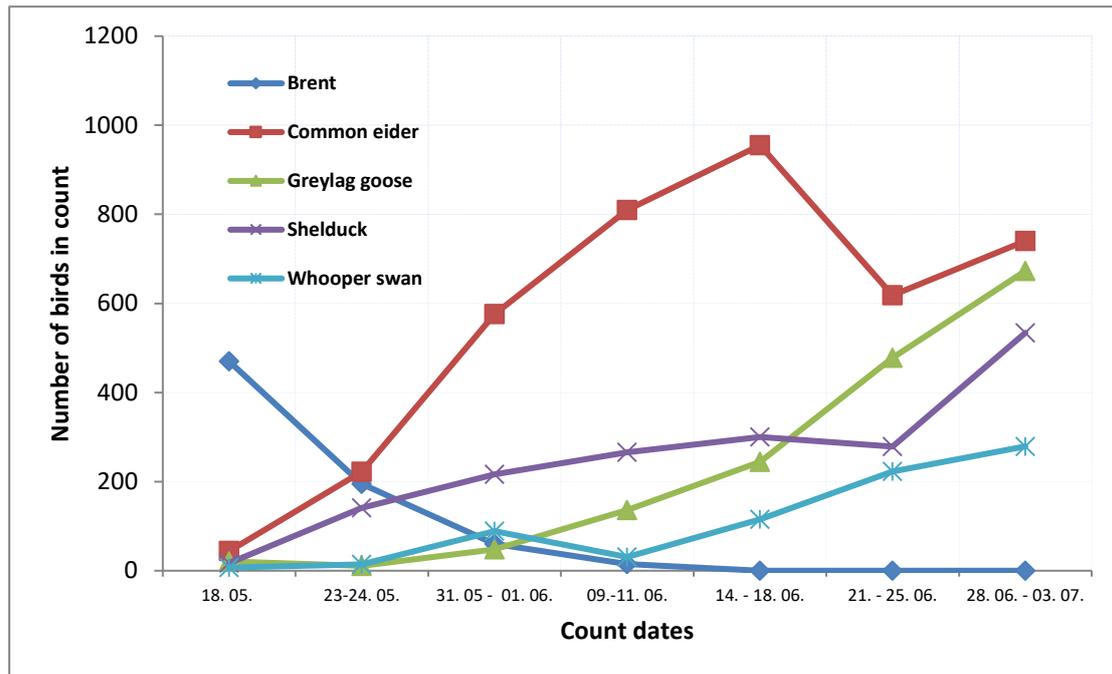


Figure 11: Most abundant waterbirds in individual counts (cumulative numbers for all areas)

swans, Brents, Mallards (*Anas platyrhynchos*), Red-throated divers, Eurasian wigeons (*Anas penelope*), Red-breasted mergansers, Tufted ducks (*Aythya fuligula*), Scaups (*Aythya marilla*), Horned grebes (*Podiceps auritus*), Great northern divers, Eurasian teals (*Anas creca*). A pair of Gadwalls (*Anas strepera*), which is a rare sight, was seen swimming in Kalmansvík on 1 June.

Eiders were most often seen in groups of over 100 birds, either in the marine or brackish environment. At Bergsteinsvatn 2, around 50 pairs were recorded in their nesting habitat at a very short distance from the road. Their numbers during the research increased steadily until the end of June, where a slight decrease was recorded.

The largest group of Greylag geese was approximately 650 birds at Andakílsós on June 28. Some birds were seen while sitting on eggs in the fields of Andakíll, and later, on their way to the water by getting down the bank to go swimming with

fledglings. Due to distance, the exact number or of young birds wasn't possible to obtain. On previous count, (23June), around 270 birds were seen, of which possibly around 120 ducklings.

Groups of Brents larger than 10 birds were seen in four areas, Blautós, Grunnafjörður, and Bergsteinsvatn 1 and 2. (A group of 180 Brents was also observed in Grunnafjörður on one occasion, but that count was omitted because it only included the approximation of this group and no other birds were counted at that time).

Shelducks were seen in Andakíl feeding in mudflats several hundreds of meters away from the Andakílsós site with the largest number (450 birds, of that 250 young) in the last count of the research (28 June). In a previous site count (23 June), during which the visibility was better and distance shorter, about half of 240 observed birds were ducklings. Shelducks were, apart from Andakíl, seen in groups in Borgarvogur (6-30 birds) and Grunnafjörður (20-60 birds). On a few other occasions, several pairs or individual birds were observed in other areas. The number of Shelducks was larger toward the later period of the research.

The Whooper swans are the only swans breeding in Iceland. The groups seen in the research ranged from 5-200 birds. Larger groups were seen at Andakíl (150, on 28 June) and Grunnafjörður, (200 on 25 June) and Akraós (65 on 29 June). Many individual birds were also seen either in flight, resting, and in their nesting habitats.

Mallards were seen at twelve of fifteen study sites. Their largest group (90 birds) was recorded at Blautós. Sometimes the groups ranged from 5-10 birds, but in most other occasions the birds were either in couples or as individuals, often in drainages and puddles near the side of the road.

Red-throated divers were seen in their nesting habitats at four lakes in the Mýrar area (Hádegistjörn, Hólmavatn, Nýlenduvatn, and Laxárholtsvatn). At Hádegistjörn, one pair nested (one adult bird repeatedly was seen lying on a nest at the same location) while at the other three sites the range was most likely from five to ten pairs at each site. The birds were often seen lying on eggs and with young birds after hatching.

A group of around 70 Eurasian wigeons were seen on 23 and 28 June at Vatnshamravatn where they were also seen in fewer numbers following a group of Whooper swans during bottom-feeding. Most of Tufted ducks was seen at Nýlenduvatn site and fewer at Sandvatn and Laxárholtsvatn sites.

Four Horned grebes were seen at Nýlenduvatn on 21. June near the larger group of Tufted ducks.

Landbirds and passerines

Three species of landbirds, Rock ptarmigan (*Lagopus muta*), Short-eared owl and White-tailed eagle were seen only once each during the study. Five species of passerine birds were Starling (*Sturnus vulgaris*), White-wagtail (*Motacilla alba*), Meadow pipit (*Anthus pratensis*), Raven, and Redwing (*Turdus iliacus*).

All landbirds were seen in the Mýrar area; Rock ptarmigan and Short-eared owl both near Laxárholt farm. They were both seen while driving and not at the usual study sites. The ptarmigan was seen on 31 May next to the road somewhere around these coordinates: 64.612, -22.340 and the owl on 21 June at these coordinates: 64.597, -22.324. The eagle, an adult individual, was seen feeding on a bird carcass (maybe an Oystercatcher, but it a confirmative record wasn't possible, due to distance) on June 14 at Akraós site, towards the estuary, at these approximate coordinates: 64.656, -22.384.

Starlings had the largest cumulative records of the passerines, with the largest group (75 birds) in flight over the Laxárholt farm. White wagtails, Meadow pipits, Ravens, and Redwings were low in numbers.

4. Discussion

Biological factors influencing species' behavioral patterns

Most of the Icelandic birds belong to either marine or wetland species, while the landbirds and passerine species make only about one-fifth of the total number of species (Snorri Baldursson, 2014). Three major habitat types stand out in this research – marine, freshwater and brackish. Eight of the fifteen sites were lakes surrounded by wetlands vegetation, but nearly all within several kilometers from the sea; five were river estuaries with brackish or saltwater habitats where the mudflats were exposed at low tide and two were marine rocky or sandy littoral habitats without mudflats (see detailed descriptions of all sites in the Study areas chapter). Though many species utilized more than one habitat type, the pattern showed clear variances between species composition in different habitats. The use of mudflats in littoral areas as a food source was the most common by most species in the research. Most species belonged to waterfowl, waders, gulls and relatives or seabirds (taxonomy described in methods), and very few to the passerine or landbird taxa.

The seabirds in this research were most often seen in marine environments. They were only of four species, which isn't surprising since the predominantly marine habitat areas were only two. Northern fulmars were the most numerous birds in Kalmansvík, where rocky littoral habitat was dominant. They were in groups of several hundred individuals in most counts and were the largest group of birds seen in the research (around 1000 on 23 May and 18 June). They fed on what seemed to be organic waste coming from a sewage outlet. Some Cormorants were seen in distant skerries where they breed and nest. The Cormorants were also seen at Lambasker, where rocky littoral habitat also prevails. Rocky islands and smaller skerries in the Mýrar area are important breeding grounds for both Shags and the Great cormorants (Arnþór Garðarsson, 2008; Arnþór Garðarsson & Ævar Petersen, 2009).

Waders most often fed extensively on low tide and were most abundant in littoral mudflats, but many wader species were also seen in lower numbers around the lakes and in marine littoral areas without mudflats. Redshanks peaked in numbers in the last week of May (23 and 24), while Ringed plovers and Oystercatchers followed the same pattern a week later, in the very beginning of June. The Redshanks start their breeding period in late May (Jóhann Óli Hilmarsson, 2000), which could explain their

lower numbers in June, if we suppose they have been feeding intensively after arrival and then left for their breeding territories. Ringed plovers and Oystercatchers may have followed the same pattern as the Redshanks and Oystercatchers normally start breeding earlier than the other two species but they are also partially non-migratory, so the migratory birds may have arrived from abroad and started breeding later than the non-migratory ones, who also staged in the same area (Jóhann Óli Hilmarsson, 2000). In the later observations, Redshanks increased slightly in numbers again, which could mark the end of the fledging period, when the adult birds collect nutrition to make the return to their wintering grounds, though other factors, like tidal changes or weather could have contributed to this change in numbers since the visibility could have been limited. The birds could have also moved to a close by area not covered by the study. Groups of staging waders (Turnstone, Red knot) were seen in their standard migratory period at the end of May (Jóhann Óli Hilmarsson, 2000).

Lesser black-backed gulls are likely decreasing in numbers (Kristinn Haukur Skarphéðinsson et al., 2016). The Greater black-backed gull population has been in large decline for decades and the species is seriously endangered, but the European population is showing the opposite trends (Guðmundur A. Guðmundsson & Kristinn Haukur Skarphéðinsson, 2012). The Mýrar area is an important habitat for the Greater/black backed gulls (Kristinn Haukur Skarphéðinsson et al., 2016). The Icelandic Arctic tern population is also in decline mainly because of the lack of sandeel; their main prey during the breeding season (Guðmundur A. Guðmundsson & Kristinn Haukur Skarphéðinsson, 2012). Their nesting grounds change often, likely depending on the food availability. No nesting sites were recorded in this research, but very many birds were seen, if compared to the other species.

Wildfowl species showed a similar habitat use as the waders. Lakes and river estuaries were their preferred habitats, but they used lakes significantly more than the waders. Some species of wildfowl used the marine habitats (not mudflats) extensively, like Eider ducks and Mallards; some were seen on their fishing trips (both diver species, the Great northern and the Red-throated divers) but the majority of the wildfowl species was seen in mudflats and brackish habitats.

The Eider ducks were by far the most abundant of all species, both in numbers and presence, which is not surprising since the Eider is by far the most common duck in Iceland and the Borgarfjörður area is a habitat to over 160,000 birds (Kristinn Haukur Skarphéðinsson et al., 2016). Their increase in numbers in the first two-thirds

of the research could be explained by the constant noticed arrival of young birds to the feeding grounds, and their decrease could be explained by the dispersal departure, in case the ducklings leave their home grounds for another area.

Greylag geese are common and well distributed in Iceland (Kristinn Haukur Skarphéðinsson et als, 2016). They had a similar pattern, but their numbers increased steadily. The birds were there with their goslings and were likely nesting in the fields, though they weren't seen while hatching. In the last count (28.06.) their number was around 650 birds, but it could have been higher, because the flock was in part located in the area not visible from the monitoring site. In the previous count (23.06.) the number of goslings could have been determined by their size difference (they were somewhat smaller than the adult birds), this time the distance was too large and the number for the whole group was approximated. It isn't excluded that all of them were moulting adult birds, since Andakíll is an important moulting site for Greylag geese (Kristinn Haukur Skarphéðinsson et al, 2016).

Brent geese were abundant in the first period of research and left in early June to their Arctic breeding grounds (Jóhann Óli Hilmarsson, 2000). Brents are passage migrants and their Icelandic habitats are important feeding grounds in which they collect nutrients for their summering and wintering destinations. Grunnafjörður is one of internationally important Brent staging sites (Kristinn Haukur Skarphéðinsson et al, 2016) and along Blautós and Borgarfjörður-Löngufjörur one of the places in Iceland which are most visited by these birds (Kristinn Haukur Skarphéðinsson et al, 2016).

Shelducks colonized Iceland in 1990 and Andakíll is one of their breeding sites (Jón Einar Jónsson, 2011). The absence of rabbit holes, their preferred nesting places, doesn't stop them from nesting, and they likely do it either in sand pits, or man-made structures (Jón Einar Jónsson, 2011). The constant rising numbers in their presence towards the end of the research are explained by the addition of ducklings in the feeding habitats. It isn't clear whether all the birds seen in the last count were nesting locally or migrated there from another area, but the number of adult birds wasn't significantly higher than before in Andakílsós. The grouping could be explained by moulting. In Andakílsós, Shelducks enjoy the benefits of the protected status of a Ramsar site. The Shelduck population had a rapid increase in size since the first records (Jón Einar Jónsson, 2011).

The Whooper swans increased in numbers towards the end of the research, and until late June they were only seen in smaller groups, or as individual birds. They

probably gathered in Andakílsós, Grunnafjörður, and Akraós for feeding and moulting. Their population is about 5% of the total world population. The number of Icelandic nesting birds is uncertain and varies between years (Kristinn Haukur Skarphéðinsson et al, 2016).

Around thirty pairs of Red-throated divers nested at the studied lakes in the Mýrar area. These birds are the smallest in the diver family. Their nesting areas in Mýrar were around the small lakes, with nests just next to the water.

Horned grebes nested in Mýrar area until 1950 or 1960. The birds stopped nesting there because of the introduction of minks and drainage of fields for agricultural usage (Kristinn Haukur Skarphéðinsson, 2000). They were seen at Nýlenduvatn Lake in their usual breeding time in late June. According to Ævar Petersen (personal communication), a few pairs have been nesting in the area in the last few years. The return of the Horned grebes as a nesting species to Mýrar does not only contribute to the biodiversity in the Mýrar but also shows the importance of land reclamation, (the recently reclaimed lakes in Mýrar area are very close to the site where the birds were seen) (Samráðshópur um endurheimt votlendis, 2016) and the importance of wetlands as an ecosystem in general.

Passerines and landbirds made for only 150 birds in the research (of 21,689). The numbers of these birds are normally low in Iceland, either because of the lack of food, or the lack of forest habitats. Starlings were the most numerous passerines, around 75 birds were seen on one occasion, and they have likely increased in numbers since the last records (Kristinn Haukur Skarphéðinsson, 2000). Meadow pipits and Ravens were seen sporadically. The density of these species is often low in wetlands and marine areas. Many more birds were seen while in motion between the sites, but there was no opportunity of recording them while driving at the same time. These numbers would be undoubtedly higher if they were all included, but that would at the same time prolong the already time-consuming counting.

Accessibility & value of areas and individual sites for birdwatching

All sites have easy access and can be reached within minutes from the road. Grunnafjörður was the only area that wasn't accessible without contacting the landowners of Skipanes farm, and this is also advised for anyone wishing to engage in

bird observation there. Since Grunnafjörður is a Ramsar site and an Important Bird Area, it would be positive to make it more accessible to birdwatchers.

The species composition patterns related well between the areas with similar habitat types, except maybe from the Ducks, geese and swans. Seabirds were absent from the lakes and found in marine and brackish water habitats. Waders preferred the mudflats but some were also found around the lakes in agricultural fields. Gulls and relatives were mainly seen in marine habitats, but were also present in the other two types. Ducks, geese and swans, somewhat surprisingly, showed a similar pattern as the waders, preferring the mudflats to the lakes, except the Eider who uses the brackish and marine water habitats equally, but also lakes in a smaller degree. Their usage of mudflats grew in the later period of the research, and is most likely connected to moulting.

The weather was a factor that occasionally influenced the counting. On two occasions in the research the counts were omitted because of rain and evaporation, but in general, the conditions were favorable regarding precipitation and temperature.

The traffic was light, at most about three cars per minute on the busiest strips (Vegagerðin, 2017). In Mýrar the traffic was almost none, and during several counts no other car was seen passing (on the gravel road). The distances observed at most places were short to moderate, but sometimes groups of birds were seen at longer distances and/or only partially, which made it impossible to count the whole flocks, which affecting the final results because the flocks, of which only parts were possibly seen, could have been substantially larger. This could be an important factor when choosing the best positions at individual sites. Tidal changes are very important in the areas where birds feed on the mudflats, and the best time to visit those areas is at lowering or low tide, preferably as soon as the sea has pulled out. Some birds nest very close to the roadside, a car used a shield both from weather and as a cover-up (birds are likely to be less scared by a car than a group of people walking) was a best alternative, which disturbed the birds the least.

Colonization of species like Shelducks, that colonized the island in 1990 (Jón Einar Jónsson, 2011), importance of staging sites for the species that breed elsewhere in the Holarctic (Fox et al, 2010; Kristinn Haukur Skarphéðinsson et al, 2016), preservation of the species that were on the brink of extinction in the country (Kristinn Haukur Skarphéðinsson, 2011) and the preservation of all other species and their habitats by protecting their natural habitats shows that the mechanisms for their

preservation in the last decades can be well implemented and the measures taken by the Icelandic government can work in accordance with the laws of nature, at least when certain species are looked at. The recovery of the White-tailed eagle's population shows clearly how these mechanisms work. Additionally, egg poaching is a serious problem in many countries. Some cases of egg poaching have been known in Iceland and in certain visited areas the locals are alert for poachers (Hlynur Óskarsson, personal communication).

Tourism has been growing rapidly as an industrial branch in Iceland since the beginning of the millennium. From several hundred thousand tourists in 2005 the numbers have gone to close to 2,2 million in 2017 (Icelandic Tourist Board, 2017). This rapid growth may be beneficial for the economy in whole, but some places may get exposed. Larger bird watching areas like Grunnafjörður, Blautós and Borgarvogur, and areas with already implemented urban infrastructure like Hvanneyri and Kalmansvík could withstand the increased activity, and wouldn't require large-scale adaptation. Mýrar, on the other hand, would hardly benefit from it. The area, listed as an Important Bird Area by the Icelandic Natural History Institute, has suffered in the past from extensive agricultural activity, which propagated the drainage of wetlands and extensive mink farming. Mink farming ceased, but the animal colonized the country and lives feral in nature, mostly along rivers, lake banks and the seashore. Some bird species, like the Horned grebe, is believed to have ceased to breed in the area because of mink predation (Kristinn Haukur Skarphéðinsson, 2000). Today, in the light of the beginning of the wetlands reclamation and the filling of drainages, any increased industrial activity in the reclaimed areas could have a negative effect on the, and decide whether the return of the Horned grebe to its nesting home grounds will be permanent.

Most Icelandic bird species are migratory or vagrant, which additionally stresses the international importance of these ecosystems, since their species survival may highly depend on them, either as a breeding habitat or a staging site. A low physical distance of these areas from the urban centers is sometimes staggering - it often takes only a couple of minutes' drive on a paved road to reach them. Another characteristic of the Icelandic nature is a seemingly complete absence of trees – the view is like the view from the sea, almost limited only by the horizon. In the breeding periods in late spring and early summer, it is possible to find evidence of bird life at any randomly chosen site, except maybe in the desertified highlands. In most of the

observed areas the specialized infrastructure for bird watching is none, but this is not necessarily a disadvantage. Some sites, like Grunnafjörður, where the areas observed are vast, may benefit by building walking trails and bird watching cabins. Most of the other areas would only require simple basic facilities (if any), such as a bench in a neutral zone, outside the view range of the birds, where the tourists could take a rest. Anything more could mean a potential bird habitat disturbance.

5. Conclusions

Commercial exploitation of bird species and their habitats has been a common practice in Iceland for centuries. Keeping track of a constantly rising number of activities connected to it is equally important as spreading the knowledge about it, and researching and documenting the individual species and ecosystems. This is especially true for the species and ecosystems which have suffered from human activities in the past. Unfortunately, only a fraction of these species and habitats are recovering from it. Still, the initial steps are taken in both land reclamation and species recovery, which are mutually connected. These species and habitats make our legacy to the future generations. Much work needs to be done in protecting areas such as national parks, wetlands and their reclamation, and bird species, especially the ones which we want to keep commercially exploiting either as a food source or in tourism.

Natural reserves and habitats do not necessarily exclude human activities. Legislation in the administrative sector should consult the researchers and other professionals to advise all parties included in the application of touristic facilities and work towards the preservation of endangered bird species. The executive legislation should apply conservational measures, especially in the Important Bird Areas and protect them on a national level. Whether our next step will be toward an intensive or an extensive use could greatly depend on these decisions. Intensive use could lead to habitat deterioration, while extensive use could help preserve the bird habitats, both through funds received from tourism and the data gathered by the bird watchers, whether they are professional or amateurs.

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