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Floristic inventory of Vigur island: a comprehensive survey using opportunistic and systematic methods

David Pierre Milesi-Gaches[1]

Abstract

This study presents a comprehensive floristic inventory of Vigur Island, building upon previous botanical work through the establishment of a herbarium. A total of 63 species, representing 19 plant families, were documented using a combination of systematic transects and opportunistic surveys during various field activities. The findings underscore the value of flexible fieldwork approaches in maximising species detection while minimising disturbance to sensitive wildlife habitats. The absence of invasive *Lupinus nootkatensis* and the unexpected discovery of certain species highlight the need for ongoing monitoring to assess the dynamics of native and introduced flora.

Keywords: Island flora, floristic inventory, Iceland, coastal vegetation, bird habitat, invasive species

Résumé

Cette étude présente un inventaire floristique complet de l'île de Vigur, s'appuyant sur des travaux botaniques antérieurs, notamment grâce à la création d'un herbier. Au total, 63 espèces appartenant à 19 familles de plantes ont été recensées à l'aide d'une combinaison de transects systématiques et d'inventaires opportunistes lors de diverses activités de terrain. Les résultats soulignent l'intérêt d'approches de terrain flexibles pour maximiser la détection des espèces tout en minimisant les perturbations des habitats fauniques sensibles. L'absence de l'espèce invasive *Lupinus nootkatensis* et la découverte inattendue de certaines espèces mettent en évidence la nécessité d'un suivi continu pour évaluer la dynamique de la flore indigène et introduite.

Mots-clés : Flore d'Islande, Inventaire floristique, Islande, végétation côtière, habitat des oiseaux, espèces invasives.

1. Introduction

Plant communities play a central role in ecosystem dynamics, forming the basis for a wide range of ecological functions. They contribute to habitat formation, support soil integrity, and facilitate nutrient cycling, all of which are essential for maintaining biodiversity and ecosystem resilience (Ayyam *et al.* 2019). In coastal regions, vegetation serves additional roles by mitigating erosion, moderating local microclimates, and offering vital resources such as nesting sites, foraging grounds, and cover for many species (Graells *et al.* 2022).

The interdependence between plant life and bird populations is especially pronounced in the context of avian conservation. The composition and health of plant communities significantly influence the availability of nesting habitats and the abundance of food sources, which are critical for both migratory and ground-nesting birds. A strong correlation exists between vegetation density and species richness, as dense plant cover offers crucial protection from predators and creates favourable breeding conditions (Graells *et al.* 2022). In coastal settings like Vigur Island, preserving native plant species is fundamental to sustaining bird populations and maintaining the ecological balance that underpins these habitats (Ayyam *et al.* 2019; Graells *et al.* 2022).

Located in the fjord Ísafjarðardjúp, Vigur Island (0.6 km^2) stands as a verdant gem in the Westfjords of Iceland (**Fig. 1**). The region lies on Miocene to Lower Pliocene basalt shaped by volcanic and glacial processes (Ellero *et al.* 2023). Its geological structure, combined with strong maritime influence, affects soil properties and vegetation distribution.

The Westfjords experience a subpolar oceanic climate, combining high wind exposure and frequent precipitation with comparatively mild conditions for

1. University of South Bohemia, Czech Republic, Department of Zoology, 420 Súðavík, Iceland: milesi.david@gmail.com

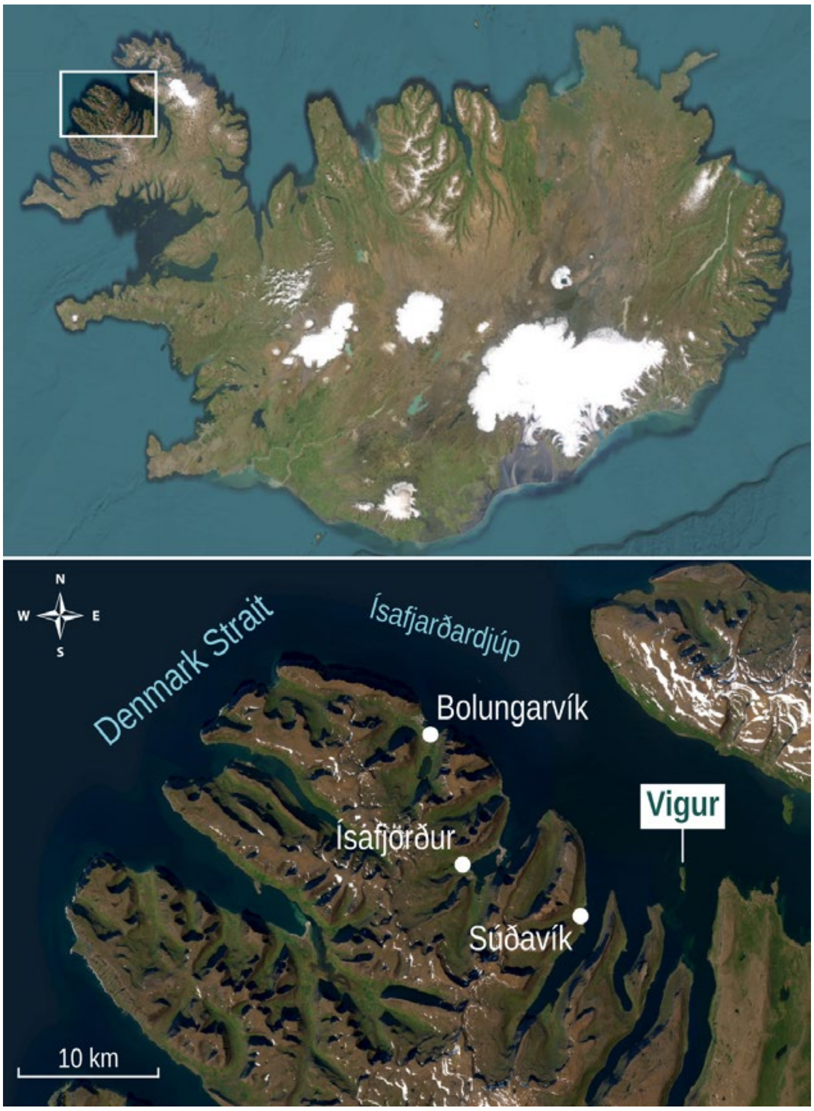

Fig. 1 - Location of Vigur Island, Westfjords, Iceland.

such northern latitudes. In lowland areas below 400 m, average temperatures reported in 2007 ranged between −2 °C and +9 °C, with July typically the warmest month and January the coldest. Over the past few decades, this region has seen a clear warming trend, especially in winter, along with a marked rise in annual precipitation since the early 1990s (Bannan *et al.* 2022).

Iceland's coastal ecosystems reflect the interaction of a cold oceanic climate, basaltic geology, and strong maritime exposure. Plant communities are typically sparse and composed of hardy species adapted to poor soils, wind, and short summers. Seabirds contribute significantly to the functioning of these environments by transporting marine nutrients to land through their nesting activity, which alters soil properties and affects vegetation patterns. These processes support biodiversity and provide ecosystem services, notably in relation to cultural heritage and birdwatching tourism. Locations like Vigur island exemplify these coupled land–sea systems, where ecological dynamics are strongly influenced by seasonal events such as seabird breeding.

Known for almost a millennium, Vigur has witnessed a myriad of changes, from being a bustling sheep and cow farm until the early 2000s to its current status as eiderdown farm and a renowned tourist destination. However, the island's rich botanical diversity remains relatively unexplored. Renowned for its birdlife, Vigur also boasts a diverse array of flora that contributes to its unique ecosystem (Ayyam *et al.* 2019), supporting its famed bird populations (Graells *et al.* 2022), such as the Atlantic Puffin *Fratercula arctica*, Arctic terns *Sterna paradisaea* and the Common Eider *Somateria mollissima* (Hansen 2019 ; Milesi-Gaches & Lhériau 2022).

Vigur's flora is an integral part of its maritime heritage. The island's vegetation not only provides sustenance and shelter to its wildlife but also plays a pivotal role in maintaining the island's ecological balance (Ayyam *et al.* 2019). The longstanding tradition of eiderdown farming, supported by approximately 5,000 breeding pairs (Vigur Island 2021), is intricately linked to the island's flora, which offers nesting grounds and habitats.

With increasing numbers of visitors from around the world and global challenges such as climate change

(Bannan *et al.* 2022), concerns are growing about the potential impacts on the island's sensitive flora. Consequently, it becomes imperative to understand and conserve its botanical treasures, ensuring they thrive amidst human interactions.

In 2022, a volunteers initiated the development of a herbarium (Julia Mast & Sally Herzig, unpublished), providing a preliminary foundation for documenting the island's flora. This current study expands on that initial effort to compile a comprehensive inventory of Vigur Island's plant species. During the 2023 fieldwork, volunteers contributed further by identifying additional species, which were then added to the herbarium. It is important to note that while these herbarium contributions complement the flora inventory, they represent a separate endeavour from the present research.

2. Methods

The floristic inventory utilised three distinct methodologies. The primary data collection occurred during fieldwork conducted by Julia Mast and Sally Herzig between June and August 2022. For this phase, the island was systematically divided into eight plots, each measuring 100 m by 200 m. Within these plots, four sampling coordinates were randomly selected, and a central coordinate was designated as the fifth sampling point, resulting in a total of 40 sampling points across the island. At each coordinate, a 1x1 m quadrat was placed, where two observers recorded the plant species present and estimated the proportional coverage of each species.

In 2023, plant species were also identified opportunistically during various activities, such as eiderdown collection, bird population monitoring, and shoreline clean-up. This was followed by a thorough reassessment of the previous identifications through a tertiary sampling phase in July and August.

The sampling plan was designed with consideration for avian impacts on the habitat. Although my paper on bird influence on habitat classification (Milesi-Gaches 2024) had not yet been published at the time of the fieldwork, the knowledge from that research was already available and informed the delineation of habitats during the flora survey. Likewise, some habitats were divided according to different exposure they present. For example, the middle part of the island being shaped as a hill, the top and both east and west sides of this area were investigated (**Fig. 3**). For this phase, sampling involved three randomly placed quadrats (**Fig. 2**) within each habitat type, as defined in **Fig. 3**, for a total of 42 quadrats. More challenging areas, such as caves and cliffs, were assessed using transects, with three to four team members covering 20-30 m wide sections. Additionally, transitions between habitat types were

Fig. 2 - Example of a quadrat used in each defined habitat.

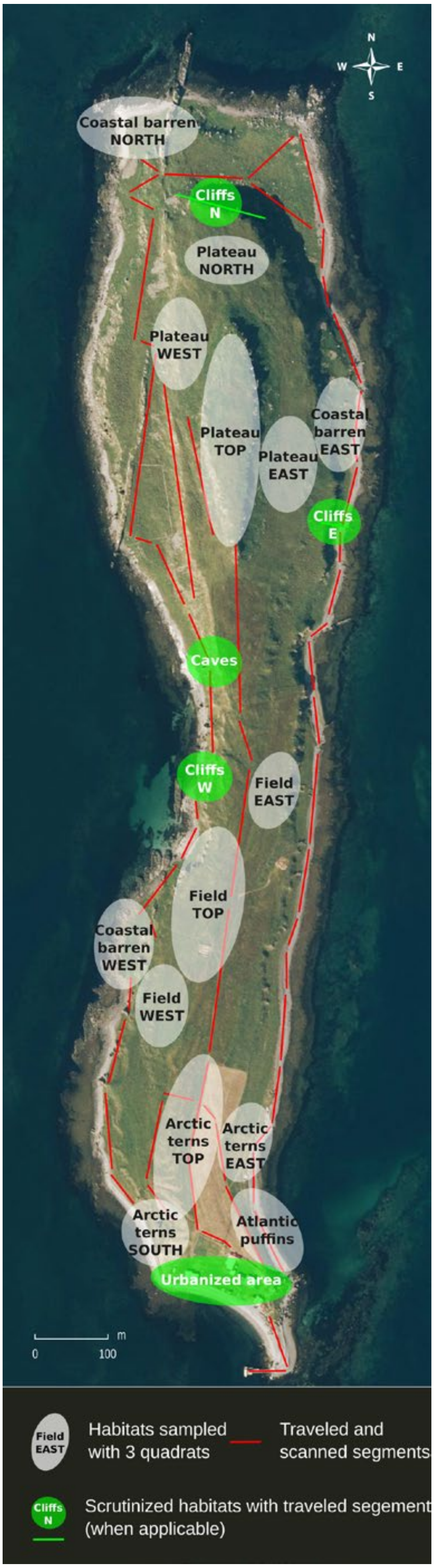

Fig. 3 - Map of Vigur Island showing sampling locations based on habitat classification. The sampling design incorporates areas influenced by significant bird colonies, including Arctic terns and Atlantic puffins.

systematically examined in predetermined segments to identify additional plant species, as illustrated in **Fig. 3**. Plant species identification was primarily guided by the field manual *Flowering Plants and Ferns of Iceland* (Kristinsson 2010). In cases where identification was more difficult, the Flora Incognita mobile application was used as a supplementary resource (Mäder *et al.* 2021). Plant taxa were identified and named following Wąsowicz (2020), whose checklist serves as the current taxonomic reference for vascular plants in Iceland, including author citations and accepted species names.

3. Results

A total of 63 species, distributed across 19 plant families, were identified (**Fig. 4**). The *Poaceae* family was the most prominent, with 15 species recorded on the island, comprising 23.8% of the documented flora. This corresponds to an average density of 1,5 species per hectare across the 41 ha surveyed area.

The 47 plant species included in the herbarium at the start of the inventory were confirmed through various activities conducted on the island, such as eider down collection, bird censuses, and routine maintenance. An additional eight species were recorded exclusively during transects and segments while moving between areas: *Achillea millefolium*, *Aquilegia vulgaris*, *Cochlearia anglica*, *Dianthus hyssopifolius*, *Erigeron borealis*, *Gentianella aurea*, *Honckenya peploides*, and *Solidago virgaurea*. Only one species, *Rheum rhabarbarum*, is cultivated on purpose for the commercial activities on the island and serves as habitat for nesting Black guillemots *Cepphus grylle*. Notably, two species — *Dianthus hyssopifolius* and *Solidago virgaurea*— were unexpected discoveries, both discovered during transecting in the western part of the island (**Fig. 5**).

The three caves, which constituted distinct habitats, revealed the presence of only three species: *Cochlearia officinalis*, *Cystopteris fragilis*, and *Stellaria media* (**Fig. 6**).

4. Discussion

This study aimed to compile a comprehensive inventory of the plant species present on Vigur Island, expanding upon earlier work conducted in 2022 through the establishment of a herbarium (Julia Mast & Sally Herzig, unpublished). The herbarium provides a valuable resource for the long-term conservation and study of local plant species. However, it has limitations, as not all species can be added, particularly those identified based on a single specimen, such as *Dianthus hyssopifolius*.

The floristic survey on Vigur Island recorded 63 vascular plant species over an area of 41 ha, yielding an average of 1.5 species per hectare. While comprehensive benchmarks for plant density in Iceland are lacking, long-term data from Surtsey, a recently formed volcanic island, provide a useful reference. On Surtsey,

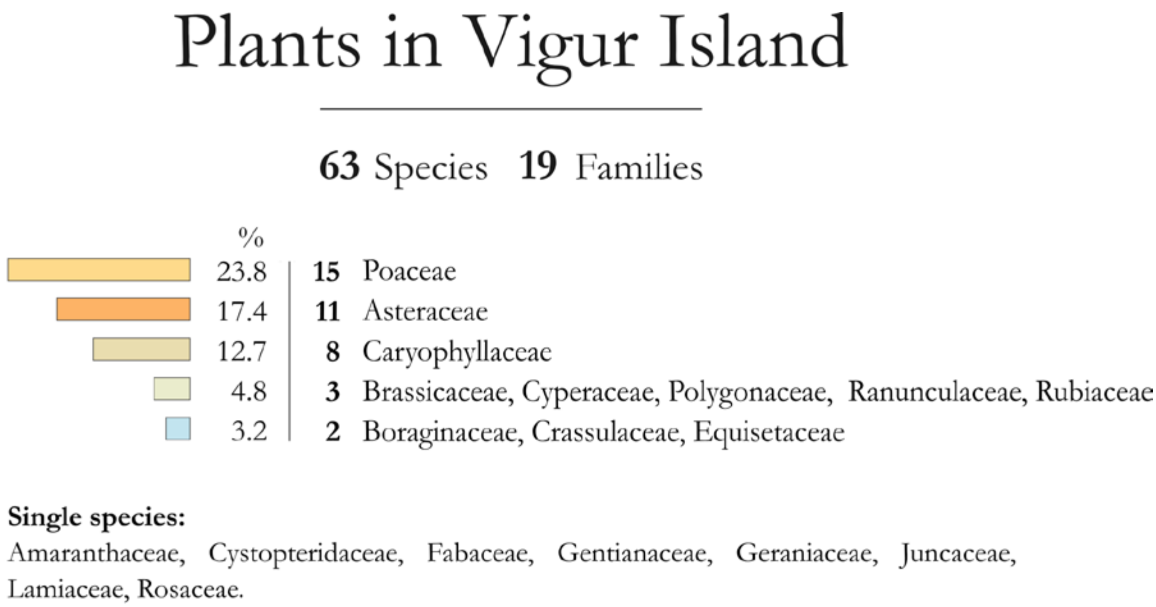

Fig. 4 - Number of species and plant families identified on Vigur Island, along with the percentage contribution of each family to the total inventory.

species richness ranged from 4.8 to 10.4 species per hectare between 1996 and 2015, depending on habitat development and seabird presence (Magnússon *et al.* 2022). The values observed on Vigur are low, suggesting the influence of seabirds on flora remains low in the context of Vigur.

Vigur was selected for its role as seabird nesting areas, and long-term observations from Surtsey have demonstrated that seabird presence can significantly influence plant colonisation through nutrient enrichment. Although such processes were not directly measured in Vigur, it is plausible that a decline in seabird populations could affect soil conditions and, in turn, vascular plant diversity.

The floristic composition recorded on Vigur Island reveals a range of plant communities shaped by topography and maritime exposure. The presence of *Leymus arenarius*, *Honckenya peploides*, and *Cakile maritima* along the coasts indicates pioneer dune and beach communities linked to the *Juncetea maritimi* class. Upland and interior zones, hosting species such as *Thymus praecox*, *Festuca vivipara*, *Alchemilla alpina*, and *Taraxacum spp.*, correspond to mesic grassland and subarctic meadow types, loosely associated with *Elyno-Seslerietea* or *Calluno-Ulicetea*. The identification of *Galium normanii*, *Gentianella aurea*, and *Carex bigelowii* also points to the presence of species-rich transitional habitats. Although precise phytosociological classification would require plot-based analysis, these patterns suggest a heterogeneous but ecologically coherent set of vegetation types shaped by seabird presence, exposure, and soil conditions.

The present inventory highlights the significance of conducting extended fieldwork sessions for effective species identification. While opportunistic identification during other activities, such as eider down collection or bird censuses, should not be considered a primary method, it does offer complementary benefits. Such activities, even though they require researchers' attention on other tasks, still present opportunities to record additional species while moving between fieldwork locations. This approach is especially pertinent on Vigur Island, where any human movement has the potential to disturb wildlife (Milesi-Gaches 2024). Additionally, the use of transects or quadrats is not necessary in all areas. For instance, areas with nesting birds, such as cliffs, can be visually scanned or quickly surveyed, rather than using quadrats. This approach reduces the time spent near sensitive bird habitats while still ensuring accurate and reliable vegetation identification, thereby minimising disturbances to wildlife and aligning with conservation priorities.

The inventory also underscores the island's susceptibility to non-native species, exacerbated by ongoing tourism, human activities, visitors to Vigur throughout its history, and the presence of migratory birds. The detection of two unexpected species, *Dianthus hyssopifolius* and *Solidago virgaurea*, may indicate human-mediated introductions or shifts in species distributions. These findings could serve as a starting point for connecting the island's ecological history with historical human activity. For example, on the newly formed island of Surtsey (1963), studies have estimated the proportion of plants introduced by birds (75%), ocean currents (11%), and airborne dispersal (14%) (Fridriksson 2000). By contrast, Vigur's long history of human activity and natural colonisation suggests that humans have likely played a significant role in species introductions. Therefore, further research into the relative contributions of anthropogenic transport compared to

Fig. 5 - A: *Dianthus hyssopifolius*; **B:** *Solidago virgaurea*. Both species were found on the west coast of Vigur island.

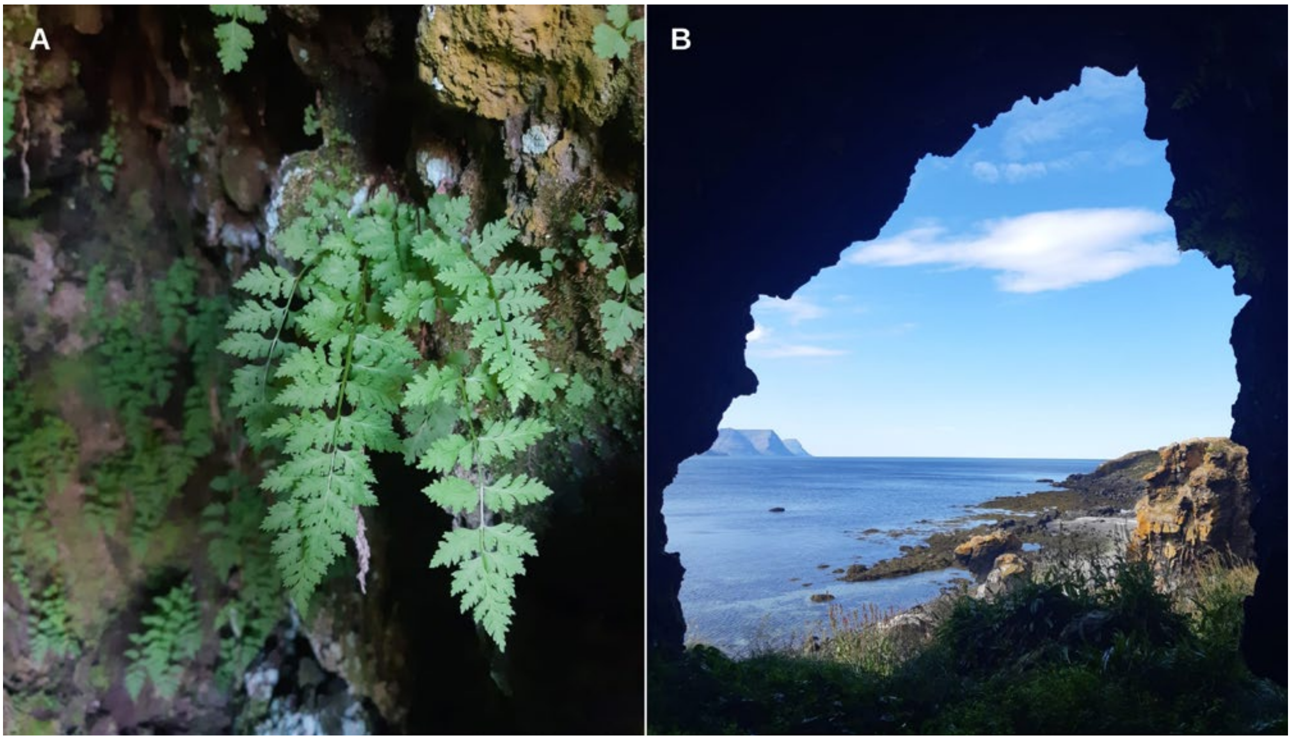

Fig. 6 - A: The brittle bladder-fern (*Cystopteris fragilis*) was found in all caves; **B :** View from inside a cave, with the entrance facing northwest.

natural vectors on Vigur would be particularly valuable.

An important observation from this study is the absence of the Nootka lupine (*Lupinus nootkatensis*). Icelandic ecosystems are particularly sensitive to new species introductions, especially when these species exhibit invasive traits (Arnalds 2015). *Lupinus nootkatensis* has been shown to disrupt the natural succession of native plant communities, complicating ecosystem restoration efforts. Despite numerous eradication initiatives, controlling the spread of this lupine remains challenging (Benediktsson 2015), and its impact on native biodiversity continues to be a significant conservation concern (Arnalds 2015). Consequently, ongoing monitoring of plant species on Vigur Island is essential, not only for documenting biodiversity but also as a preventive measure to detect and manage potential threats to local ecosystems and bird habitats (Jónsson *et al.* 2006).

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List of species

Amaranthaceae (1)
Atriplex sp.

Asteraceae (10)
Centaurea montana
Erigeron borealis
Hieracium alpinum
Hieracium elegantiforme
Hieracium thaectolepium
Scorzoneroides autumnalis
Solidago virgaurea
Taraxacum officinale
Taraxacum spp.
Tripleurospermum maritimum

Boraginaceae (5)
Cakile maritima subsp. Islandia arctica
Cardamine hirsuta
Cardamine pratensis
Mertensia maritima
Myosotis spp.

***Caryophyllaceae** (8)*
Cerastium alpinum
Cerastium fontanum
Cerastium nigrescens
Cochlearia anglica
Cochlearia officinalis
Dianthus hyssopifolius
Honckenya peploides
Stellaria media

***Crassulaceae** (2)*
Rhodiola rosea
Sedum acre

***Cyperaceae** (3)*
Carex atrata
Carex bigelowii
Carex saxatilis

***Cystopteridaceae** (1)*
Cystopteris fragilis

***Equisetaceae** (2)*
Equisetum arvense
Equisetum pratense

***Fabaceae** (1)*
Trifolium repens

***Gentianaceae** (1)*
Gentianella aurea

***Geraniaceae** (1)*
Geranium sylvaticum

***Juncaceae** (1)*
Luzula sudetica

***Lamaceae** (1)*
Thymus praecox subsp. Arcticu

***Poaceae** (15)*
Agrostis capillaris
Agrostis stolonifera
Alchemilla alpina
Alopecurus geniculatus
Alopecurus pratensis
Festuca richardsonii
Festuca rubra
Festuca vivipara
Holcus lanatus
Leymus arenarius
Phleum alpinum
Phleum pratense
Poa alpina
Poa annua
Poa pratensis

***Polygonaceae** (3)*
Bistorta vivipara
Rumex acetosa
Rheum rhabarbarum

***Ranunculaceae** (3)*
Aquilegia vulgaris
Ranunculus acris
Ranunculus repens

***Rosaceae** (1)*
Argentina anserina

***Rubiaceae** (3)*
Galium boreale
Galium normanii
Galium verum

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