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Finding some seagrass optimism in Wales, the case of *Zostera noltii*

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ABSTRACT

There exists limited understanding of the long-term dynamics of the seagrass *Zostera noltii* and how this is influenced by anthropogenic pressures. Milford Haven is a heavily industrialised estuary and also one of the important sites for Zostera sp. in the UK. In this study we examine all available long-term spatial variability and abundance data of *Zostera noltii* within Milford Haven using historic datasets. Results show that *Z. noltii* in all sites have shown meadow expansion when compared to the first obtainable records. Little change in abundance over the past 10–15 years for the two sites confirms certain seagrass populations to be robust and thriving. We hypothesise that these populations are showing a level of resilience to the high nutrient levels, disturbance and high turbidity present within the water column of the Haven.

1. Introduction

The functional value of seagrasses by way of stabilizing sediments, providing food and shelter, and carbon sequestration, for example, is well understood (Fourqurean et al., 2012; Guidetti and Bussotti, 2000; Mcleod et al., 2011; van der Heide et al., 2011). The extent of the decline of seagrasses worldwide is also well documented (Short and Wyllie-Echeverria, 1996; Waycott et al., 2009), with poor water quality thought to be one of the biggest risks (Dennison et al., 1993; Hemminga, 1998). As a consequence, there exists a propensity for studies on long-term dynamics of seagrass to be mostly those that present a negative story, showing a declining meadow caused by a major impact. However, far fewer studies have been published which document the recovery of seagrass meadows (Campbell and McKenzie, 2004; Greening et al., 2014; Walker et al., 2006) or showing long-term stability (Lyons et al., 2012; Yaakub et al., 2014). This could possibly be due to the need for researchers to highlight concerns over sites that appear to be more threatened, so that better management practises can then be advocated.

The dwarf eelgrass, *Zostera noltii,*[1] is an intertidal species found growing on muddy or sandy substrates (Den Hartog, 1970), providing stabilization of sediments (Costanza et al., 1997) and an important food source for migrating waterfowl, especially brent geese (*Branta bernicla*) and wigeon (*Anas Penelope*) (Fox, 1996; Nacken and Reise, 2000; Widdows et al., 2008). *Z. noltii* is commonly found in estuaries and sheltered bays, often at risk of conflict with coastal development, and anthropogenic impacts from industrial, agricultural and domestic sources (Bernard et al., 2007; Giesen et al., 1990). For example, in the Berre lagoon, and Bassin d' Arcachon, France, huge losses in *Z. noltii* extent have been recorded where areas have been hugely effected by urban and industrial pollution (Bernard et al., 2007; Plus et al., 2010). Management of coastal waters and waterways is necessary to ensure that habitats such as seagrass beds, are maintained in favourable conservation status whilst also trying to accommodate commercial and recreational uses (CCW, 2005). Successful management of water quality has resulted in recovery of *Z. noltii* in some locations. The Wadden Sea has seen areas of the seagrass double between the early 1970s to the end of the 1980s (Philippart, 1995), and steady expansion of meadows has been observed in Bourgneuf Bay France (Barillé et al., 2010).

In the UK, Milford Haven (west Wales) has been identified as one of the important sites for *Zostera* sp. (Brazier et al., 2007) and is home to subtidal *Z. marina* meadows and several well established *Z. noltii* beds. The Haven is also renowned for its shipping and petrochemical industry. Improvements in water quality in UK waters are also assumed to be contravening historical losses of seagrass (Jackson et al., 2013), but long-term data are spatially limited (Jones and Unsworth, 2016) with some sites recording significant reductions in shoot density (Bull and Kenyon, 2015; Burton et al., 2015). In Milford Haven, monitoring of seagrass meadows has been relatively consistent especially with the contamination risk from oil spills and port operations. Unfortunately,

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[1] *Zostera noltii* is now regarded as *Z. noltei* (WoRMS, 2017). For purposes of continuity with previous scientific research, it will remain as *Z. noltii* for this study.

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Milford Haven has been subjected to a number of oil spills since 1960 (Petpiroon and Dicks, 1982), the biggest being the Sea Empress in 1996 (Carey et al., 2015; Hodges and Howe, 2007; Moore, 2006). This has resulted in the area being relatively well monitored in comparison to other locations (Hiscock and Kimmance, 2003). In recent years, concern over the potential decline of *Zostera* and changes in the populations of birds that utilize seagrass in the Haven has led to the demand for assessing long-term changes and understanding more about the health and potential resilience of these seagrass meadows. For this study we aim to review all the long-term monitoring data available regarding *Z. noltii* meadows in Milford Haven including additional data collected for a study by Pratt et al., 2016, and where possible assess any changes the over time. Compiling and summarizing all existing data will contribute to the understanding of the current status of *Z. noltii* in Milford Haven.

2. Methods

2.1. Study site

Milford Haven waterway is found in the county of Pembrokeshire in west Wales, UK. It is Wales' largest estuary and one of the deepest natural harbours in the World making it a historically significant location for maritime commerce, shipping and more recently, the petrochemical industry (Carey et al., 2015). The large tidal range within the Haven, of over 8 m (Nikitik and Robinson, 2003), results in the presence of large tidal flats providing suitable substrate for *Z. noltii* growth. The Haven is also a part of the Pembrokeshire marine Special Area of Conservation (SAC) containing a number of designated conservation features including seagrass beds (Burton, 2008; Langston et al., 2012). Several sites have been identified as having consistently present populations of *Z. noltii* within Milford Haven (Fig. 1), all of which have been monitored to varying degrees since 1996.

2.2. Monitoring data

A comprehensive review of available data regarding *Z. noltii* in the Milford haven area was conducted in 2016 using sources from monitoring reports undertaken by CCW (Countryside Council for Wales), NRW (Natural Resources Wales, formed in April 2013, largely taking over the functions of the Countryside Council for Wales, Forestry Commission Wales and the Environment Agency in Wales) and consultancy reports where monitoring of *Z. noltii* had been conducted on behalf of industry as a requisite by CCW/NRW. The sites with continued presence of *Z. noltii* in Milford Haven were found to be Angle Bay, Pembroke river, Carew, Cosheston, Garron Pill, Hobbs Point, Pwllcrochan Flats, Sprinkle Pill and Sandy Haven Pill (Fig. 1). The Sea Empress disaster in 1996, lead to the more frequent and detailed monitoring of sites where *Z. noltii* beds had previously been recorded, for the 5 years after the spill. However, surveying was limited to Angle Bay, Pembroke River and Sandy Haven Pill, and only the Angle Bay population was monitored for abundance and associated species. The first record of *Z. noltii* extent in Angle Point was estimated as 5.22 ha in 1996 (Table 1), but was more accurately mapped using field survey and GPS from 2007 onwards along with Pembroke River. Other *Z. noltii* meadows within the Haven have been mapped using field survey and aerial imagery from 2008 onwards, although some sites have been missed out on separate survey years (Table. 1). Sandy Haven Pill was only recorded to have two small patches of 1 × 0.5 m, in the report by Hodges and Howe (2007), with no other data available for this study. Monitoring was intensified again from 2008, with more sites being mapped and *Z. noltii* recorded at Garron Pill and Pwllcrochan Flats, locations which were previously found to be absent of the seagrass (Hodges and Howe, 2007). The extent of the *Z. noltii* bed in Pembroke River has been monitored since 2007, with abundance and infaunal surveys conducted from 2009 to 2015 (Nikitik, 2012, 2014, 2015). Data also includes more recent field surveys conducted by Pratt et al. (2016), which involved a detailed assessment of *Z.noltii* distribution throughout south and west Wales, using GPS field survey and UAV (Unmanned Aerial Vehicle) assessments where sites were inaccessible (e.g. Garron Pill). In 2016, most sites in Milford Haven were mapped with the exception of Pembroke River, Sandy Haven Pill and Cosheston.

In order to determine changes in the extent of *Z. noltii* in Milford Haven, all data containing sites with areas of the seagrass mapped using GPS field survey techniques were compiled for comparison. To assess

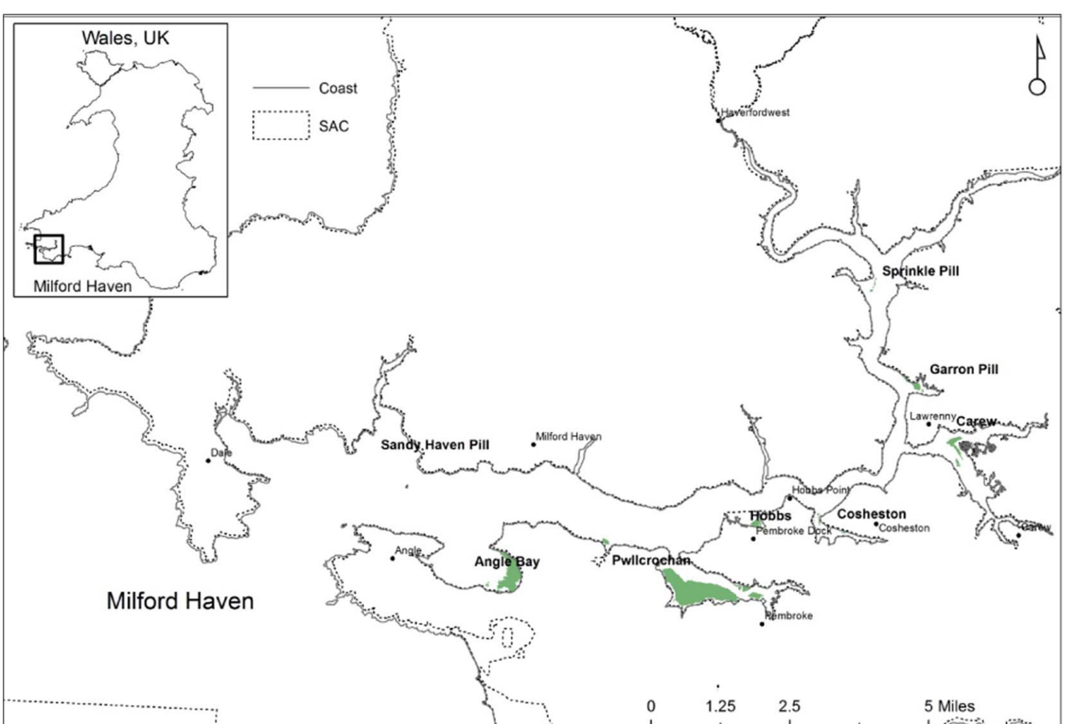

Fig. 1. Map showing Milford Haven, UK, with *Zostera noltii* mapped locations taken from GIS layers provided by NRW.