FERÐAMÁL Á NORÐURSLÓÐUM
JOURNAL OF ARCTIC TOURISM

Volume 2
Issue 1, pp. 15-26
ISSN: 2772-168X
www.arctictourism.is

Mobility Patterns and Sustainable Tourism:

Planning and Managing Tourism in Iceland

Gyda Thórhallsdóttir[a]
Rögnvaldur Ólafsson[b]
Gunnar Thór Jóhannesson[c]
Thorvardur Árnason[d]
Rögnvaldur Gudmundsson[e]

Abstract

Tourism in Iceland has experienced significant changes in the past decade. Visitor numbers increased from 459,000 in 2010 to 2.3 million in 2018. However, there was a 14% decrease in visitor numbers between 2018 and 2019, and in 2020, the visitor numbers collapsed because of the COVID-19 pandemic. The effect of the pandemic started to decrease in spring 2022 as visitors returned.

The great increase from 2010 to 2018 prompted Icelandic authorities to focus on sustainable tourism management in their policymaking. The focus has been on distributing the flow of visitors and associated revenues more evenly across regions, while protecting the main tourist attraction: nature, as well as nature-based destinations. Knowledge of mobility patterns at different scales is crucial for the sustainable development and management of tourism. This study analyses mobility patterns in Iceland through examining visitor numbers at 18 nature-based destinations scattered around the country. The mobility patterns are then related to the sustainable tourism objectives of the Icelandic tourism authorities.

The results indicate that the south and southwest region of Iceland is more visited and exhibits less seasonality than other regions of the country. Seasonality has decreased in all regions but not to the same extent as in the south and southwest, the area that includes both the main gateway, Keflavík International Airport, and the capital city of Reykjavík, which often serves as a basecamp for natural attractions. When planning for and managing sustainable tourism in Iceland, it is crucial to know the number of visitors at nature-based destinations, as these numbers are key for analysing mobility patterns.

Keywords: Sustainable Tourism, Mobility, Time and Space, Seasonality, Iceland, Arctic

Published by the Icelandic Tourism Research Centre | rmf@rmf.is | www.rmf.is
Corresponding author *gth85@hi.is*
[a] PhD student | Faculty of Life- and Environmental Sciences | University of Iceland
[b] Emeritus | Faculty of Life- and Environmental Sciences | University of Iceland / (deceased 1 March 2024)
[c] Professor | Faculty of Life- and Environmental Sciences | University of Iceland
[d] Director | Hornafjordur Research Centre | University of Iceland
[e] Director | Tourism Research & Consulting | Iceland

DOI: https://doi.org/10.33112/arctour.2.2

ARTICLE HISTORY: Submission: 25. August 2023 | Acceptance: 17. May 2024 | Publication: 24. June 2024

Introduction

In recent years, there has been a growing interest in nature and the Arctic as a tourist destination (Maher et al., 2022). This trend is evident in Iceland, where the number of visitors increased significantly from 2010 to 2018 (The Icelandic Tourist Board, 2024). In 2020 there was a collapse in visitor numbers because of the COVID-19 pandemic, but since then, the tourism industry has rapidly recovered and is now, in terms of number of international visitors, back on a similar track (Figure 1). The Arctic regions, including Iceland, have low population densities spread across vast areas. Many similarities exist in tourism across the Arctic region, such as high seasonality and uneven regional distribution of visitors, which results in uneven distribution of revenues (Huijbens, 2022; Maher et al., 2022; Rantala et al., 2019).

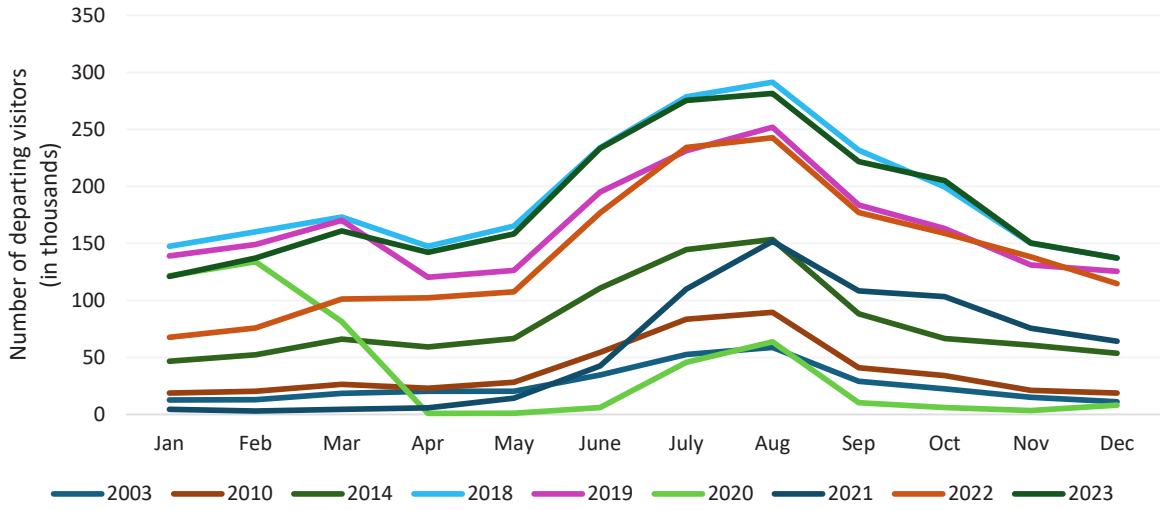

Figure 1. *Number of visitors departing Keflavík International Airport (The Icelandic Tourist Board, 2024).*

In Iceland, tourism authorities have promoted sustainable tourism planning and management for decades (Jóhannesson et al., 2010), which has been loosely translated into an aim to reduce regional seasonality and distribute the flow of international visitors from the main gateway to Iceland, Keflavík International Airport, which is used by 99% of all international visitors (The Icelandic Tourist Board, 2024). The focus has also been on protecting nature, distributing revenues from tourism more evenly around the country, and protecting both locals and tourists from the negative experiences of tourism. Concrete examples of efforts working towards more sustainable tourism are the establishment of the Tourist Site Protection Fund, the National Plan on the Development of Tourist Sites (Lög um landsáætlun um uppbyggingu innviða til verndar náttúru og menningarsögulegum minjum nr. 20/2016), and the development of Vakinn in 2012, which is a quality and environmental assurance initiative (The Icelandic Tourist Board, n.d.-a). The Tourist Site Protection Fund was established to promote the development, maintenance, and protection of tourist attractions and tourist routes in Iceland and to alleviate pressure on highly visited sites by increasing the number of tourist sites (The Icelandic Tourist Board, n.d.-c). The aim of the National Plan is to formulate and coordinate a strategy for the development, operation, and maintenance of infrastructure in the interest of nature conservation and for the protection of cultural and historical monuments due to pressure caused by tourism and outdoor recreation (Lög um landsáætlun um uppbyggingu innviða til verndar náttúru og menningarsögulegum minjum nr. 20/2016).

Despite these efforts, Isavia, the airport operator in Iceland, has emphasised the expansion of Keflavík International Airport, and plans to triple the airport's size before 2040. Less focus has been placed on strengthening other regional airports, such as Egilsstaðir in the east and Akureyri in the north (Huijbens & Jóhannesson, 2020). Keflavík International Airport is in southwest Iceland, less than an hour´s drive from the capital area of Reykjavík and its surrounding municipalities (Figure 2). Reykjavík is the single most visited destination in Iceland and serves as an independent destination and basecamp, as well as, increasingly, a gateway to natural attractions in neighbouring rural areas (Huijbens & Jóhannesson, 2020; Jóhannesson & Welling, 2020).

Growth in urban-based tourism in the Arctic is not unique to Iceland. Urban areas are often perceived as offering better value for money, more choices, and higher standards than rural areas (Carson et al., 2020). This preference for urban areas is prevalent in various Arctic countries and other regions characterised by long distances between service hubs and natural attractions (Müller et al., 2020). Consequently, distance decay is a prominent factor. The more distant and therefore less accessible destinations inevitably lose out, unless they manage to provide the scale, quality, and uniqueness required to overcome distance (Prideaux, 2002). This is seen in, for instance, Sweden, where the highly populated south is much more visited than the less populated north. Both areas have similar attractions, landscapes, and natural resources, but the south, with the capital city Stockholm in the southeast, Gothenburg in the southwest, and Malmö in the south, is much more accessible for international travellers than the north (Lundmark & Carson, 2020). An important consequence of an urban centre serving as a basecamp is that excursions rarely go beyond an easy commuting distance from the city (Carson et al., 2020). Day tours from urban areas reduce the time and money spent in rural areas and affect the potential for sustainable development of tourism in rural regions.

In this paper, sustainable tourism management is analysed through regional seasonality in time and space. The following research questions are addressed:

- To what extent have tourism authorities in Iceland succeeded in reducing regional seasonality?
- How can the analysis of visitor numbers at nature-based destinations contribute to planning and management for sustainable tourism?

To answer these research questions, data on the number of visitors at 18 nature-based destinations and at Keflavík International Airport are used. The visitor numbers are derived from counters at the nature-based destinations but also from a border survey. The mobility pattern is analysed by comparing the sites and the ratio between the sites and Keflavík International Airport but also from vehicle counters on the highway along the southern coast. Seasonality at the nature-based destinations and the airport is analysed using the Gini coefficient and the ratio of visitors between seasons.

Managing for Sustainable Tourist Mobility

Understanding the mobility patterns of tourists, including their destinations in time and space, is essential for sustainable tourism management (Lew & McKercher, 2006). The mobility pattern of tourists relates to how services, such as transportation and diverse infrastructure, are planned and managed (De Cantis et al., 2015). As international travel increases, it is becoming increasingly important to plan and manage tourism to protect all those affected by it, as well as the destinations themselves (Beeco et al., 2013). Therefore, it is important to understand the mobility patterns of tourists and their travel behaviour at all levels, making several factors key in tourism mobility planning and management: transportation in its broadest sense (Scuttari et al., 2013), accessibility to a destination (McKercher & Lew, 2003), and distance (McKercher, 2018). The distance a tourist

can travel from their starting point is highly influenced by their available travel time (Hall, 2005). Transportation technologies have developed greatly, becoming more efficient and economical, and with increased leisure time, travel has become a part of many people's routine (Hall, 2012).

As tourism is based on travel, the transportation system plays a vital role in connecting tourist destinations. If the transportation system is inconvenient, tourists will seek alternative routes and destinations (Qian Pei et al., 2022). While spatial mobility has expanded with advancements in transportation technology, time for travelling remains limited for most people (Hall, 2005). Private and rental cars have the advantage over public transportation in that they allow tourists to travel faster, and therefore further, in less time (Dickinson et al., 2013). Individual vehicles also give tourists more flexibility and autonomy to change course during their travels. The internet, social media, and mobile phones have also greatly influenced tourism mobility (Gössling & Stavrinidi, 2015; Urry & Larsen, 2011) and where visitors go during their travels (Cohen et al., 2014).

The concept of distance decay, proposed in the 1960s (McKercher & Lew, 2003), explains why in the case of tourism, visitation to a site decreases as distance increases (Hooper, 2015). According to the distance decay theory, the further a destination is away from a starting point, the fewer visitors it will attract (Yee & Ismail, 2020). Additionally, if many destinations provide similar experiences, the one closest to the starting point is likely to be the most visited (Hooper, 2015). However, other factors also influence the distance travelled from a starting point. The effect of distance may vary, and its effect in one area may be different from its effect in another area. The effect of distance therefore also depends on the attraction and the accessibility of the destination (McKercher & Lew, 2003).

Hägerstrand's (1970) concept of time geography, introduced in the 1960s (Kang, 2016), is a conceptual framework that describes a behaviour in time and space (Grinberger et al., 2014). Time geography focuses on the movement and interaction of individuals in time and space. While initially focused on daily routines like commuting and local activities, time geography has become one of the most influential theoretical frameworks for describing tourism mobility. Like daily travel, tourism travel is constrained by time and space resources. Time geography enables observation of the complex connection between space, time, and mobility, a relationship that can be challenging to study. A study of German car tourists in Sweden revealed that those who stayed for shorter periods tended to travel more each day than those who stayed longer. The visitors also stayed the longest in the region farthest away from their home (Zillinger, 2007). Zillinger (2007) found that the tourists followed a discernible mobility rhythm that was not only shaped by the tourist attractions but also by the proximity of these attractions to other sites, the distance from the tourists' residences, and the duration of the tourists' stays in Sweden.

Sustainable tourism management aims to minimise the negative impacts that can occur from tourism, e.g., on nature, local communities and on the tourists themselves. Many countries have developed strategies based on the three pillars of sustainability (economic, sociocultural, and environmental), seeking to balance the impacts of tourism on these three aspects (Mihalic et al., 2021). However, scholars have criticised the use of the sustainability concept as it inadequately addresses practical needs and challenges (Sharpley, 2020). Nevertheless, the discussions on sustainability have drawn attention to the need for future-oriented tourism planning (Mihalic, 2016; Mihalic et al., 2021).

Tourism in Iceland

Tourism Development

Before 2010, international tourism in Iceland was highly seasonal and hardly existed outside the three summer months of June, July, and August (The Icelandic Tourist Board, 2024). Increased in-

terest in the Arctic as a tourist destination (Maher et al., 2022) has benefitted Iceland as a sub-Arctic country located between North America and Europe with good air connectivity (IATA, n.d.). Visitor numbers increased significantly, from 459,000 visitors in 2010 to 2.3 million in 2018 (Figure 1). In 2019, there were nearly 2 million annual visitors, with 42% of these arriving during the summer (The Icelandic Tourist Board, 2024). The reason for the decrease in visitor numbers between 2018 and 2019 is not fully known. Then at the beginning of the COVID-19 pandemic in April 2020, the number of visitors collapsed. Even so, there were 482,000 total visitors to Iceland in 2020, which is not far off the number of visitors in 2010. In June 2021, visitor numbers began to recover, and the second half of 2022 was similar to the second half of 2019. The years 2018 and 2023 were also similar in visitor numbers (Figure 1) (The Icelandic Tourist Board, 2024).

The tourism sector has become the most important industry in Iceland's economy in terms of foreign currency income (Statistics Iceland, 2022). However, Iceland was not prepared for the rapid growth in tourism, which created numerous challenges for tourism management at all levels. In 2019, international visitors stayed in Iceland for an average of 7.9 nights during the summer (May to October) and 5.2 nights during the winter (January to April and November and December in the same calendar year). The tourists drove more during the summer than during the winter, and the use of rental cars has also been increasing; many foreign visitors now use a rental car to explore Iceland. In 2009, 37% of visitors used a rental car, but in 2019, 60% of visitors chose a rental car for their travel within Iceland (Guðmundsson, 2020).

The Research Area

The most visited nature-based destinations in Iceland were selected for analysis in this study to reflect the distribution of the tourist flow in Iceland. The sites are located in the so-called Golden Circle, along the Ring Road around Iceland, on Reykjanes Peninsula in the southwest, on Snæfellsnes Peninsula in the west, and in the Westfjords in the northwest (Figure 2). All of these sites have protected area status in one form or another (Reykjanes Geopark, n.d.; The Environment Agency of Iceland, n.d.; Vatnajökull National Park, n.d.).

The Golden Circle travel route is a day tour from the capital area along the lowlands east of Reykjavík. The main attraction on this route is the Geysir area with its hot springs, including the erupting hot spring Strokkur. Nearby is Gullfoss, a large and spectacular waterfall located on the river Hvítá. The third main attraction on the Golden Circle route is the UNESCO World Heritage site Þingvellir National Park. This historic site is where the Icelandic parliament was held from the tenth to the eighteenth century. Þingvellir National Park is situated in a rift valley created by the separation of two tectonic plates (Figure 2). The traffic on the popular Golden Circle route is comprised primarily of tourists (Guðmundsson, 2020).

In general, traffic on the Ring Road, in the lowlands, and around 100 km west and east of the capital area, is mostly local traffic. This is not the case further east from Seljalandsfoss to Jökulsárlón, where there are few inhabitants, and the traffic is mostly international visitors (Guðmundsson, 2020). East of Reykjavík on the Ring Road along the South Coast is Katla UNESCO Global Geopark, which was established in 2010 and includes a sequence of nature-based destinations (Figure 2). The westernmost site is the Seljalandsfoss waterfall, about 125 km east of Reykjavík. Further east, 55 km from Seljalandsfoss, is the bird cliff Dyrhólaey. The bird cliff is a rock arch that has been protected by the Icelandic government since 1978 to preserve its natural beauty and birdlife and to provide visitor enjoyment. East of Dyrhólaey is Reynisfjara, a black sand beach with unique rock formations, and the rock formations Reynisdrangar, which rise from the sea. Further east is the village Vík. Skaftafell is 150 km east of Reynisfjara and was established as a national park in 1967; since 2008, it has been a part of Vatnajökull National Park, and a UNESCO World Heritage Site. Skaftafell is considered, by many, to be a natural pearl with an exceptionally scenic landscape and many hiking trails. Further east along

the South Coast, 378 km from Reykjavík, is the glacial lagoon Jökulsárlón, which has been a part of Vatnajökull National Park since 2017. East of Jökulsárlón is the town Höfn. The easternmost site on the South Coast used for this analysis is Vestrahorn, which is around 470 km from Reykjavík (Figure 2). The South Coast is important for the tourism industry in Iceland, as it offers a chain of different nature-based destinations that are popular among tourists (Ólafsson & Thórhallsdóttir, 2018; Thórhallsdóttir, 2023). The Icelandic Road and Coastal Administration (IRCA) has placed vehicle counters along the South Coast that can be used to analyse the traffic in the region. Figure 2 demonstrates the locations of IRCA's counters, from Hvammur in the west to Smyrlabjörg in the east.

Going further anticlockwise along the Ring Road, there are few important destinations until reaching the geothermal area Námaskarð in the northeast. Near Námaskarð are two large waterfalls, Dettifoss, which is in the canyon of the glacial river Jökulsá á Fjöllum, and Goðafoss, which is in the river Skjálfandafljót. Ásbyrgi is a unique natural formation shaped like a horseshoe; it has many hiking trails. Dettifoss and Ásbyrgi are within Vatnajökull National Park. In the northwest, Hvítserkur is a basalt rock stack that rises from the sea and is home to numerous seabirds and seals (Figure 2).

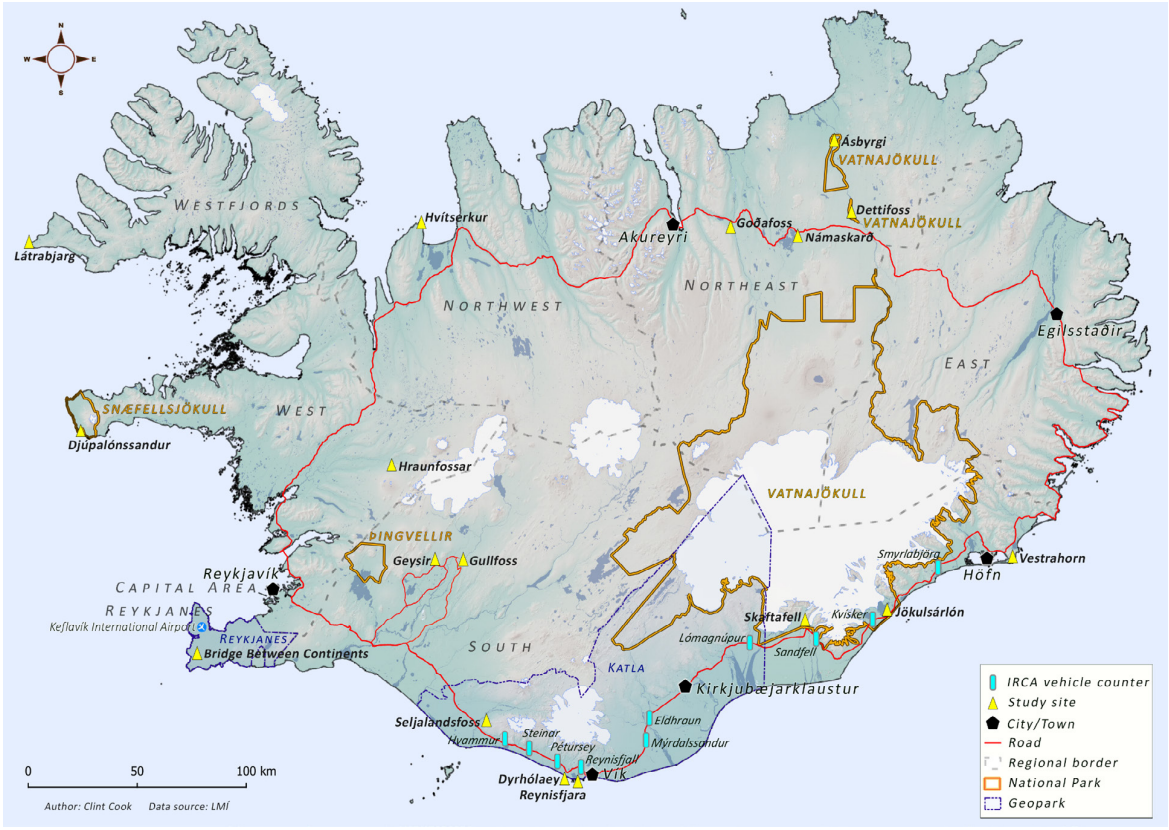

Figure 2 *Map of Iceland with the locations of the 18 nature-based destinations and IRCA's vehicle counters.*

In northwest Iceland are the Westfjords, which contain the bird cliff Látrabjarg, the largest of its kind in both Iceland and Europe. North of the capital area is Borgarfjörður, where the main attraction is Hraunfossar, a series of waterfalls formed by rivulets streaming out of the Hallmundarhraun lava field. West of Borgarfjörður is Snæfellsnes Peninsula, with which has interesting geological formations. The main attraction is Djúpalónssandur, a black sand beach located in Snæfellsjökull National Park. On Reykjanes Peninsula is Reykjanes Geopark, which has been a UNESCO Global Geopark since 2015. In Reykjanes Geopark is a small footbridge over a large fissure, called the Bridge Between Continents. It provides clear evidence of the presence of diverging tectonic plates (Figure 2).

Methods

Number of Visitors Departing Keflavík International Airport

To determine the number of visitors to Iceland, the number of visitors departing from Keflavík International Airport (Figure 2) is used in this analysis. The Icelandic airport service Isavia manually counts departing passengers as they enter airport security. All passengers who pass the security check are included in these numbers. They also include a small number who are not considered tourists, such as connecting passengers, those who did not spend any time in Iceland, and foreign citizens living temporarily in Iceland. The remaining majority, ranging from 86.3% to 92.7%, are considered tourists visiting Iceland for personal or commercial purposes (The Icelandic Tourist Board, n.d.-b). No correction is made for this inclusion in this paper, as the numbers are relatively small and can change over time.

Number of Visitors at Nature-Based Destinations

To analyse the mobility in time and space of international visitors in Iceland, data on the number of visitors at 18 nature-based destinations is used (Figure 2). This data derived from two datasets: vehicle counters at the access roads to the nature-based destinations and a border survey, *Dear Visitor*, conducted at Keflavík International Airport. The data for Geysir and Gullfoss in the south and Goðafoss in the north are derived from the border survey. The number of visitors at these three sites is computed from the replies to the survey and the number of departing visitors at Keflavík International Airport. One of the survey questions is to mark on a map which sites were visited during the travel in Iceland.

The data for the other 15 sites is derived from vehicle counters located at their access roads. They are managed by the first and second author of this paper. In Iceland, most tourist sites have only one access road. Every vehicle that passes a counter on the access road is counted and recorded, independent of the direction of travel and vehicle size. To determine the number of vehicles arriving at a site the count from the counters is divided by two. To obtain the number of visitors from the number of vehicles it is important to be able to detect the size of the vehicles as private cars and buses carry different numbers of occupants. Vehicle size measurement has been done both manually (Thórhallsdóttir & Ólafsson, 2017) and automatically using radar (Thórhallsdóttir et al., 2021). Average occupancy has been estimated from various data (Thórhallsdóttir & Ólafsson, 2015). The number of visitors at a site is computed from the formula:

*Number of visitors = Number of vehicles*The average occupancy of vehicles*

Table 1 indicates when the counting at the 18 nature-based destinations started at all sites and ended at Geysir, Goðafoss, Gullfoss, Hvítserkur, Námaskarð, Reynisfjara, and Seljalandsfoss. Sometimes the counting is interrupted by road construction or there is a malfunction in the equipment. This explains the empty cells in the sub-sections of the Results section.

Table 1. *Years when counting began and ended.*

	Started	Ended
Ásbyrgi	2010	-
Bridge Between Continents	2017	-
Dettifoss	2010	-
Djúpalónssandur	2014	-
Dyrhólaey	2017	-
Geysir	1996	2020
Goðafoss	1996	2020
Gullfoss	1996	2020
Hraunfossar	2014	-
Hvítserkur	2015	2021
Jökulsárlón	2012	-
Látrabjarg	2017	-
Námaskarð	2015	2020
Reynisfjara	2017	2022
Seljalandsfoss	2017	2020
Skaftafell	2009	-
Vestrahorn	2011	-
Þingvellir	2014	-

The Ratio between the Sites and Keflavík International Airport

To evaluate the importance of each site, the number of tourists counted at Keflavik International Airport is compared to the number counted at each site. This calculation is performed for the entire year, as well as separately for the summer and winter seasons:

Percentage of tourists that visit site =
Number of tourists at Site/Number of visitors departing from Keflavík International Airport

In the analysis of the vehicle counter data, it is assumed that everyone arriving at the sites is a foreign visitor, as the number of Icelandic visitors is negligible. This assumption is justified by the fact that the total population of Iceland in 2019 was around 360,000 (Statistics Iceland, 2020), while the number of international visitors to Iceland was almost two million (The Icelandic Tourist Board, 2024). This assumption does not apply to Gullfoss, Geysir, and Goðafoss as the *Dear Visitor* survey is exclusively directed at international visitors. The bias for this assumption is not known and was probably greater during the COVID-19 pandemic in 2020 and 2021 than before and after the pandemic. During the pandemic there were almost only Icelandic residents travelling in Iceland. Icelanders travel mostly in the summer, and they hardly travel at all during the colder winter months (Bjarnadóttir, 2008; The Icelandic Tourist Board, 2023).

Number of Vehicles on the Icelandic Highway System

Vehicle counters operated along the highway system in Iceland by IRCA. They are inductive loop counters that count the number of vehicles passing per day. The primary purpose of IRCA's counters is to monitor traffic for maintenance and security purposes. This study analyses tourist traffic on a section of the Ring Road along the South Coast from Hvammur in the west to Smyrlabjörg in

the east (see locations in Figure 2) using data from IRCA's vehicle counters. Along this stretch of road, the local population is sparse and there are few side roads; the many tourist sites and the tourist traffic thus constitute a significant proportion of the overall traffic. Around 78% of the traffic passing IRCA's vehicle counter at Lómagnúpur is tourists in rental cars (Guðmundsson, 2020). West of the Hvammur counter, traffic is more of local origin, as that area is more populated, and there are many side roads leading to the so-called uplands of the south. It would have been interesting to analyse the traffic at the whole Ring Road from IRCA's counters, but it was considered unreliable because the origin of the traffic is unclear and there are quite many side roads from the Ring Road outside of the south region. Along the South Coast there are two villages, Vík and Kirkjubæjarklaustur. The inhabitants of Vík and Kirkjubæjarklaustur (Figure 2) are likely to influence the numbers by driving in the region, and this addition has not been analysed. East of Jökulsárlón and the Smyrlabjörg counter, the traffic is also more local (Figure 2).

Seasonality Measures

This paper addresses seasonality in two ways:

- By computing the percentage of guests visiting the nature-based destinations during the summer and winter compared with the entire year.
- By computing the Gini coefficient at each site from monthly data.

In this analysis, the year is divided into two equal parts: summer and winter. Summer is comprised of the months May, June, July, August, September, and October, while winter includes January, February, March, April, November, and December. This division is made from a previous analysis of visitor numbers at nature-based destinations in southern and western Iceland. Previous analysis indicates that the summer traffic peaks in July and August but extends into the shoulder seasons at both ends (Thórhallsdóttir & Ólafsson, 2017). For this study, it was considered adequate to divide the year into these two seasons. For a more detailed analysis, the year could be divided into four seasons or even into intervals of months or weeks.

The Gini coefficient is the tool most often utilised to analyse seasonality (Duro, 2016). In this work, it serves as a numerical measure of the degree of inequality in visitation numbers to a site throughout the year. It is derived from the Lorenz curve that displays the cumulative frequency of ranked observations, starting with the lowest number. The Gini coefficient takes values from zero to one. The closer it is to zero, the less seasonality there is, and the closer it is to one, the greater the seasonality (Thórhallsdóttir & Ólafsson, 2017).

Results

Visitors departing Keflavík International Airport

There was a steady increase in the number of visitors to Iceland from 2015 to 2019. During this time, seasonality also decreased. Then in March 2020, COVID-19 hit Iceland, resulting in a decrease in visitor numbers and an increase in seasonality. In 2022, international tourism to Iceland began to recover from the pandemic and seasonality decreased (Table 2 and Table 3).

Table 2. *Number of departing passengers (in thousands) at Keflavík International Airport.*

Keflavík	2015	2016	2017	2018	2019	2020	2021	2022	2023
Summer	821	1.122	1.310	1.400	1.151	133	530	1.097	1.375
Winter	441	645	886	916	835	349	158	600	849
Total	1.262	1.767	2.196	2.316	1.986	482	688	1.697	2.224

Table 3. *Seasonality in departing visitors at Keflavík International Airport.*

Keflavík	2015	2016	2017	2018	2019	2020	2021	2022	2023
Summer	65%	63%	60%	60%	58%	28%	77%	65%	62%
Winter	35%	37%	40%	40%	42%	72%	23%	35%	38%
Gini	0.21	0.19	0.14	0.14	0.14	0.61	0.49	0.22	0.16

The Golden Circle

In this section, the data from Geysir, Gullfoss, and Þingvellir National Park is presented. In 2015, the visitor numbers at Þingvellir National Park were lower than at Geysir and Gullfoss, but between 2016 and 2019 the visitor numbers were similar. The annual visitor numbers at Þingvellir National Park began to recover after COVID-19 in 2022 and then reached the visitor numbers of 2016 (Table 4). Seasonality decreased at these sites from 2015 to 2019 and began to recover after the pandemic in 2022 (Table 5). Apart from the COVID-19 period, around two thirds of all departing visitors travelled to Geysir, Gullfoss, and Þingvellir National Park during their stay, independent of the season (Table 6).

Table 4. *Number of visitors (in thousands) at the nature-based destinations in the Golden Circle.*

		2015	2016	2017	2018	2019	2020	2021	2022
Geysir	Summer	579	795	885	957	831	-	-	-
	Winter	306	409	550	555	530	-	-	-
	Total	885	1.204	1.435	1.512	1.361	-	-	-
Gullfoss	Summer	572	785	869	943	822	-	-	-
	Winter	299	403	537	544	518	-	-	-
	Total	871	1.188	1.406	1.487	1.340	-	-	-
Þingvellir National Park	Summer	487	783	933	873	836	97	268	853
	Winter	209	391	593	541	500	204	69	346
	Total	696	1.174	1.526	1.414	1.336	301	337	1.199

Table 5. *Seasonality at the nature-based destinations in the Golden Circle.*

		2015	2016	2017	2018	2019	2020	2021	2022
Geysir	Summer	65%	66%	62%	63%	61%	-	-	-
	Winter	35%	34%	38%	37%	39%	-	-	-
	Gini	0.22	0.22	0.18	0.17	0.17	-	-	-
Gullfoss	Summer	66%	66%	62%	63%	61%	-	-	-
	Winter	34%	34%	38%	37%	39%	-	-	-
	Gini	0.22	0.22	0.18	0.18	0.17	-	-	-
Þingvellir National Park	Summer	70%	67%	61%	62%	63%	32%	79%	71%
	Winter	30%	33%	39%	38%	37%	68%	21%	29%
	Gini	0.26	0.22	0.15	0.17	0.18	0.52	0.45	0.27

Table 6. *The ratio between tourist numbers at the nature-based destinations in the Golden Circle and the number of departing passengers at Keflavík International Airport.*

		2015	2016	2017	2018	2019	2020	2021	2022
Geysir	Summer	71%	71%	68%	68%	72%	-	-	-
	Winter	69%	63%	62%	61%	63%	-	-	-
	Total	70%	68%	65%	65%	69%	-	-	-
Gullfoss	Summer	70%	70%	66%	67%	71%	-	-	-
	Winter	68%	62%	61%	59%	62%	-	-	-
	Total	69%	67%	64%	64%	67%	-	-	-
Þingvellir National Park	Summer	59%	70%	71%	62%	73%	73%	50%	78%
	Winter	47%	61%	67%	59%	60%	58%	44%	58%
	Total	55%	66%	70%	61%	67%	62%	49%	71%

South and Southeast

In this section, data from Seljalandsfoss, Dyrhólaey, Reynisfjara, Skaftafell, Jökulsárlón, and Vestrahorn is presented. In 2018 and 2019, Seljalandsfoss and Jökulsárlón were the most visited of these sites. Vestrahorn was less visited than the other sites, but the visitor numbers demonstrated a significant increase in those years over 2015 (Table 7). In 2018 and 2019, the ratio between seasons was similar at Seljalandsfoss, Reynisfjara, and Jökulsárlón, with around 65% of their visitors arriving in the summer; in 2019. Seasonality increased during the pandemic but decreased again in 2022 (Table 8). Apart from the COVID-19 period, around 40% of all departing visitors travelled to Jökulsárlón during their stay. In 2022, this ratio was 50%. In 2018 and 2019, around 50% of departing visitors travelled to Seljalandsfoss. This ratio was lower at the other sites (Table 9).

Table 7. *Number of visitors (in thousands) at the nature-based destinations on the South Coast travel route.*

		2015	2016	2017	2018	2019	2020	2021	2022
Seljalandsfoss	Summer	-	-	-	823	720	-	-	-
	Winter	-	-	-	392	362	-	-	-
	Total	-	-	-	1.215	1.082	-	-	-
Dyrhólaey	Summer	-	-	-	391	347	86	214	341
	Winter	-	-	-	146	138	58	35	95
	Total	-	-	-	537	485	144	249	436
Reynisfjara	Summer	-	-	-	572	533	164	350	-
	Winter	-	-	-	290	303	130	97	-
	Total	-	-	-	862	836	294	447	-
Skaftafell	Summer	370	498	545	582	505	148	332	461
	Winter	63	123	190	215	189	70	46	128
	Total	433	621	735	797	694	218	378	589
Jökulsárlón	Summer	406	539	595	658	617	206	429	603
	Winter	105	194	288	302	319	132	93	242
	Total	511	733	883	960	936	338	522	845
Vestrahorn	Summer	40	56	68	106	124	48	108	153
	Winter	14	17	26	36	44	24	19	41
	Total	54	73	94	142	168	72	127	194

Table 8. *Seasonality at the nature-based destinations on the South Coast travel route.*

		2015	2016	2017	2018	2019	2020	2021	2022
Seljalandsfoss	Summer	-	-	-	68%	67%	-	-	-
	Winter	-	-	-	32%	33%	-	-	-
	Gini	-	-	-	0.24	0.23	-	-	-
Dyrhólaey	Summer	-	-	-	73%	72%	60%	86%	78%
	Winter	-	-	-	27%	28%	40%	14%	22%
	Gini	-	-	-	0.31	0.31	0.53	0.51	0.36
Reynisfjara	Summer	-	-	-	66%	64%	56%	78%	-
	Winter	-	-	-	34%	36%	44%	22%	-
	Gini	-	-	-	0.22	0.19	0.42	0.41	-
Skaftafell	Summer	85%	80%	74%	73%	73%	68%	88%	78%
	Winter	15%	20%	26%	27%	27%	32%	12%	22%
	Gini	0.47	0.39	0.32	0.31	0.31	0.54	0.53	0.36
Jökulsárlón	Summer	79%	74%	67%	69%	66%	61%	82%	71%
	Winter	21%	26%	33%	31%	34%	39%	18%	29%
	Gini	0.40	0.33	0.25	0.25	0.23	0.49	0.47	0.28
Vestrahorn	Summer	74%	76%	72%	75%	74%	67%	85%	79%
	Winter	26%	24%	28%	25%	26%	33%	15%	21%
	Gini	0.34	0.34	0.30	0.32	0.32	0.38	0.48	0.36

Table 9. *The ratio between tourist numbers at the nature-based destination on the South Coast travel route and the number of departing passengers at Keflavík International Airport.*

		2015	2016	2017	2018	2019	2020	2021	2022
Seljalandsfoss	Summer	-	-	-	59%	63%	-	-	-
	Winter	-	-	-	43%	43%	-	-	-
	Total	-	-	-	52%	54%	-	-	-
Dyrhólaey	Summer	-	-	-	28%	30%	65%	40%	31%
	Winter	-	-	-	16%	17%	17%	22%	16%
	Total	-	-	-	23%	24%	30%	36%	26%
Reynisfjara	Summer	-	-	-	41%	46%	123%	66%	-
	Winter	-	-	-	32%	36%	37%	61%	-
	Total	-	-	-	37%	42%	61%	65%	-
Skaftafell	Summer	45%	44%	42%	42%	44%	111%	63%	42%
	Winter	14%	19%	22%	23%	23%	20%	29%	21%
	Total	34%	35%	34%	34%	35%	45%	55%	35%
Jökulsárlón	Summer	49%	48%	45%	47%	54%	155%	81%	55%
	Winter	24%	30%	33%	33%	38%	38%	59%	40%
	Total	40%	41%	40%	41%	47%	70%	76%	50%
Vestrahorn	Summer	5%	5%	5%	8%	11%	36%	20%	14%
	Winter	3%	3%	3%	4%	5%	7%	12%	7%
	Total	4%	4%	4%	6%	8%	15%	18%	11%

The South Coast Travel Route

In this section, the mobility patterns in 2016, 2019, and 2022 along the South Coast travel route are presented for further clarification, utilising IRCA´s existing network of vehicle counters on the Ring Road. These years were selected to see the development in traffic before and after the pandemic. The location of IRCA's counters compared to the study sites are found in Figure 2. There was a malfunction in IRCA's Mýrdalssandur counter in 2016, therefore there is no data for the summer of 2016 (Figure 3).

In 2016, there was less traffic along the South Coast travel route compared to 2019 and 2022. Within each year the summer traffic between Hvammur and Reynisfjall was relatively stable. The Reynisfjall counter is between Reynisfjara and the village Vík (Figure 2). Independent of year and season, the traffic decreased between the Reynisfjall counter and Mýrdalssandur counters, by around 50%. Within each year, the traffic levels at the Mýrdalssandur and Eldhraun counters were similar (Figure 3 and Figure 4). Independent of year, the traffic decreased further between Eldhraun and Lómagnúpur, around 11% in summer and 15% in winter. There was a decrease between Kvísker and Smyrlabjörg. In 2016, the decrease was 20% in summer and 32% in winter. In 2019 and 2022, the decrease was around 25% in summer and 40% in winter.

It is estimated that around 60% of vehicles driving the highway past the Kvísker counter went to Jökulsárlón, independent of season. That estimation is based on the number of vehicles driving the highway in both directions, as it is not known in which direction vehicles were driving. There is an access road to Jökulsárlón, therefore vehicles to this site pass the counter twice. The data for Jökulsárlón has therefore been divided by two.

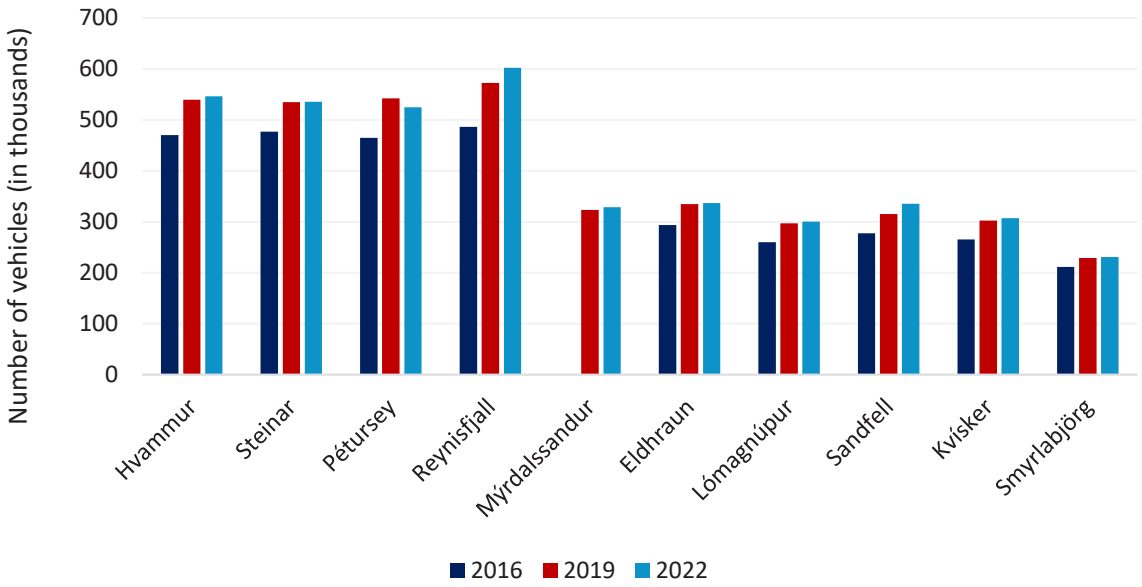

Figure 3. *Number of vehicles along the South Coast travel route in the summers of 2016, 2019, and 2022 (The Icelandic Road and Coastal Administration, 2020).*

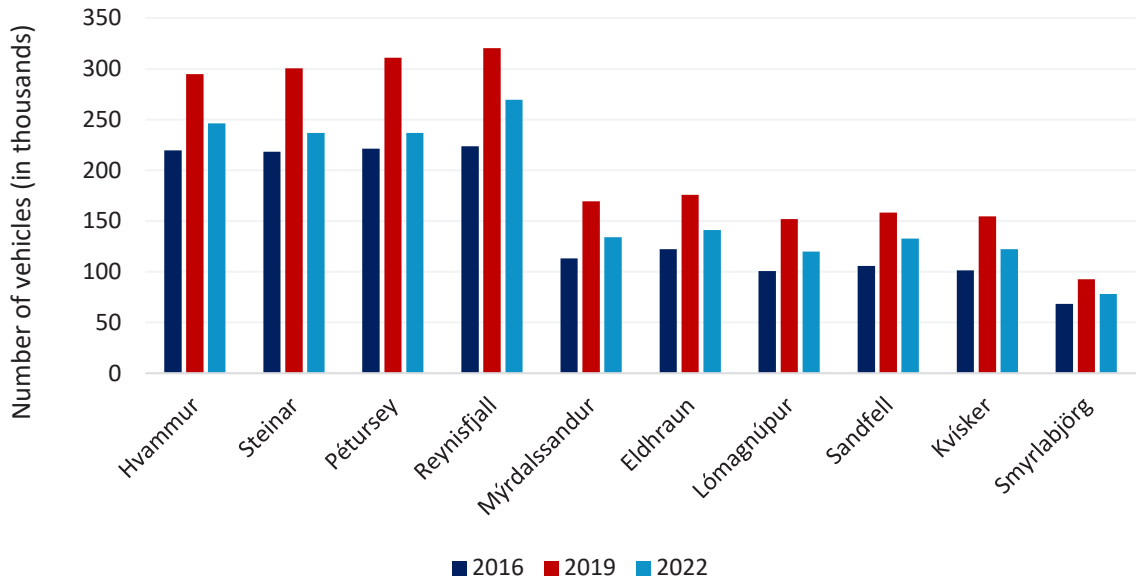

Figure 4. *Number of vehicles along the South Coast travel route in the winters of 2016, 2019, and 2022 (The Icelandic Road and Coastal Administration, 2020).*

North and Northwest

In this section, the data from Hvítserkur, Goðafoss, Námaskarð, Ásbyrgi, and Dettifoss is presented. The COVID-19 effect was very visible at Ásbyrgi and Dettifoss in 2020 and 2021; however, numbers in 2022 increased and were close to the numbers before the pandemic. Námaskarð was the most visited site in the region in 2019, with 467,000 visitors, followed by Goðafoss, with 420,000 visitors, and Dettifoss, with 370,000 visitors. Hvítserkur in the northwest and Ásbyrgi in the northeast had lower visitor numbers (Table 10). Seasonality decreased from 2015 to 2019. In 2019, around 85% of the visitors that went to Námaskarð, Goðafoss, and Hvítserkur went during the summer, and the Gini coefficient at these sites was 0.46. The Gini coefficient at Námaskarð decreased from 0.51 in 2016. In 2019, 93% of visitors to Dettifoss went during the summer. In 2022, seasonality at Ásbyrgi and Dettifoss was lower than before the pandemic (Table 11). Using the data from Keflavík International Airport, it appears that approximately 24% of departing visitors visited Námaskarð in 2019, while 21% visited Goðafoss, mostly during the summer (Table 12).

Table 10. *Number of visitors (in thousands) at the nature-based destinations in the north and northwest.*

		2015	2016	2017	2018	2019	2020	2021	2022
Hvítserkur	Summer	-	79	104	112	123	36	-	-
	Winter	-	3	9	15	20	1	-	-
	Total	-	82	113	127	143	37	-	-
Goðafoss	Summer	219	342	363	377	354	-	-	-
	Winter	27	28	55	67	66	-	-	-
	Total	246	370	418	444	420	-	-	-
Námaskarð	Summer	-	362	421	425	398	-	-	-
	Winter	-	42	66	73	69	-	-	-
	Total	-	404	487	498	467	-	-	-
Ásbyrgi	Summer	-	103	118	108	111	80	105	113
	Winter	-	3	6	6	6	2	3	7
	Total	-	106	124	114	117	82	108	120
Dettifoss	Summer	214	-	368	331	344	107	226	310
	Winter	-	-	47	39	27	2	8	34
	Total	-	-	415	370	371	109	234	344

Table 11. *Seasonality at the nature-based destinations in the north and northwest.*

		2015	2016	2017	2018	2019	2020	2021	2022
Hvítserkur	Summer	-	96%	92%	88%	86%	98%	-	-
	Winter	-	4%	8%	12%	14%	2%	-	-
	Gini	-	0.57	0.53	0.49	0.46	0.72	-	-
Goðafoss	Summer	89%	92%	87%	85%	84%	-	-	-
	Winter	11%	8%	13%	15%	16%	-	-	-
	Gini	0.57	0.53	0.50	0.46	0.46	-	-	-
Námaskarð	Summer	-	90%	87%	85%	85%	-	-	-
	Winter	-	10%	13%	15%	15%	-	-	-
	Gini	-	0.51	0.47	0.46	0.46	-	-	-
Ásbyrgi	Summer	-	97%	95%	95%	95%	98%	97%	94%
	Winter	-	3%	5%	5%	5%	2%	3%	6%
	Gini	-	0.64	0.63	0.61	0.61	0.72	0.66	0.58
Dettifoss	Summer	-	-	89%	89%	93%	98%	97%	90%
	Winter	-	-	11%	11%	7%	2%	3%	10%
	Gini	-	-	0.51	0.53	0.57	0.74	0.63	0.52

Table 12. *The ratio between tourist numbers at the nature-based destinations in the north and northwest and the number of departing passengers at Keflavík International Airport.*

		2015	2016	2017	2018	2019	2020	2021	2022
Hvítserkur	Summer	-	7%	8%	8%	11%	27%	-	-
	Winter	-	0.5%	1%	2%	2%	-	-	-
	Total	-	5%	5%	5%	7%	8%	-	-
Goðafoss	Summer	27%	30%	28%	27%	31%	-	-	-
	Winter	6%	4%	6%	7%	8%	-	-	-
	Total	19%	21%	19%	19%	21%	-	-	-
Námaskarð	Summer	-	32%	32%	30%	35%	-	-	-
	Winter	-	6%	7%	8%	8%	-	-	-
	Total	-	23%	22%	21%	24%	-	-	-
Ásbyrgi	Summer	-	9%	9%	8%	10%	60%	20%	10%
	Winter	-	0.5%	1%	1%	1%	0.5%	2%	1%
	Total	-	6%	6%	5%	6%	17%	16%	7%
Dettifoss	Summer	26%	-	28%	24%	30%	81%	43%	28%
	Winter	-	-	5%	4%	3%	1%	5%	6%
	Total	-	-	19%	16%	19%	23%	34%	20%

Southwest, West and Westfjords

In this section, data from four nature-based destinations in the southwest, west, and Westfjords is presented: the Bridge Between Continents, Hraunfossar, Djúpalónssandur, and Látrabjarg. Table 13 indicates the development of visitor numbers at these four sites. The effect of the pandemic is very clear in 2020 and 2021, but the visitor numbers in 2022 were close to pre-pandemic levels. Seasonality increased during the pandemic but decreased in 2022 (Table 14). Even though the Bridge Between Continents is very close to the main airport, it is not highly visited (Table 15).

Table 13. *Number of visitors (in thousands) at the nature-based destinations in the southwest, west, and Westfjords.*

		2015	2016	2017	2018	2019	2020	2021	2022
Bridge Between Continents	Summer	-	-	124	126	116	37	75	127
	Winter	-	-	52	56	49	26	18	42
	Total	-	-	176	182	165	63	93	169
Djúpalónssandur	Summer	84	113	140	154	166	49	106	160
	Winter	9	20	34	37	43	15	11	28
	Total	93	133	174	191	209	64	117	188
Hraunfossar	Summer	136	186	224	201	196	74	109	160
	Winter	17	37	57	56	55	23	20	39
	Total	153	223	281	257	251	97	129	199
Látrabjarg	Summer	-	-	-	61	61	33	46	56
	Winter	-	-	-	3	3	1	1	1
	Total	-	-	-	64	64	34	47	57

Table 14. *Seasonality at the nature-based destinations in the southwest, west, and Westfjords.*

		2015	2016	2017	2018	2019	2020	2021	2022
Bridge Between Continents	Summer	-	-	70%	69%	70%	59%	81%	75%
	Winter	-	-	30%	31%	30%	41%	19%	25%
	Gini	-	-	0.29	0.26	0.28	0.41	0.44	0.32
Djúpalónssandur	Summer	90%	85%	80%	80%	79%	77%	90%	85%
	Winter	10%	15%	20%	20%	21%	23%	10%	15%
	Gini	0.55	0.47	0.41	0.40	0.40	0.55	0.54	0.45
Hraunfossar	Summer	89%	83%	80%	78%	78%	76%	85%	81%
	Winter	11%	17%	20%	22%	22%	24%	15%	19%
	Gini	0.53	0.45	0.40	0.38	0.38	0.48	0.47	0.39
Látrabjarg	Summer	-	-	-	96%	96%	97%	98%	97%
	Winter	-	-	-	4%	4%	3%	2%	3%
	Gini	-	-	-	0.62	0.64	0.73	0.66	0.64

Table 15. *The ratio between tourist numbers at the nature-based destinations in the southwest, west, and Westfjords and the number of departing passengers at Keflavík International Airport.*

		2015	2016	2017	2018	2019	2020	2021	2022
Bridge Between Continents	Summer	-	-	10%	9%	10%	28%	14%	12%
	Winter	-	-	6%	6%	6%	7%	11%	7%
	Total	-	-	8%	8%	8%	13%	14%	10%
Djúpalónssandur	Summer	10%	10%	11%	11%	14%	37%	20%	15%
	Winter	2%	3%	4%	4%	5%	4%	7%	5%
	Total	5%	7%	8%	8%	11%	13%	17%	11%
Hraunfossar	Summer	17%	17%	17%	14%	17%	55%	21%	15%
	Winter	4%	6%	6%	6%	7%	7%	12%	6%
	Total	12%	13%	13%	11%	13%	20%	19%	12%
Látrabjarg	Summer	-	-	-	5%	5%	25%	9%	5%
	Winter	-	-	-	0.2%	0.2%	0.2%	1%	0.2%
	Total	-	-	-	3%	3%	7%	7%	3%

Discussion

Mobility in Time and Space to Visit Unique Attractions

The analysis of the mobility patterns of international visitors in Iceland in this study has both theoretical and practical value. Time geography has been used to observe the connections between space, time, and mobility (Zillinger, 2007). This study reveals the connection between space, time, and mobility as manifested in seasonality at various sites in Iceland. Visitors have limited time during their holidays, which determines how far they can travel. During the summer, when visitors have more time to travel, they stay longer in the country and explore regions further away from Keflavík International Airport, the main gateway to Iceland. This study therefore illustrates how spatial mobility is dependent on time. The study also underscores how the uniqueness of attractions can override the barrier that distance creates for visitation. Furthermore, the study reveals the importance of access to regions and sites and of an efficient transportation system as tourists will go elsewhere if the transportation system is inconvenient (Qian Pei et al., 2022).

Jökulsárlón is a unique site with good access and efficient transportation system that is highly visited throughout the year although it is situated 380 km from Keflavík International Airport. It is considered a must-see site that international tourists should visit, independent of time. This situation relates to the distance decay concept, as unique attractions are more likely to overcome the distance decay factor. Goðafoss, Námaskarð, Dettifoss, and Ásbyrgi are further from the main gate-

way, around 550 km away; however, these nature-based destinations have higher visitor numbers than the nature-based destinations in the west, Hraunfossar and Djúpalónssandur, and the Bridge Between Continents, which are much closer to the Keflavík International Airport. This indicates that greater distance is not the main reason for fewer visitors; the explanation also lies in the attraction itself and its location. As a black sand beach, Djúpalónssandur is a similar site to Reynisfjara on the South coast. Goðafoss and Dettifoss in the north are spectacular waterfalls, not unlike Gullfoss in the vicinity of the capital area. Both Námaskarð and Geysir are geothermal areas. What benefits Reynisfjara compared to Djúpalónssandur is its location on the South Coast travel route. The same can be said of Gullfoss and Geysir. Geographical location is important, and if multiple destinations provide similar experiences, the ones closest to the starting point are likely to be the most visited (Hooper, 2015). Along the South Coast is a chain of nature-based destinations, that benefits from being between the capital area and Jökulsárlón. The nature-based destinations in the other regions may suffer from having too extended "boring bits" in between as Koster and Carson (2019) describe the rural areas that lie in between major metropolitan core or unique natural attractions. In these areas, tourism has not become an important industry of employment, they may be considered drive through areas, the infrastructure is weak and there is a more explicit seasonality (Carson et al., 2020).

It is interesting to analyse the tourism mobility in Iceland during the years 2020 and 2021, when there was hardly any international tourism due to the COVID-19 pandemic. The pandemic hit Iceland in February/March 2020, and in April, the country was closed for tourists (Figure 1). However, this did not change the mobility pattern in Iceland. The results indicate that residents in Iceland visited the same sites as international visitors did before the pandemic. Before the summer of 2020, the Icelandic authorities gave all residents in Iceland older than 18 a travel gift in the amount of five thousand ISK. This was done to influence Icelanders to travel domestically that summer. This gift was then repeated in 2021. During the summer of 2020, Jökulsárlón was the most visited site, second most visited site was Reynisfjara and third, Skaftafell, all of which are nature-based destinations along the South Coast travel route. During the winter of 2020, Jökulsárlón was slightly more visited than Reynisfjara, and next came Þingvellir National Park, which is quite popular among domestic travellers in the capital area as a day trip. Most Icelanders live in the capital area: in 2019, 64% of the nation lived there. The results from 2021 were quite similar to the 2020 results. These results indicate the importance of an attraction itself if a site is to attract visitors. Distance appears to be less relevant.

Unfortunately, the ratio between international and domestic visitors at the sites is not known. It has been stated that the number of inhabitants in Iceland is outnumbered by international visitors. The bias is considered to be greater during the summer than winter, as Icelanders mostly travel domestically during the summer. This bias is also more apparent at some sites compared to others. Therefore, when the number of departures from Keflavík International Airport was compared to a given individual site, it was decided to assume that all visitors were foreign. The bias is therefore not known, but it was clearly much greater during the pandemic period than before or after. The ratio between Icelandic residence and international visitors is something that needs to be considered for future research.

Sustainable Tourism Planning and Management in Iceland

The practical implications of this study are significant for sustainable tourism planning and management in Iceland. The findings provide valuable information for determining the necessary services and infrastructure at nature-based destinations. Additionally, the results provide valuable information on regional seasonality. All of this, including data on number of visitors, is important when planning and managing for sustainable tourism (Lew & McKercher, 2006). Moreover, the findings

of this study can be valuable for tourism management beyond Iceland, particularly in the Arctic regions, where nature and nature-based attractions dominate, and there is high seasonality and uneven regional distribution of visitors and revenues.

This study indicates that both the spatial distribution and seasonality of tourism in Iceland work against the sustainability goals of the government. Official policy has for years been to distribute and diversify the tourist flow to protect nature and ensure a positive experience for both locals and international visitors (The Ministry of Industries and Innovation, 2015). As far as seasonality is concerned, however, this policy has not been successful. The number of attractions in the south and their uniqueness, as well as their relative proximity to the main gateway, mean that it will be a challenge to aim for a more equal distribution of tourist flow throughout Iceland, particularly during the winter season when the main road may close and the access roads to the sites may be closed for snow and ice. This high regional seasonality is also seen elsewhere in the Nordic countries, especially in the Arctic regions (Lundmark & Carson, 2020).

The results demonstrate that Keflavík International Airport plays a significant role in shaping the spatial distribution of tourism in Iceland. Altering this pattern would require strengthening other gateways, such as Akureyri in the north and Egilsstaðir in the east. While strengthening these airports might have some effect, the question arises as to whether the attraction of the sites in the north and east is strong enough to bring substantial numbers of visitors, even with reduced distances. It is important to recognize the attraction of the nature sites in the south and the proximity of Reykjavík, the only city in Iceland, with its diverse cultural and social attractions and services. According to Carson et al. (2020), urban areas are often perceived as offering better value for money and more choices. This is also seen in the Arctic regions (Müller et al., 2020), where visitors tend to stay in the urban centres and take day-tours to nature-based destinations from there (Carson et al., 2020). Therefore, it is important to analyse tourism mobility patterns in the Arctic regions from nature-based destinations, not overnight stays (Runge et al., 2020). Several attempts have been made to begin international flights from Akureyri Airport in the north of Iceland, and all have failed. This indicates that for such flights to be commercially successful, more is needed than the local market. In October 2023, Easy Jet began to fly to Akureyri Airport from London Gatwick Airport, with flights that are scheduled until March 2024 (Daðason, 2023). It remains debatable whether the nature sites that are the attractions in the north are strong or unique enough to counterbalance other factors. However, well-established international airline sees an opportunity to schedule flights to the north of Iceland indicates that further bolstering of attractions in the region is likely to take place, and that may change the dynamics of tourist mobility to some degree. Developing other sites would require significant investment in infrastructure and services. Therefore, it is worth considering whether distributing the visitor flow should remain a core agenda in Icelandic tourism management.

Conclusions

This study analysed the mobility patterns of international visitors in Iceland based on visitor numbers at nature-based destinations. The results provide valuable information on tourism flow in time and space in Iceland. Awareness of these factors is important when planning and managing sustainable tourism and evaluating the effectiveness of existing policies. This paper focuses on the temporal and spatial mobility of international visitors starting and ending their travel at Keflavík International Airport. Within the limited timeframe they have during summer or winter, these visitors typically set out to visit numerous nature sites that are predominantly located in the rural south and along the South Coast before returning to the airport to catch a flight home. It would have been interesting to further analyse the South Coast travel route, but it was not possible with this dataset. However, in light of how important that travel route is to the tourism industry, further research should be done on this stretch of the highway.

The first research question asks about the actions that Icelandic tourism authorities have taken to reduce regional seasonality. Apart from the pandemic years, Icelandic tourism authorities have succeeded in reducing seasonality in the country. There are policies for reducing regional seasonality and making tourism more sustainable economically, socially, and for the environment. Sustainability has been an aim of the Icelandic tourism authorities for decades but has not been successful outside of the most popular areas. So far, it appears that post-COVID-19 tourism mobility is following similar patterns to before the pandemic.

The second research question asks about the method of using visitor numbers at nature-based destinations to plan and manage sustainable tourism in Iceland. In a country such as Iceland, where the main attraction is nature and therefore nature-based destinations that are distributed around the island, this method provides a good indication of tourism mobility patterns. By analysing the mobility patterns for these attractions, where people travel can be determined. In Iceland, this form of analysis is more reliable than overnight stay data, as overnight stay data only provides an indication of where visitors stay overnight, not where they visit during the day. It is known that Reykjavík is the most visited site in Iceland and serves as a basecamp for nature-based destinations, but the overnight data cannot inform us about which actual sites these guests visit during the daytime. This is an important consideration for nature protection as many day-time visits take place in protected areas. The day-visitors set pressure on the nature-based destination that is important to monitor directly for the protection and the management of these sites.

The data and analysis in this paper are expected to be useful for the Icelandic government in managing tourism in Iceland and planning its future. The study indicates that for international visitors in Iceland, the attraction of a site is more important than its distance from their starting point. What exactly influences the attractiveness of individual sites for tourists needs to be further researched in more depth than has thus far been the case.

References

Beeco, J. A., Huang, W.-J., Hallo, J. C., Norman, W. C., McGehee, N. G., McGee, J., & Goetcheus, C. (2013). GPS Tracking of Travel Routes of Wanderers and Planners. *Tourism Geographies*, *15*(3), 551-573. https://doi.org/10.1080/14616688.2012.726267

Bjarnadóttir, E. J. (2008). Ferðahegðun Íslendinga yfir vetrartímann með áherslu á Norðurland. In I. Hannibalsson (Ed.), *Rannsóknir í félagsvísindum IX* (pp. 115-126). Háskólaútgáfan. https://tinyurl.com/5n8j3hmz

Carson, D. A., Åberg, K. G., & Prideux, B. (2020). Cities of the North: Gateways, Competitors or Regional Markets for Hinterland Tourism Destinations? In L. Lundmark, D. B. Carson, & M. Eimermann (Eds.), *Dipping in to the North - Living, Working and Traveling in Sparsely Populated Areas* (pp. 285-310). Palgrave Macmillan.

Cohen, S. A., Prayag, G., & Moital, M. (2014). Consumer behaviour in tourism: Concepts, influences and opportunities. *Current Issues in Tourism*, *17*(10), 872-909. https://doi.org/10.1080/13683500.2013.850064

Daðason, K. T. (2023). EasyJet flýgur frá Akureyri til London í vetur. *Vísir*. https://tinyurl.com/zwcvv3bn

De Cantis, S., Parroco, A. M., Ferrante, M., & Vaccina, F. (2015). Unobserved tourism. *Annals of Tourism Research*, *50*(0), 1-18. https://doi.org/http://dx.doi.org/10.1016/j.annals.2014.10.002

Dickinson, J., Filimonau, V., Cherrett, T., Davies, N., Norgate, S., Speed, C., & Winstanley, C. (2013). Understanding temporal rhythms and travel behaviour at destinations: potential ways to achieve more sustainable travel. *Journal of Sustainable Tourism*, *21*(7), 1070-1090. https://doi.org/10.1080/09669582.2013.802328

Duro, J. A. (2016). Seasonality of hotel demand in the main Spanish provinces: Measurements and decomposition exercises. *Tourism Management*, *52*(C), 52-63. https://doi.org/http://dx.doi.org/10.1016/j.tourman.2015.06.013

Grinberger, A. Y., Shoval, N., & McKercher, B. (2014). Typologies of tourists' time–space consumption: a new approach using GPS data and GIS tools. *Tourism Geographies*, *16*(1), 105-123. https://doi.org/10.1080/14616688.2013.869249

Guðmundsson, R. (2020). *Akstur erlendra ferðamanna á 13 stöðum 2010-2019 - Hringvegurinn og öryggismál*. Tourism Research and Consulting (TRC).

Gössling, S., & Stavrinidi, I. (2015). Social Networking, Mobilities, and the Rise of Liquid Identities. *Mobilities*, *11*(5), 723-743. https://doi.org/10.1080/17450101.2015.1034453

Hägerstrand, T. (1970). What about people in regional science? *Papers in Regional Science*, *24*(1), 7-24. https://doi.org/10.1111/j.1435-5597.1970.tb01464.x

Hall, C. M. (2005). Time, Space, Tourism and Social Physics. *Tourism Recreation Research*, *30*(1), 93-98. https://doi.org/10.1080/02508281.2005.11081236

Hall, C. M. (2012). Spatial analysis: A critical tool for tourism geographies. In J. Wilson (Ed.), *The Routledge handbook of tourism geographies* (pp. 163-173). Routledge.

Hooper, J. (2015). A destination too far? Modelling destination accessibility and distance decay in tourism. *GeoJournal*, *80*(1), 33-46. https://doi.org/10.1007/s10708-014-9536-z

Huijbens, E. H. (2022). The Arctic as the Last Frontier: Tourism. In M. Finger & G. Rekvig (Eds.), *Global Arctic: An Introduction to the Multifaceted Dynamics of the Arctic* (pp. 129-146). Springer.

Huijbens, E. H., & Jóhannesson, G. T. (2020). Urban Tourism. In O. B. Jensen, C. Lassen, V. Kaufmann, M. Freudendal-Petersen, & I. S. G. Lange (Eds.), *Handbook of Urban Mobilities* (pp. 314-324). Routhledge.

IATA. (n.d.). *Air Connectivity - Measuring the connections that drive economic growth*. https://tinyurl.com/5cpftjw2

Jóhannesson, G. T., Huijbens, E. H., & Sharpley, R. (2010). Icelandic tourism: Past directions—future challenges. *Tourism Geographies*, *12*(2), 278 - 301. https://doi.org/10.1080/14616680903493670

Jóhannesson, G. T., & Welling, J. (2020). A Gateway, Basecamp or Independent Destination? Changing Seasonality and Changing Destination Hierarchies in Iceland. In L. Lundmark, D. B. Carson, & M. Eimermann (Eds.), *Dipping in to the North Living, Working and Traveling in Sparsely Populated Areas* (pp. 290-292). Palgrave Macmillan.

Kang, S. (2016). Associations between space–time constraints and spatial patterns of travels. *Annals of Tourism Research*, *61*(Supplement C), 127-141. https://doi.org/https://doi.org/10.1016/j.annals.2016.09.010

Koster, R. L., & Carson, D. A. (2019). Considerations for differentiating among rural tourism geographies. In R. L. Koster & D. A. Carson (Eds.), *Perspectives on rural tourism geographies: Case studies from developed nations on the exotic, the fringe and the boring bits in between* (pp. 253-271). Springer.

Lew, A., & McKercher, B. (2006). Modeling Tourist Movements: A Local Destination Analysis. *Annals of Tourism Research*, *33*(2), 403-423. https://doi.org/https://doi.org/10.1016/j.annals.2005.12.002

Lundmark, L., & Carson, D. A. (2020). Who Travels to the North? Challenges and Opportunities for Tourism. In L. Lundmark, D. B. Carson, & M. Eimermann (Eds.), *Dipping in to the North - Living, Working and Traveling in Sparsely Populated Areas* (pp. 265-284). Palgrave Macmillan.

Lög um landsáætlun um uppbyggingu innviða til verndar náttúru og menningarsögulegum minjum nr. 20/2016.

Maher, P. T., Jóhannesson, G. T., Kvidal-Røvik, T., Müller, D. K., & Rantala, O. (2022). Touring in the Arctic: Shades of grey towards a sustainable future. In D. C. Natcher & T. Koivurova (Eds.), *Renewable Economies in the Arctic* (pp. 82-89). Routledge.

McKercher, B. (2018). The impact of distance on tourism: a tourism geography law. *Tourism Geographies*, *20*(5), 905-909. https://doi.org/10.1080/14616688.2018.1434813

McKercher, B., & Lew, A. A. (2003). Distance Decay and the Impact of Effective Tourism Exclusion Zones on International Travel Flows. *Journal of Travel Research*, *42*(2), 159-165. https://doi.org/10.1177/0047287503254812

Mihalic, T. (2016). Sustainable-responsible tourism discourse – Towards 'responsustable' tourism. *Journal of Cleaner Production*, *111*, 461-470. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.12.062

Mihalic, T., Mohamadi, S., Abbasi, A., & Dávid, L. D. (2021). Mapping a Sustainable and Responsible Tourism Paradigm: A Bibliometric and Citation Network Analysis. *Sustainability*, *13*(2), 1-22. https://doi.org/http://dx.doi.org/10.3390/su13020853

Müller, D., Carson, D., Barre, S., Granås, B., Jóhannesson, G., Øyen, G., Rantala, O., Saarinen, J., Salmela, T., Tervo-Kankare, K., & Welling, J. (2020). *Arctic Tourism in Times of Change: Dimensions of Urban Tourism*. Nordisk Ministerråd. https://doi.org/10.6027/temanord2020-529

Ólafsson, R., & Thórhallsdóttir, G. (2018). *Dreifing ferðamanna um landið - Talningar ferðamanna á áfangastöðum út árið 2017*. Icelandic Tourism Research Center. https://doi.org/https://tinyurl.com/2xbp3jzx

Prideaux, B. (2002). Building Visitor Attractions in Peripheral Areas – Can Uniqueness Overcome Isolation to Produce Viability? *International Journal of Tourism Research*, *4*, 379-389. https://doi.org/10.1002/jtr.387

Qian Pei, Li Wang, Peng Du, & Zhaolan Wang. (2022). Optimization of tourism routes in Lushunkou District based on ArcGIS. *PLOS ONE*, *17*(3), e0264526. https://doi.org/https://doi.org/10.1371/journal.pone.0264526

Rantala, O., Barre, S. d. l., Granås, B., Jóhannesson, G. T., Müller, D. K., Saarinen, J., Tervo-Kankare, K., Maher, P. T., & Niskala, M. (2019). *Arctic Tourism in Times of Change: Seasonality*. Nordisk Ministerråd. https://doi.org/10.6027/TN2019-528

Reykjanes Geopark. (n.d.). *Geosites*. https://reykjanesgeopark.is/is/geosites/

Runge, C. A., Daigle, R. M., & Hausner, V. H. (2020). Quantifying tourism booms and the increasing footprint in the Arctic with social media data. *PLOS ONE*, *15*(1), e0227189. https://doi.org/10.1371/journal.pone.0227189

Scuttari, A., Lucia, M. D., & Martini, U. (2013). Integrated planning for sustainable tourism and mobility. A tourism traffic analysis in Italy's South Tyrol region. *Journal of Sustainable Tourism*, *21*(4), 614-637. https://doi.org/10.1080/09669582.2013.786083

Sharpley, R. (2020). Tourism, sustainable development and the theoretical divide: 20 years on. *Journal of Sustainable Tourism*, *28*(11), 1932-1946. https://doi.org/10.1080/09669582.2020.1779732

Statistics Iceland. (2020). *Population - key figures 1703-2020*. https://shorturl.at/lpSUY

Statistics Iceland. (2022). *Selected items of the exports of goods and services 2013-2022*. https://shorturl.at/duxMO
The Environment Agency of Iceland. (n.d.). *Protected areas*. https://shorturl.at/lrx59
The Icelandic Tourist Board. (2023). *Ferðalög Íslendinga 2022 og ferðaáform þeirra 2023*. The Icelandic Tourist Board. https://rb.gy/6tqrgv
The Icelandic Tourist Board. (2024). *Erlendir gestir um Flugstöð Leifs Eiríkssonar eftir mánuðum 2002 - 2023*. https://rb.gy/f1w5lb
The Icelandic Tourist Board. (n.d.-a). *About Vakinn*. https://rb.gy/tqqg81
The Icelandic Tourist Board. (n.d.-b). *Numbers of foreign visitors*. https://rb.gy/xa1zfz
The Icelandic Tourist Board. (n.d.-c). *The Tourist Site Protection Fund*. https://tinyurl.com/2p9p8x42
The Ministry of Industries and Innovation. (2015). *Road Map for Tourism in Iceland*. The Ministry of Industries and Innovation https://tinyurl.com/ycybsxcs
Thórhallsdóttir, G. (2023). *Fjöldi í Vatnajökulsþjóðgarði 2018 til 2022 - Talningar*. Vatnajökull National Park.
Thórhallsdóttir, G., & Ólafsson, R. (2015). *Fjöldi gesta í Vatnajökulsþjóðgarði*. Vatnajökull National Park.
Thórhallsdóttir, G., & Ólafsson, R. (2017). A method to analyse seasonality in the distribution of tourists in Iceland. *Journal of Outdoor Recreation and Tourism*, *19*, 17-24. https://doi.org/http://dx.doi.org/10.1016/j.jort.2017.05.001
Thórhallsdóttir, G., Ólafsson, R., & Jóhannesson, G. T. (2021). A methodology of estimating visitor numbers at an Icelandic destination using a vehicle counter and a radar. *Journal of Outdoor Recreation and Tourism*, *35*, 100378. https://doi.org/https://doi.org/10.1016/j.jort.2021.100378
Urry, J., & Larsen, J. (2011). Mass Tourism. In *The Tourist gaze 3.0* (Vol. 3, pp. 31-48). Sage Publications.
Vatnajökull National Park. (n.d.). *Visit us*. https://www.vatnajokulsthjodgardur.is/
Yee, T. P., & Ismail, H. N. (2020). A Review of Distance Decay Research Trends in Tourism from 2000-2020. *Environment-Behaviour Proceedings Journal*, *5*(14), 137-145. https://doi.org/https://doi.org/10.21834/ebpj.v5i14.2275
Zillinger, M. (2007). Tourist Routes: A Time-Geographical Approach on German Car-Tourists in Sweden. *Tourism Geographies*, *9*(1), 64-83. https://doi.org/10.1080/14616680601092915