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Coastal roots: the history of seagrass in Northern Ireland

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Research Article

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Abstract

A considerable knowledge gap exists in relation to the presence and even existence of seagrass within Northern Ireland's waters. Peer-reviewed publications on the historical ecology of seagrass are scarce and a collated timeline of references directly focusing on Northern Irish seagrasses does not exist. Recognising abiotic and biotic induced environmental change within key marine features such as seagrass is vital when attempting to measure the biodiversity and carbon sequestration services they provide. The research undertaken during this study identified three distinct periods within the archival records, which could be matched to the ecological history of seagrass in Northern Ireland. The first period (extensive and dense seagrass meadows from 1790 to 1880) was characterised by extensive seagrass meadows which were dense and healthy. The second period (degradation from 1880 to 1940) saw the beginnings of decline in seagrass from the 1790s, initially from anthropogenic influences and later from the seagrass wasting disease) and the final period (signs of recovery from 1940 to present day) showed small amounts of local regrowth of seagrass but at far reduced densities compared to the historical baseline described. These three defined periods all delivered varying degrees of anthropogenic stressors which determined the conservational health of seagrass in Northern Ireland. Seagrass habitats have become integral components in future-proofing the coastal marine environment against the effects of climate change and its associated impacts. Therefore, it is envisaged that the historical baseline that this manuscript provides will greatly benefit habitat managers in protecting, repairing, and restoring lost seagrass meadows.

Highlights

- *Zostera marina* was a once abundant species occurring on Northern Ireland's coasts.
- *Zostera marina* was first used as a resource in Northern Ireland in the early 1800s.
- *Zostera noltei* was first recorded in Northern Ireland, in Dundrum Bay in 1914.
- Seagrass populations have not recovered to the levels observed before the 1930s.
- Due to foreshore development, seagrass is no longer present in Belfast Lough.

Introduction

Seagrasses are marine flowering plants, forming expansive meadows in shallow-subtidal and intertidal coastal zones and spanning a range of six global bioregions from tropical to temperate seas (Short *et al.*, 2007). As ecosystem engineers, seagrasses alter their environment in turn providing a range of ecosystem services, including coastal protection, supporting fisheries, enhancing biodiversity, improving water quality, and nutrient cycling (see overview of benefits in Gamble *et al.*, 2021). Recognised as a vital blue carbon habitat due to their ability to store and sequester significant amounts of CO_2, seagrasses are considered as a nature-based solution through mitigating climate change and providing coastal resilience (Do Amaral Camara Lima *et al.*, 2023; Unsworth *et al.*, 2022a).

Despite their ecological importance, seagrasses are increasingly threatened by a combination of anthropogenic and environmental stressors (Orth *et al.*, 2006; Stockbridge *et al.*, 2020; Waycott *et al.*, 2009). Between 1869 and 2016, around one-third of European seagrass areas were lost, primarily due to factors such as disease, declining water quality, and coastal development (de Los Santos *et al.*, 2019). Overall *Zostera noltei* and *Z. marina* experienced the greatest proportion of area decline in seagrass sites across Europe, however a trend reversal in 2000s showed the recovery of *Zostera* spp. (de Los Santos *et al.*, 2019). In the United Kingdom, it is estimated that, since 1936, 44% of seagrasses have been lost and 39% of that occurred since the 1980s (Green *et al.*, 2021). Understanding the distribution patterns, underlying drivers, and

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magnitude of this decline is imperative for the conservation of the ecosystem services that seagrasses provide (Cullen-Unsworth *et al.*, 2014; Duarte *et al.*, 2008).

In Britain, the 17th and 18th centuries saw significant coastal development activities during industrialisation, such as land reclamation, dredging, and heavy metal pollution in estuarine waters causing environmental degradation (Green *et al.*, 2021). The degradation was further echoed in Northern Ireland during the 19th century (Lloyd Patterson, 1889). The situation for seagrass worsened across the UK with losses further exacerbated during the 1930s with the emergence of the seagrass wasting disease *Labyrinthula zosterae* (Lynn, 1936). As coastal populations, human activities on the coast, and land development continue to grow, existing threats have intensified and are expected to increase (Duarte, 2002). Consequently, Europe, particularly the Northern British Isles, is predicted to be one of the most vulnerable regions at high risk of seagrass loss due to these pressures (Turschwell *et al.*, 2021).

The decline and threat of seagrass habitats in the UK has prompted efforts to restore the lost and degraded seagrass meadows (Gamble *et al.*, 2021; Green *et al.*, 2021). Large-scale seagrass restoration efforts have occurred in the Dale, Pembrokeshire followed by recent seagrass planting efforts in the Humber, England (Lincolnshire Wildlife Trust, 2023; Unsworth *et al.*, 2022b). While these initiatives are significant and essential, when comparison is made with international restoration efforts, the UK's overall response can be considered inadequate. A limiting factor in the progression of seagrass restoration in the UK is a lack of information in several areas; monitoring indicators, management protocols, protection measures, and restoration techniques (Strachan *et al.*, 2022).

Seagrass meadows in Northern Ireland are typically distributed throughout sheltered coastal embayment's and all sea loughs apart from Belfast Lough, with *Zostera marina* (eelgrass) predominantly found in the subtidal and *Z. noltei* (dwarf eelgrass) in the intertidal. Biotopes created by these species were recognised as a priority feature in 2003 with a tailored habitat action plan for seagrass beds; however, it was not feasible to produce specific targets due to a lack of baseline information on the extent, quality, and distribution of seagrass (Department of Agriculture, Environment and Rural Affairs [DAERA], 2003). Monitoring of seagrass meadows has primarily been episodic rather than systematic, making it difficult to gather reliable data on the spatial and temporal changes as well as the ecological condition of these habitats.

In contrast to Wales, England, and Scotland, Northern Ireland currently has no active seagrass restoration efforts. However, in 2024, the local government started consultations on the Blue Carbon Action Plan and Marine Protected Area (MPA) Strategy Review, both of which address the status of seagrass, including protecting, enhancing, and restoring the habitat (DAERA, 2024a, b). Recognition of seagrass habitats and their associated ecosystem services has led to an eagerness from local eNGOs and councils to begin efforts to protect, manage and restore seagrass meadows (Strangford Lecale AONB, 2023). As is the case with many ecological restoration projects, obtaining permissions or licences for novel plans and techniques is difficult without the backing from governmental departments. The use of historic records has proved a fundamental first step when gathering evidence to support restoration efforts for priority habitats (Hayden-Hughes *et al.*, 2023; Kirkpatrick *et al.*, 2024). It is envisaged that the historical overview of seagrass in Northern Irish waters presented in this manuscript will greatly aid future seagrass restoration programmes.

Materials and methods

Ireland was partitioned by the Government of Ireland Act 1920, establishing Northern Ireland as a part of the United Kingdom. This historical account focuses on records of seagrass specific to Northern Ireland, but relevant references from the Republic of Ireland particularly pre-1921 have been included when appropriate for broader context (Table 1). Northern Ireland has five sea loughs with both Carlingford and Foyle loughs being termed as border loughs, all of which have historically supported seagrass beds (Figure 1).

Digital and physical literature was reviewed to create a timeline documenting the history of seagrass in Northern Irish waters. Online sources such as the Biodiversity Heritage Library, The National Archives of Ireland and online scientific journals were used, employing the following key search terms; *Z. marina, Z. nana, Z. noltei, Z. noltii, Zostera, Zostera* banks, Eelgrass and Seagrass. Overall, greater than 300 documents were found across library collections, national archives, historical naturalist societies, government reports, marine taxonomic lists, peer-reviewed literature, and textbooks. However, only approximately 70 references were used in this paper.

It was discovered during the review of documents that the terminology used to refer to species of Zostera changed over time. Therefore, additional searches were undertaken using colloquial keywords such as 'Sleech', 'Sleech grass', 'Grass wrack', 'Sluch', and 'Slitch'. Physical collections from the Linen Hall Library, the National Museums NI Library, and the Public Records Office NI were searched online prior to visiting the archival records. If key words and documents of interest were identified *in-situ* confirmation was conducted in person. Results were then compiled into a historical timeline (Table 2), which revealed distinct periods within the timeline relating to the health and condition of seagrass in Northern Irish waters. Individual records of *Zostera* presence were also summarised into a heat map (Figure 1), whereby the data used was the number of written records for that location. One data point was classed as one event record. For example, if *Zostera* was recorded on the 29th of March 1835 and the word '*Zostera*' was mentioned five times in the text, we would have recorded that as one data point if it was all referring to the same location.

Results

All documents which appeared in our searches were examined. Those which were relevant to this study which related to Northern Ireland or to the spread of *Zostera noltei* to Northern Ireland, were included. Some documents had been republished or recirculated. In this instance, only the original document or record was counted to avoid duplication.

Table 2 presents an overview of key historical references of *Zostera*, revealing two significant locations: Belfast Lough and Strangford Lough (see Figure 1). Within these two sea loughs, there are varying degrees of decline of seagrass which is linked to the use of the lough and its prominence in the industrial revolution. For example, most of the early historical records of seagrass relate to those in Belfast Lough, however with increased pressure associated with a rising population in Belfast and use/development of the lough and surrounding areas during the industrial period, the

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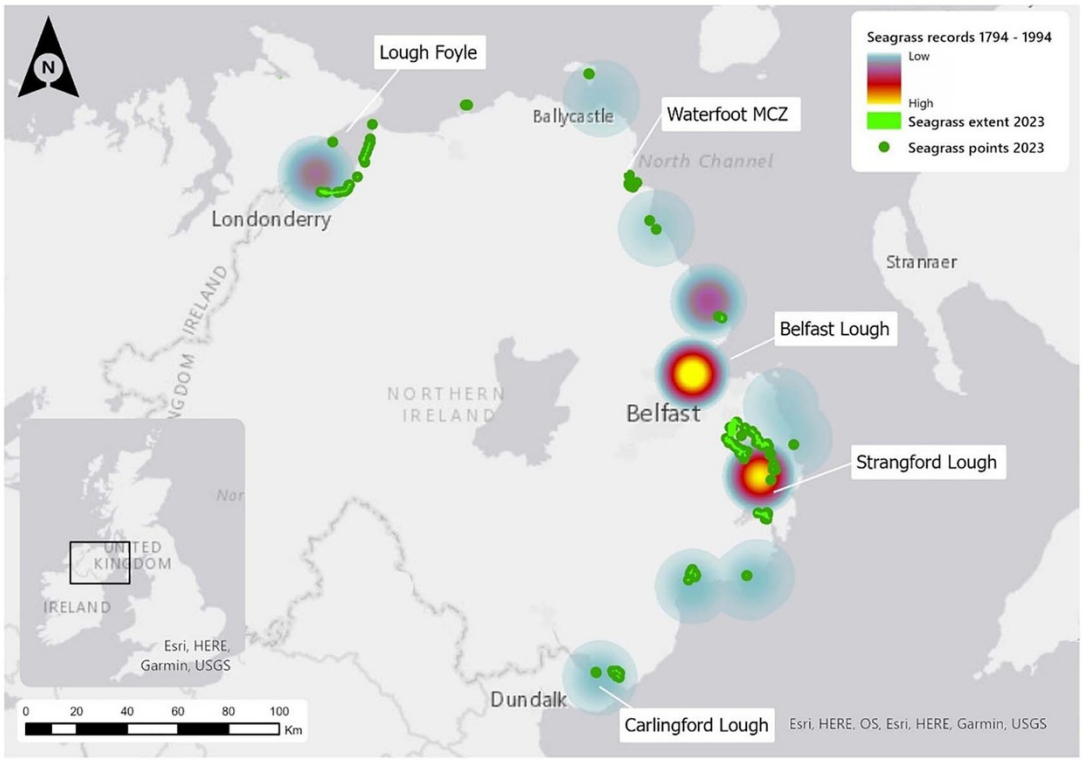

Figure 1. Records of seagrass from 1794 to 1994 overlaid with the known distribution and extent of seagrass in 2023 (emodnet seabed habitats) across Northern Ireland featuring key locations. Map lines delineate study areas and do not necessarily depict accepted national boundaries. Arcgis pro (version 3.1.2).

seagrass habitats declined with no records of seagrass present there today (Figure 1).

The research revealed three distinct periods of seagrass condition that determined the conservational health of seagrass, and the authors have used this to divide the timeline results into 'Extensive and Dense Seagrass Meadows', 'Degradation', and 'Signs of Recovery'.

The majority of records that we discovered were authored by local naturalists, typically belonging to the local naturalist societies or clubs. These people were the local experts to our understanding and therefore we are confident of the accuracy of these records and additionally, many times, the plant was referred to directly by its Latin name. Many of the records were from observations made intertidally and some were made directly from boats in shallow water. A small number of records were observed through dredging. Whether these dredges were commercial or scientific is not always noted, however, we believe that the Belfast Dredging Committee (Murray, 2003) was responsible for many of these records.

Discussion

The archives revealed three key periods, as outlined in Table 2. They identify seagrass prevalence, decline, and signs of recovery which could be collated into a timeline.

Period 1: Late 1700s to 1880 – Extensive and dense seagrass meadows

The first records of *Z. marina* specific to Northern Ireland date from the 1790s and place the species on the western shore of Belfast Lough (Nelson, 2003; Stewart and Corry, 1888). In the early 1800s, *Z. marina* was growing 'abundantly' in Belfast Lough and Strangford Lough, often described as growing in 'masses', 'heaps', and 'profusely', to the extent that the shore was defined as having a 'greenish tinge' and likened to a 'green carpet' (Thompson, 1842, 1849a, 1850).

Accounts of some ground nesting bird species at island locations in Belfast and Strangford Lough were regularly associated with the abundant growth of *Z. marina*, and it was noted that dried *Z. marina* was a major component within their nests (Thompson, 1850, 1851). Circa this period, many of the records for *Z. marina* are recorded due to associated species use, with the plant being viewed as a substrate rather than the main organism of interest. Seagrass-related species included ascidians, bryozoans, hydrozoans, marine macroalgae, gastropods, and several fish species (Fisher and Templeton, 1935a,b; Gifford, 2021; Thompson, 1840, XXVIII and XI, 1849b, 1850, 1856).

A sympatric relationship between seahorse species and seagrass meadows has been recorded throughout the temperate regions, with correlations between abundance and available vegetation (Curtis *et al.*, 2005). The Northern Irish coasts in the 1800s once supported an apparently small population of the short-snouted seahorses *Hippocampus hippocampus* (Yarrell, 1859). Individuals were found washed up at Red Bay, County Antrim in 1821 (Thompson, 1837) – an area designated presently as a Marine Conservation Zone due to its expanse of subtidal seagrass meadow (Department of Agriculture, Environment and Rural Affairs [DAERA], 2016). A single, more recent record occurred in 1921, when a live seahorse was found on the shore of Greenisland, Belfast Lough (Fisher, 1926). It was the first record from Belfast Lough since 1837 with no individuals recorded since. We have not found any direct evidence which linked the decline in seagrass quality and

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Table 1. A historical timeline of Zostera divided into three periods: 'extensive and dense seagrass meadows', 'degradation' and 'signs of recovery'

Date	Summary
Period 1	**Extensive and Dense Seagrass Meadows**
1794–1850	*Z. marina* was growing 'abundantly' in Belfast Lough and Strangford Lough, to the extent where the shore was described as having a 'greenish tinge' and likened to a 'green carpet' (Thompson, 1842, 1849a, 1850). Inquiries began to be made into the potential commercial uses for *Z. marina* (Transcript 1, MacDougall, 1829).
1850	Commercial uses for *Z. marina* were being developed. It was used for thatching roofs, often being preferred over hay or straw and was sold in shops for filling mattresses, cushions and other items (Pratt, 1850; Pratt, 1905).
1851–1863	The populations of *Z. marina* in Strangford, Belfast and Larne Loughs (Nichols, 1899) were thought to be healthy and extensive as wildfowl feeding in these locations were all found to have (often exclusively) *Z. marina* in their gut (Thompson, 1851). *Z. marina* was also noted in Lough Foyle and Fairhead (Lloyd Praeger, 1889).
1864–1887	*Z. noltei* (referred to as *Z. nana*) was recorded for the first time in Ireland (1864) in Dublin Bay (Baker and Foggitt, 1865). It began to appear in 'Lists of Desiderata' in Irish naturalist journals along with *Z. marina* and *Z. angustifolia* (Baker and Foggitt, 1865).
Period 2	**Degradation**
1880–1890	The changes along the banks of Belfast Lough were described from the County Down shore, changing from 'soft ooze' to 'hard' sand banks (Lloyd Patterson, 1889). *Zostera* banks were spoken of from Larne, Strangford and Belfast Loughs, Lough Foyle and Fairhead (Lloyd Praeger, 1889, 1892).
1893–1894	First wasting disease epidemic (Cottam, 1934)
1891–1902	*Z. nana* continued to spread around the Irish coast and findings were classed as a 'rare' or 'valuable record' in papers (Carpenter and Lloyd Praeger, 1897; Hart, 1887; Moore and Goodman More, 1866). *Z. marina* was found on the 'coasts of all Ireland,' including Co. Down, Antrim and Derry (Johnson and Hensman, 1895; Lloyd Praeger, 1902; Moore *et al.*, 1898).
1903–18	Decaying Zostera was noted in a muddy bay in Strangford Lough (Lloyd Praeger, 1904a). *Z. nana* was listed as 'very rare' with its centre of distribution lying 'further south in Ireland.' It was first recorded in Northern Ireland in Dundrum Bay in 1914 and was recorded for the first time in Strangford Lough in 1916 (Wear and Lloyd Praeger, 1923).
1929–1935	Second Wasting Disease Epidemic (Cottam, 1934)
1933–1940	Localised and widespread degradation of seagrass beds began to be described (Cotton, 1933; Lynn and McGurk, 1934). Declines were noted from 1926 in Strangford Lough, with the most severe effects being observed in 1934, by which time there was 'scarcely a leaf to be seen' on the shore (Lynn, 1936).
Period 3	**Signs of Recovery**
Post-1940s	*Z. nana* continued to be found in Strangford Lough (Lloyd Praeger, 1942) and by 1949, it was present on mudflats in Larne lough (Colinvaux, 1965; Lynn, 1949). Patches of *Z. marina* were described in Belfast lough (Drennan, 1964; McMillan, 1944) and throughout Strangford Lough (Platts, 1973). *Zostera* species continued to be recorded in patches throughout Northern Ireland, excluding Belfast Lough but have not recovered to the levels previously observed.
2003–2012	The extent and density of seagrasses in Strangford Lough had shown signs of recovery by the 2000s potentially due to restrictions on agricultural runoff and sewage effluent (Reid *et al.*, 2012). Comparisons between the 2003 survey of seagrass in Strangford Lough and Carlingford Lough with 2009/10 surveys showed an increase in seagrass extent (Reid *et al.*, 2012). Whilst the 2012 survey revealed a change in seagrass patches contracting and expanding locally (Reid *et al.*, 2012).
2016–2022	In December 2016, DAERA designated Waterfoot as a Marine Conservation Zone (MCZ) for the habitat of seagrass beds (*Zostera marina*) on subtidal (sublittoral) sand. To be monitored within a cycle every 6 years (Department of Agriculture, Environment and Rural Affairs (DAERA), 2016). In 2022, the most recent assessment at Waterfoot MCZ subtidal seagrass maintained a favourable condition (DAERA, 2023).

extent in Northern Ireland with the decline of seahorses. However, the occurrence of seahorses in the region coincided with the period of healthiest seagrass populations and further literature review has suggested that the records mentioned above are the only ones from this region.

During this 1st period, *Z. marina* was recorded as growing on mudflats, in parts of sea loughs which had 'oozy' sediment (Thompson, 1850), where it grew intertidally to the extent that large patches of the plant were often visible at low tide (Thompson, 1849a, 1850). Larne, Belfast and Strangford Lough are all mentioned as having 'extensive muddy Zostera-covered banks' (Thompson, 1850).

Uses for *Z. marina* were being developed during the latter end of period 1, as low cost, easily obtained material was utilised to meet the demands of industrial development. Throughout the UK seagrass species were commonly used for thatching roofs particularly within coastal communities with a 'sea-grass thatch' (Figure 2), which was said to last for 100 years (Pratt, 1850). No evidence was found to suggest that thatching using seagrass was a commercial activity.

It was also frequently used as a stuffing for mattresses, often preferred over hay or straw and was sold in shops for filling cushions and other upholstery items, under the name of 'Ulva marina', 'Alva marina', or 'Alva' (Pratt, 1905; Wood, 1860). Seagrass was a common packing material for glass bottles and earthenware in transit and the packing of choice for Italian liquor-casks (Horwood, 1919; Pratt, 1850, 1905). During this period, the concept of using seagrass as a commercial product in Northern Ireland was being explored. In 1829, A. MacDougall wrote to William Lamb, Chief Secretary, to inquire as to the best method for acquiring a patent for the 'preparing, dressing, and manufacturing, of the Ulva Marina Zostera or Sea Grass' (Appendix, Transcript 1). The intended use was described as the stuffing of 'mattresses, cushions and other useful purposes' with the price of a seagrass mattress being 'from 3s to 6s and upwards', where 's' is shillings (MacDougall, 1829).

In the 1840s, seagrass was also considered an important food source for harvestable wildfowl. Brent geese were noted to move to Belfast Lough from Strangford Lough around March, as they were presumed to have exhausted the *Zostera* beds in Strangford Lough, with the author referring to the meadows as 'closely cropped' (Thompson, 1851). An example of industrial development having an impact on seagrass habitat was recorded in the 1840s when

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Table 2. Other data sources used to support distribution data not included in reference list

Reference	Identifier
Annual reports and proceedings of the Belfast Naturalists' Field Club. New series, 1913, Series II, Vol I, p. 140	https://www.wikidata.org/entity/Q51442482
Blackler, H. 1952. An Algal Survey of Lough Foyle, Northern Ireland, Proceedings of the Royal Irish Academy. Section B: Biological, Geological, and Chemical Science, Vol 54, pp. 97–132.	NA
Lynn, M, J. (1960). Coastal Survey X (New Series) Southern End of Larne Lough, Co. Antrim, *The Irish Naturalists' Journal*, Vol 13, No. 7, pp. 159–163	https://www.jstor.org/stable/25534711
Lynn, M, J. (1961). Coastal Survey XI (New Series) Southern End of Larne Lough, Co. Antrim, *The Irish Naturalists' Journal*, Vol 13, No. 10, pp. 223–227	https://www.jstor.org/stable/25534773
Ingold, C, T. (1929). Botanical Society of Northern Ireland. Coastal Survey No. 1. Grasswrack Community in Ballyholme Bay, *The Irish Naturalists' Journal*, Vol 2, No. 8, pp. 165–166	https://www.jstor.org/stable/25531629
Lynn, M, J. and McGurk, J. (1932). Botanical Society of Northern Ireland. Coastal Survey: VI. Ardglass: From The Pill to St. Patrick's Well, *The Irish Naturalists' Journal*, Vol 4, No. 6, pp. 114–117	https://www.jstor.org/stable/25532109
Lloyd Praeger, R. (1934/35). A Contribution to the Flora of Ireland. Including a 3rd Supplement to "Irish Topographical Botany," Proceedings of the Royal Irish Academy. Section B: Biological, Geological, and Chemical Science, Vol 42, p. 55–86	https://www.jstor.org/stable/20517068
Lynn, M, J. (1935). Rare Algae from Strangford Lough. Part II, *The Irish Naturalists' Journal*, Vol 5, No. 11, p. 275–283	https://www.jstor.org/stable/25532478
McMillan, N, F. (1966). Zostera Spp. in Belfast Lough, *The Irish Naturalists' Journal*, Vol 15, No. 8, p. 243	https://www.jstor.org/stable/25537077
Davison, D, M. and Hughes, D, J. (1998). Zostera biotopes, An overview of dynamics and sensitivity characteristics for conservation management of marine SACs, Prepared by Scottish Association for Marine Science (SAMS) for the UK Marine SACs Project, Task Manager, A.M.W. Wilson, SAMS	http://ukmpa.marinebiodiversity.org/uk_sacs/pdfs/zostera.pdf
McMillan (1944). The Marine Mollusca of Greenisland, Co. Antrim, *The Irish Naturalists' Journal*, Vol. 8, No. 5, pp. 158–167	https://www.jstor.org/stable/25533223

the County Down Railway Company constructed the Holywood section of the railway line, reclaiming parts of the shore, embanking east from the Conn's Water estuary up to the area opposite the Palace grounds (Figure 3; McCutcheon's, 1980). Thompson (1851) referred to the recently constructed railway embankment on the western shore of Belfast Lough which involved extensive land reclamation and as a result, 'fields of corn now wave where banks of *Zostera* once prevailed'. These are the earliest references we have, which describe contributions to the structural changes that have altered Belfast Lough over the last 200 years (Lloyd Praeger, 1904b). Another example is that of the expansion of the Victoria Channel through dredging, which facilitated an increased tidal influence over the mudflats, removing the surface layer of mud and with it the seagrass near Holywood (Praeger, 1920; Swanston, 1870).

From the historical records, *Z. marina* and *Z. angustifolia* appear to be the only seagrasses present in Ireland until *Z. noltei* (referred to as *Z. nana*) was recorded in 1864 for the first time in Dublin Bay (Baker and Foggitt, 1865). It began to be included in 'Lists of Desiderata' in Irish naturalist journals along with *Z. marina* and '*Z. angustifolia*' (Baker and Foggitt, 1865). Records of *Z. nana* continued to be sought after by Irish naturalist journals, being described as a 'rare Irish native plant' (Hart, 1887). In 1866, *Z. marina* continued to be listed as 'common', while *Z. nana* was described to be found along the east coast of Ireland in muddy estuaries but being very rare (Moore and Goodman More, 1866). It was described as growing amongst '*Z. marina, var. angustifolia*' (Moore and Goodman More, 1866).

By the late 1800s, *Z. marina* in Belfast was still thought to be healthy and extensive (Nichols, 1899) as brent geese feeding in these locations were all found to have, often exclusively, *Z. marina* in their gut with similar results from other birds (Thompson, 1851). There was a parallel situation in Strangford Lough, where there was '*Zostera* in abundance' with a variety of marine organisms continuing to be found growing on the blades (Balfour, 1854; Carpenter *et al.*, 1902; Thompson, 1851, 1856) and *Z. marina* was also noted in Lough Foyle and Fairhead (Lloyd Praeger, 1889). It was around this period that *Z. marina* began to be referred to as 'eel-grass' (Clark, 1863).

The early decline in Northern Ireland's seagrass meadows is highlighted within references from 1840. Most of the disturbance can be attributed to anthropogenic activity, with the majority of habitat impacts related to coastal development projects or increased resource use from a rapidly growing population. This second period is being classed as beginning when consistent degradation due to the dredging of the Victoria Channel was observed. In the cases of the earlier damage due to embankment, these are considered individual damage events as opposed to a consistent new pattern and therefore have not been chosen to define a new period.

Period 2: 1880 to 1940 – Degradation

Naturalists in the early 1900s began to describe changes along the banks of Belfast Lough on the County Down shore, documenting that the former 'great expanse of banks' which were covered with *Z. marina* had changed from 'soft ooze' to 'hard and clean sand banks' (Lloyd Patterson, 1889). Patches of *Zostera* and mud banks 'vanished' and blue mussels were seen for the first time starting

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Figure 2. Example of a seagrass thatched roof on a Danish House © visitlæsø.

to grow intertidally (Thompson, 1895). This was attributed to the developments that came with improvements to Belfast Harbour, culminating in the Victoria Channel, but particularly the dredging of the 'new cut'. It was said to have 'diverted the former flow of the tide and the river' and by 'making an increased "scour," gradually swept the mud or ooze off the banks, and with it the Ribbon or Grass Wrack (*Zostera marina*) that grew on it' (Lloyd Patterson, 1889). Other industrial processes were applying similar pressures onto seagrass communities, such as in mud flats within Larne Lough at Magheramorne, Co. Antrim. The mud was considered to still be able to support living *Z. marina*, if it were not for the advancement of a large 'spoil bank' from nearby chalk quarries into the sea, raising the height of the clay by several feet above the high-water mark (Lloyd Praeger, 1892).

While declines in seagrass populations were particularly noted close to areas of industrial development, healthy seagrass meadows continued to be recorded in less developed areas and in some locations, it was actively expanding. Lloyd Praeger (1892) recorded *Z. marina* in Carlingford Lough and it was observed that it was to be found on the 'coasts of all Ireland' including County Down, Antrim and Derry (Carpenter and Lloyd Praeger, 1897; Carpenter *et al.*, 1902; Johnson and Hensman, 1895; Lloyd Praeger, 1901; Moore *et al.*, 1898). *Zostera* banks were spoken of from Larne Lough and Strangford Lough, particularly near Newtownards and the Comber River estuary and Belfast Lough, Lough Foyle, and Fairhead (Lloyd Praeger, 1889, 1892). The plant was often dredged from 'a depth of several fathoms off Glenarm' and was described as found closer to the low water mark but still listed as common (Stewart and Corry, 1888). The smaller species, *Z. nana*, continued to spread around the coasts of Ireland with findings initially classed as a 'rare' or 'valuable record' in papers but records remained isolated to the Republic of Ireland (Carpenter and Lloyd Praeger, 1897; Hart, 1887; Moore and Goodman More, 1866). During the 1900s, a shift in nomenclature was apparent with 'Zostera' starting to be referred to as Sea-Grass/sea grass (Carpenter and Lloyd Praeger, 1897; Clarke, 1865).

Seagrass losses were not always attributed to coastal development; indeed, 'Masses of decaying *Zostera*' were noted locally in Strangford Lough in 1903 (Lloyd Praeger, 1904a). However, this occurred between the two recorded 'wasting epidemics' suggesting this may have been due to a locally damaging event such as pollution or disease. As seagrass continued to decline, it's role in coastal protection began to be understood. The absence of *Z. marina* in parts of Belfast Lough began to be felt, as 'the formerly softening effect' of the Zostera meadows was no longer there to prevent the full force of the waves breaking on the beach and sea walls, resulting in a more rapid degradation of the shoreline (Lloyd Praeger, 1904b). The role of seagrass as a sediment trap also began to be recognised during this period as it was suggested that it contributes to clay formation (Lloyd Praeger, 1892). The effects of these changes on local animal life were also noted, including a local decline in wading birds (Lloyd Praeger, 1904b).

As *Zostera nana* continued to be recorded in new locations, it was listed as 'very rare' with its centre of distribution lying 'further south in Ireland'. It was first recorded in Northern Ireland at Dundrum Bay in 1914 and again at Strangford Lough in 1916 (Wear and Lloyd Praeger, 1923). *Zostera marina* and its variation *angustifolia* were growing 'in great masses' in the area with washed

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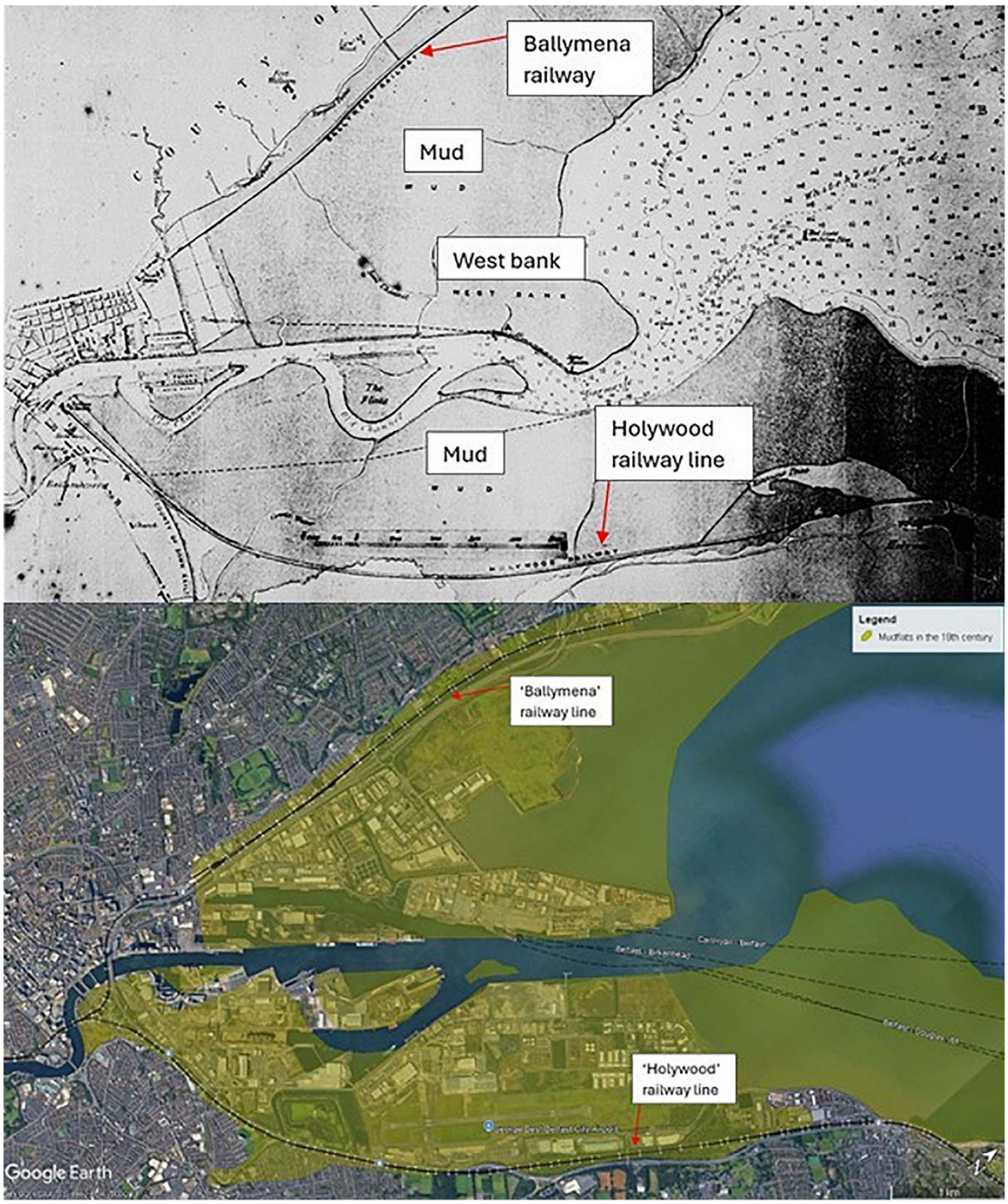

Figure 3. A 19th century map of Belfast Lough showing the vast mudflats, annotated to improve readability © BELUM.Y4962 map of Belfast and Lough. Late 15th century, A. R. Hogg courtesy of national museums NI Ulster Museum Collection. Shown against a Google Earth image of the same location, with the shaded area showing the historical extent of mudflats © Google Earth pro 6.2.1.6014, 2024, Belfast Lough, data: SIO, NOAA, U.S. Navy, NOA, GEBCO, accessed 14 March 2025.

up blades referred to as 'sleech'. These detached blades were collected from mounds on the shore and used to cover potato bins during the winter, locally (Waddell, 1917).

Localised and widespread degradation of the seagrass beds throughout Northern Ireland began to be described in the 1930s (Cotton, 1933; Lynn and McGurk, 1934). Declines were noted from 1926 in Strangford Lough, with the most severe effects being observed in 1934, with 'scarcely a leaf to be seen' (Lynn, 1936). *Zostera marina* was still referred to periodically as 'slitch' or occurring as 'slitch-beds'. A change from soft mud to harder sand was noticed in the Lough and the changes were attributed to the degradation of the *Zostera* rhizomes beneath the sediment, destabilising the mud and allowing it to be washed away over time (Lynn, 1936). It was noticed that in many cases, the space of time during this epidemic in which *Z. marina* was absent, which was up to several years, was enough to allow significant coastal erosion and change due to the absence of the rhizomes (Cottam and Munro, 1954). In many locations in Northern Ireland where the impacts of the wasting disease epidemic were observed, *Z. marina angustifolia* and *Z. nana* were not greatly affected. However, this did

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not apply to Strangford Lough, as *Z. marina* was doing quite well in places while the other two varieties faced major local declines (Lynn, 1936). The decline of *Zostera* and its link to the ecology and population declines of certain bird species such as those within the family Anatidae, was noted by multiple authors, including the International Committee for Bird Preservation, prompting them to call for an investigation (Bird Preservation, 1937; Editorial, 1936).

In 1939, *Z. marina* at Belfast Lough was still recorded on the muddy shore between Sydenham and the Holywood train stations but this appears to be the final record for the species upon that once-extensive mudflat (Brenan *et al.*, 1949). However, the intertidal species, *Z. nana*, continued to be documented at Strangford Lough at sites just below Newtownards and near Greyabbey (Lloyd Praeger, 1942) and in 1949, it was present on mudflats in Larne lough (Colinvaux, 1965; Lynn, 1949).

Period 3: 1940 to present – Signs of recovery

The final period within the timeline relates to the persistence and recovery of seagrass meadows within Northern Ireland. At present, this is all in a passive context with no proactive restoration programmes in place. However, the references identify areas where the return of seagrass is underway unaided and as such, these sites offer potential restoration managers good baselines or pilot areas to begin active restoration trials.

Belfast Lough was once home to 'banks' of seagrass and by the 1940s into the 60s *Z. marina* beds had been reduced to patches (Drennan, 1964; McMillan, 1944). Figure 1 displays the high number of records relating to seagrass in Belfast Lough; however, the last record was in 1962 on the western shore (Drennan, 1964). The decline in records and subsequent seagrass habitat is most likely due to the accumulation of impacts from the development of Belfast Port, with stronger tidal influence, increased sedimentation from dredging, substrate loss, and increased effluent discharge. Until these pressures are addressed, Belfast Lough will possibly not see the natural recovery of seagrass and successful proactive restoration is unlikely.

Enhancing and restoring seagrass in Strangford Lough is more promising because it has not faced the same anthropogenic stressors as Belfast Lough. Moreover, small sections of *Z. marina* were recorded as recovering naturally (Platts, 1973) as well as a noticeable increase in the narrow-leaved variety of *Z. marina* (Cottam and Munro, 1954). However, there appears to have been an overall decrease in percentage cover of seagrass at Strangford when comparing data from 2009 to 2012 to baseline conditions in 2003 (Reid *et al.*, 2012). In contrast, Strangford Lough is noted as having the largest intertidal extent of *Z. noltei* on the island of Ireland (Portig *et al.*, 1994; Wilkes *et al.*, 2017). This provides an ideal opportunity to protect and manage seagrass meadows in the lough which are directly aligned with recent draft marine policies (DAERA, 2024a, b).

In 1990, it became evident that boat moorings were negatively impacting the subtidal seagrass bed at Castleward in Strangford Lough (Brown, 1990). However, environmentally friendly alternatives known as eco-mooring are currently being tested by Newry, Mourne, and Down District Council, with support from DAERA. In 2022, two types of eco-moorings were installed in the seagrass meadow at Ballyhenry Bay to evaluate whether they cause less impact or damage compared to traditional mooring systems (Strangford & Lecale AONB, 2023).

Conclusion

As mapping and monitoring of the seagrass meadows increases across Northern Ireland in line with the anticipated Blue Carbon Action Plan, which is currently under review, proactive restoration programmes will be required. This research will offer future project managers an insight into the extent of seagrass habitat Northern Ireland possessed in the past and how rapidly it was lost. The historical analysis from this study has highlighted the extent to which the marine coastal habitats of Northern Ireland have changed over the past 200 years and has provided an image of the historical baseline. It is recommended that the amount of habitat change experienced at sites should be carefully considered when assessing the feasibility of restoration work. It is hoped this manuscript will highlight the delicate balance between responsible habitat use and destruction and assist in the future recovery of the seagrass meadows of Northern Ireland.

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Appendix

Transcript 1. Letter from A. MacDougall to William Lamb, 1829 © The National Archives of Ireland, CSORP/1827/1802. Transcribed to improve readability. Gaps in place where words could not be read.

Belfast 19th November 1829

Sir,

I take the liberty of addressing you and of asking a most particular favor, it is that you would do me the honor of informing me if I can obtain a patent for twenty one years for this kingdom, for preparing, dressing, and manufacturing, the Ulva Marina Zostera or Sea Grass.

If you will be pleased on my producing a specification of the patent, to obtain me the grant solicited, it would enable me to employ a vast number of the poor people who reside on the coasts of the Maritime Counties.

I would intend, the manufacture, preparing and dressing of the Zostera all along the coast, and every person would benefit more or less by the discovery and manufacturing of it, particularly as the work suits the most tender constitution. Old and young persons of both sexes would get employment, the occupation is light, clean, and healthy. Before incurring any more expense, and that too with the view of creating employment for the poor on the coast, more than the object of profit, it is necessary my discovery should be protected by patent, which would enable me to carry it on effectually. The Ulva Marina or the Zostera Sea Grass, for mattresses, cushions and other useful purposes will require a considerable capital. It is necessary to guard if possible against failure, mismanagement and casualties and to ensure success a patent whatever the cost may be is absolutely necessary. The manufactory will be established on the most liberal principles, and it will give employment to thousands of young and aged persons of both sexes that would not be fit to work at any other occupation whatsoever. If the manufacture of the Zostera be once established every person can have a clean neat, healthy mattress from 3s to 6s and upwards instead of lying on damp heath chaff, sawdust, rotten weeds, or fusty straw.

I trust through your kind representation that I shall be honored with the generous support of the government of this country and that you will as soon as convenient countenance my plan not on account of its merit but in confidence of its utility.

I beg to add that I have devoted much of my time which has been attended with some expense to proof the usefulness of the Zostera _____ for a good, durable, warm thatch for the houses of the poor peasantry along the coast. I sincerely hope and have no doubt but that the discovery will do good to thousands.

Have the goodness to pardon this unavoidable intrusion, and in conclusion I beg leave to mention that I can be particularly well recommended by the Marquess of Donegall, Earl O'Neill, General O'Neill, Lord Ferrard, The Honorable Colonel Packenham, Sir Aurthur Chichester Hart (?). The Right Honorable E. A. MacNaghten, M. P and by several others of the nobility and gentry of the country.

With sentiments of esteem and much respect.
I have the _____ to be
Sir
Your most obedient
Humble Servant
A. McDougall

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