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Abstract

This study presents the initial findings of a pilot intertidal inventory conducted on Vigur Island, Iceland. The primary focus was to identify the flora species present in the intertidal zone, without delving into their distribution or coverage. Using transect and scanning methods, this inventory provides insights into the biodiversity of this coastal region. This preliminary assessment lays the groundwork for future comprehensive studies on the island's intertidal biodiversity.

Introduction

The intertidal zone, often described as the transitional boundary between terrestrial and marine environments, plays a pivotal role in coastal ecosystems. This zone is characterized by its unique biotic and abiotic factors, influenced by both marine and terrestrial conditions. The ecological significance of intertidal zones is multifaceted. They serve as habitats for a diverse range of organisms, act as buffers against coastal erosion, and play a role in nutrient cycling and energy flow within coastal ecosystems (Tomanek 2002, Spalding et al. 2014, Lv et al. 2020).

One of the primary ecological functions of the intertidal zone is its role in supporting a rich biodiversity. This biodiversity is not only limited to macro-organisms but also includes a plethora of microeukaryotes, which contribute to the overall functioning and resilience of these ecosystems (Brawley et al. 2017, Kong et al. 2019). However, despite their significance, there is a growing concern about the degradation of these habitats. Principally due to climate change anthropogenic activities, such as the introduction of pollutants as polycyclic aromatic hydrocarbons (PAHs) (He & Silliman 2019). These pollutants can influence the distribution and health of the flora and fauna residing in these zones (Lv et al. 2020). Meanwhile in Iceland, climate change was observed responsible for the diminution of intertidal species richness and diversity towards the north, likely influenced predominantly by temperature variations (Espinosa & Guerra-García 2005). Consequently, the intertidal zone remains vulnerable to various anthropogenic pressures, emphasizing the need for continuous monitoring and research in these areas (Lv et al. 2020). Additionally, the interplay between biotic and abiotic factors in these zones can influence community structures, with factors such as sediment composition and water content playing crucial roles (Kong et al. 2019). Hence, an inventory of the intertidal flora is paramount to understand its status, monitor changes, and implement conservation strategies.

Vigur Island, situated in the Westfjords of Iceland just below the Arctic Circle, stands as a beacon in the North Atlantic. Encircled by the clear waters of Ísafjarðardjúp fjord, the intertidal zone of Vigur Island is a testament to the delicate balance between marine elements and the rugged coastline. The development of nearby fish farms adds another layer to the marine ecosystem, highlighting the coexistence of natural and human-induced elements (Hafskipulag 2023). With its rocky coastline and tidal pools, Vigur serves as an invaluable site for the study of intertidal flora and fauna. As both a sought-after tourist destination and a sanctuary for diverse marine and avian species (Hansen 2019, Milesi-Gaches & Lhériau 2022), Vigur Island encapsulates the essence of Iceland's coastal ecology.

Therefore, understanding the flora of Vigur Island's intertidal zones becomes essential to gauge the health and resilience of its coastal ecosystems. This pilot inventory aims to shed light on the biodiversity of the intertidal flora of the island, providing a foundation for future conservation and management efforts.

Methods

Transect method

To assess the biodiversity of the intertidal zone, four transects were established at random locations (Figure 1), ensuring that each site was safely accessible during low tide. Each transect extended from the land, moving towards the sea. At every 5 m interval along these transects, a quadrat was placed, and the species within it were identified.

It's important to note that the primary objective of this survey was species identification; thus, no data on species coverage or distribution within the quadrats was recorded.

Scanning method

In addition to the transect surveys, a scanning method was employed to further understand the biodiversity of Vigur Island's intertidal zone. Referring to Figure 1, specific sections of the intertidal zone along the coast were selected for scanning. This involved visually inspecting these areas for the presence of various species and subsequently identifying them. Utilising fishing waders enabled a prolonged stay in the water, facilitating the continuation of fieldwork even after the low tide zone became submerged (Figure 2).

The fieldwork was informed and supported by two key reference books, ensuring accurate species identification: Sept **(**2008) and Preston-Mafham (2010). These reference texts were instrumental in guiding the identification process throughout the study.

Figure 1: Schematic representation of Vigur Island's intertidal zone study areas (Basemap: Loftmyndir ehf).

Figure 2: The observer scans around the last quadrat of a transect in the intertidal zone of Vigur Island, Iceland.

Results and Conclusion

In the course of the investigation on Vigur Island's intertidal zone, three distinct areas were scanned, and four transects were established (Figure 1). Across these transects, a total of 28 quadrats were examined. Within this framework, a total of 26 species were identified: 23 during the transect sessions, and three species while scanning. This diverse assemblage encompassed green, brown, and red algae, as well as lichens. Notably, a single moss species was also documented (Table 1).

Despite the primary focus being on the investigation of intertidal flora without an in-depth analysis of species coverage, the transect observations still yielded valuable insights into species abundance and distribution. Common sea lettuce emerged as the most frequently observed species, appearing in 11 quadrats (Table 2). Knotted wrack and flat rockweed were also commonly found, each appearing in 10 quadrats. Bushy red seaweed was noted in nine records, making it another frequent species. For a comprehensive breakdown of all species occurrences, refer to Figure 3, in which the distribution of each species is visually represented.

The ‘scanning’ sessions served as an opportunity to identify recurring species across different locations, as well as species that were not observed within the quadrats. Three species were found through this method: *Urospora bangioides*, *Urospora neglecta*, and *Prasiola* sp. (commonly known as short sea lettuce).

While the current sampling plan may not be sufficiently robust to provide a comprehensive assessment of the entire intertidal zone around Vigur Island, it does reveal variations in species richness based on the specific locations where data were collected (as shown in Figure 3). Transect T3, with only eight species, has the lowest plant diversity. This may be attributed to its location within the bay, near the pier, which serves as the island's sole landing point for boats. This relatively sheltered area is frequented by nesting birds, including the Common Eider *Somateria mollissima*, Black Guillemot *Cepphus grylle*, and Arctic Tern *Sterna paradisaea*, as noted in the study by Milesi-Gaches & Lhériau (2022). The primary activities in this area for these bird species are swimming and feeding.

Transects T2 and T4 are located on the outskirts of the tern colony and are primarily visited by ducks and a few Black Guillemots. These transects are also adjacent to the Atlantic Puffin *Fratercula arctica*

Table 1: Overall inventory of the identified species found on the intertidal zone of Vigur Island, Iceland.

	Species	Common name
Green algae	*Acrosiphonia* sp.	Green rope seaweed
	Blidingia minima	Dwarf green weed
	Prasiola sp.	Short sea lettuce
	Ulva intestinalis	Maiden hair sea lettuce
	Ulva lactuca	Common sea lettuce
	Ulva linza	Flat-tube sea lettuce
	Urospora bangioides	–
	Urospora neglecta	–
Brown algae	*Alaria esculenta*	Winged kelp
	Ascophyllum nodosum	Knotted wrack
	Fucus distichus	Flat rockweed
	Fucus spiralis	Spiral wrack
	Fucus vesiculosus	Northern rockweed
	Himanthalia elongata	Thongweed
	Laminaria digitata	Oarweed
	Leathesia difformis	Sea cauliflower
Red algae	*Corallina officinalis*	Coral weed
	Cystoclonium purpureum	Bushy red seaweed
	Devaleraea ramentacea	Variable tube seaweed
	Hildenbrandia rubra	Red crust alga
	Palmaria palmata	Dulse
	Porphyra umbilicalis	Purple laver
	Vertebrata lanosa	Wrack fringe tubeweed
Lichens	*Physcia caesia*	Blue-gray rosette lichen
	Verrucaria maura	Black seaside lichen
	Xanthoria parietina	Maritime sunburst lichen
Moss	*Cladophora rupestris*	Tufted sea moss

Table 2: Species frequency of species recorded in the intertidal zone of Vigur Island, Iceland.

Species	Common name	Quadrats
Ulva lactuca	Common sea lettuce	11
Ascophyllum nodosum	Knotted wrack	10
Fucus distichus	Flat rockweed	10
Cystoclonium purpureum	Bushy red seaweed	9
Corallina officinalis	Coral weed	6
Fucus vesiculosus	Northern rockweed	6
Hildenbrandia rubra	Red crust alga	5
Blidingia minima	Dwarf green weed	5
Ulva intestinalis	Maiden hair sea lettuce	4
Verrucaria maura	Black seaside lichen	4
Leathesia difformis	Sea cauliflower	4
Elachista spp.	Tufted fringe	3
Acrosiphonia spp.	Green rope seaweed	2
Cladophora rupestris	Tufted sea moss	2
Palmaria palmata	Dulse	2
Porphyra umbilicalis	Purple laver	2
Ulva linza	Flat-tube sea lettuce	2
Aleria esculenta	Windged kelp	1
Devaleraea ramentacea	Variable tube seaweed	1
Physcia caesia	Blue-gray rosette lichen	1
Xanthoria parietina	Maritime sunburst lichen	1
Laminaria digitata	Oarweed	1
Fucus spiralis	Spiral wrack	1

Figure 3: Distribution of the intertidal flora species found through the transect method on Vigur Island, Iceland.

Figure 4: With seven identified species, the quadrat T3-Q6 was the one with the largest species richness in the intertidal zone of Vigur Island, Iceland.

colony. As for Transect T1, the area is frequented by a variety of bird species, including puffins, ducks, seagulls, and Northern Fulmars *Fulmarus glacialis*, who engage in activities such as feeding and swimming.

The island's coastline exhibits notable variation not solely in the distribution of breeding and nesting species. Beyond the evident geographical exposure, distinct tidal pools and bays present varying current characteristics and tidal exposure. This naturally leads to the anticipation of species richness variation throughout the coastline. A mere four transects underscore Vigur's potential to harbour a significant intertidal biodiversity. Such variation is likely extendable to fauna as well. Although not the focal point of this pilot study, several fauna species were identified during fieldwork, including the breadcrumb sponge *Halichondria panicea*, common starfish *Asterias rubens*, blue mussel *Mytilus edulis*, northern rock barnacle *Semibalanus balanoides*, dog whelk *Nucella lapillus*, and small, rough, flat, and smooth periwinkles.

Therefore, I advocate for expanded research within Vigur Island's intertidal zone to include a broader array of factors such as currents, exposure, coastline variations, and the presence of nesting birds. Given the tourism activity and the recent establishment of fish farms in the vicinity (Hafskipulag 2023), it is imperative that decisions pertaining to biodiversity conservation are grounded in rigorous scientific research (Ferðamálastofa 2020). This pilot study has showcased the potential richness of intertidal biodiversity, and proposed a mixed method which could be further developed to monitor the richness and evolution of the identified species.

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