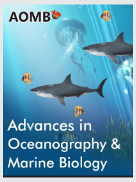

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Comparison of Fish Assemblage in Mooring Scars and Adjacent Seagrass, Studland Bay, Dorset

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Abstract

Seagrass provides vital ecosystem services from carbon cycling to hosting an abundance of fish species. However, anthropogenic impacts like mooring scars are causing a decline in seagrass and this is influencing a change in the habitat's fish assemblage. The present study has set out to investigate the fish assemblage in mooring scars and the adjacent seagrass in Studland, Dorset, UK. Underwater video systems were set up for an hour at 14 sites (7 seagrass, 7 mooring scars). Overall, 13 marine fish species from 9 families were identified and the 2 main species present included *Pomatoschistus minutus* for mooring scar sites and *Pollachius pollachius* for seagrass sites. Non-parametric statistical analysis of the results showed a clear difference between the fish assemblage within seagrass and mooring scar sites. These results are essential for the conservation and management of seagrass in Studland Bay and the fish species that it hosts.

Keywords: Fish assemblage; seagrass; community; ecosystem; mooring; niche; habitat; diet; fragmentation

Introduction

Approximately 60 species of seagrass are flowering plants, that have adapted to inhabit marine environments. Across their ranges, they provide vital services, including, coastal defence, nutrition and carbon cycling [1-5]. To add to this, seagrasses are a significant source of detrital material, which is the main source of food for numerous species [6]. Globally, seagrass is a major carbon sink and can capture carbon 35 times faster than rainforests [7]. Past literature has estimated a global seagrass spatial distribution range from 177,000 to 600,000 km^2 [8,9]. Recent research shows that since 1936, 44% of the UK's seagrass has been lost (cover estimated to be 16,524 ha in 1936) [10]. Humans are the major contributors to this degradation of seagrass through pollution, Urbanisation, and boat moorings [11]. Globally seagrasses are known for hosting a high biodiversity of fish species [12,13], with *Z. marina* said to have one of the richest varieties and abundance of marine life in the sea [14]. In addition to support this biodiversity of fish, seagrasses provide an abundance of food including small crustaceans [15,16] and infauna species [17].

Studland Bay in Dorset hosts seagrass, *Zostera marina* meadows. It was designated as a Marine Conservation Zone (MCZ) in May 2019, covering an area of approximately 4 km^2, the seagrass beds cover approximately a quarter of that area. The bay is a key seagrass habitat site as it has desirable characteristics for seagrass growth including shelter from southwest winds and coarse sediment. Conservation was prompted by its seagrass beds and its iconic spiny seahorse, *Hippocampus guttulatus* population [18]. The seagrass abundance is threatened by mooring chains and intensive boat anchoring, both these are destructive, as when moored boats move around in the wind and tide, the mooring chain churns up the seagrass when it is dragged, and anchor recovery dislodges the plants. Following this, the sediment becomes less cohesive and more mobile and has been reported to have less organic material and lower silt fractions resulting in conditions that do not support seagrass [19]. Studies of such impacts have shown that seagrass vegetative reproduction cannot withstand such ongoing disturbance [20-22].

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Past studies have revealed that seagrass holds a greater number of fish than other coastal habitats such as sandy seabed's [23]. Pihl et al. [17] detected a greater number of fish species in *Z. marina* seagrass in Sweden (n = 28) compared to areas with seagrass loss (n = 19). Research focusing specifically on seagrass loss from boat moorings and fish presence has been dominated by seine net surveys [23-27]. Previous studies looking at fish assemblages in situ have used video systems as this is a cost-effective and non-destructive method [28,29] and is desirable in the context of conservation efforts especially when monitoring in Marine Protected Areas. Most video analyses studying fish utilize bait, and this is great for attracting them to the camera, however, this also creates a bias and attracts selected species [28]. Un-baited videos remove the attractive effect of bait and allow normal behaviour to occur in the video [28]. In addition, using bait may attract fish from the seagrass into the mooring scar videos that would not naturally be there in undisturbed conditions. This study aimed to determine if there were differences between the fish assemblage within bare sediment mooring scars and the adjacent healthy seagrass using un-baited video monitoring.

Methods

Collection of data in the field was undertaken over 3 days: 19th, 20th, and 21st July 2021 between 09:00 and 18:00. The remote underwater video (RUV) system was an un-baited GoPro Hero 4 camera (1080p, 30fps) attached to a weighted stand set to record for 1 hour. Camera deployment was undertaken by paddle boarding out to mooring buoys where position and the time were recorded. Once at the site, 2 cameras were deployed: one in the mooring scar and the other in the adjacent seagrass (Figure 1). Each 1-hour video was split into five 10-minute videos with 2-minute gaps. Two minutes were excluded from the beginning and end of each video as this allowed time for settlement of the suspended matter and to reduce disturbance from deployment and retrieval. Analysing videos was undertaken using Video VLC software (Version 3.0.16, https://www.videolan.org). Many shoals of minuscule fish were present in the videos and therefore they were named altogether as 'Unidentified Fish 1' as there is no clear way of differentiating these fish without capture and inspection. After this, the videos were analysed again recording species' presence or absence, the time they were seen in the video, how often and any notable behaviour.

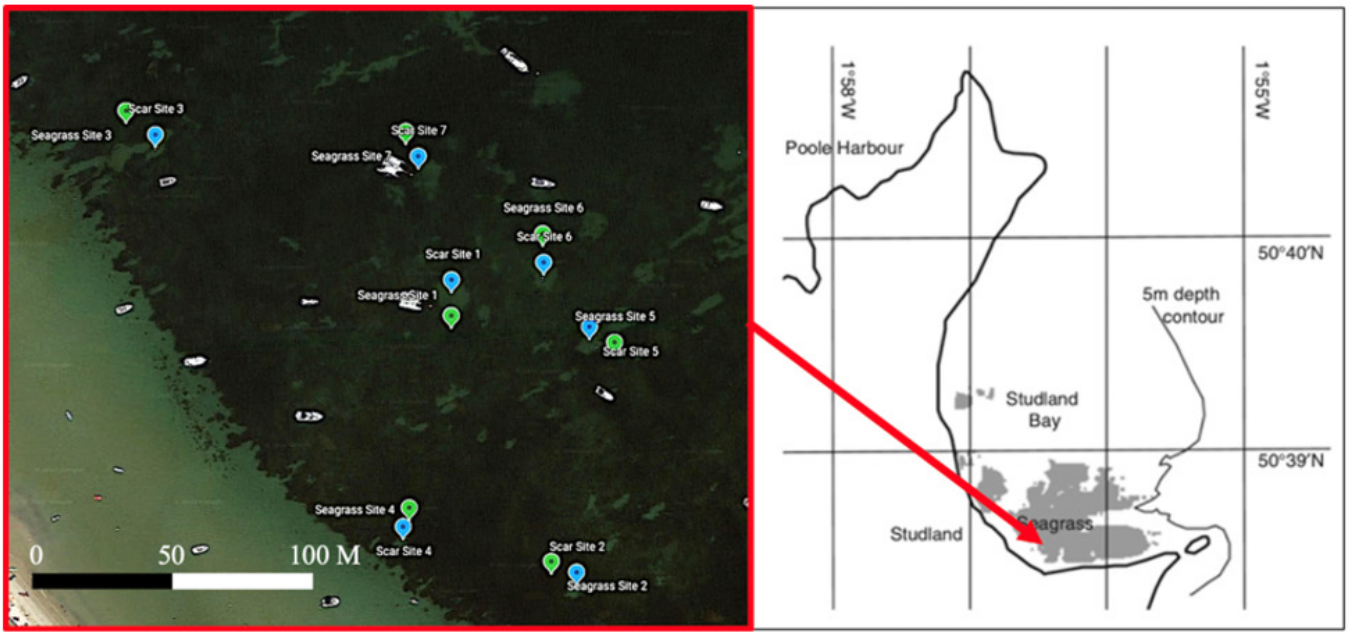

Figure 1: Google Earth image showing mooring scar (blue) and seagrass (green) video locations within Studland Bay with scale bar for reference.

Results

A notable finding in this study has been the identification of the Twaite shad (*Alosa fallax*) (Figure 2) in a seagrass site. A member of the Clupeiformes (herrings) family, this species spawns in a few rivers of Wales and England and is classed as 'Least Concern' by the IUCN in the UK [30,31]. Overall, 14 videos were taken from this study, 7 in the seagrass and 7 in the mooring scar sites. From these videos, 13 species from 9 families were identified. The species identified are as follows in Table 1 which excludes the unidentified shoals of small fish. From the video analysis, the results show that there were differences in the species composition in the videos at seagrass sites and mooring scar sites, however, the diversity of species is equal in both sites (n = 11) presented in Figure 3. For analysis of the results, an ANOSIM was performed. The fish assemblage within seagrass and mooring scar sites was found to separate into notably different groups (P <0.001, R = 0.697). Therefore, there were more differences than similarities in fish assemblage between mooring scar and seagrass sites i.e. mooring scar and seagrass sites had notably different fish assemblages. A 2D MDS plot (Figure 4)

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using PRIMER v6 shows the seagrass and mooring scar sites to be separated to some extent, as there is overlap in the middle of the two groups. Seagrass has 8 sites that are more dissimilar to the other sites and mooring scar sites have 5 dissimilar sites. There is natural variance within both sites which is expected.

Figure 2: Twaite shad (*Alosa fallax*) swimming at one of the seagrass sites in Studland Bay, Dorset, UK, 2021.

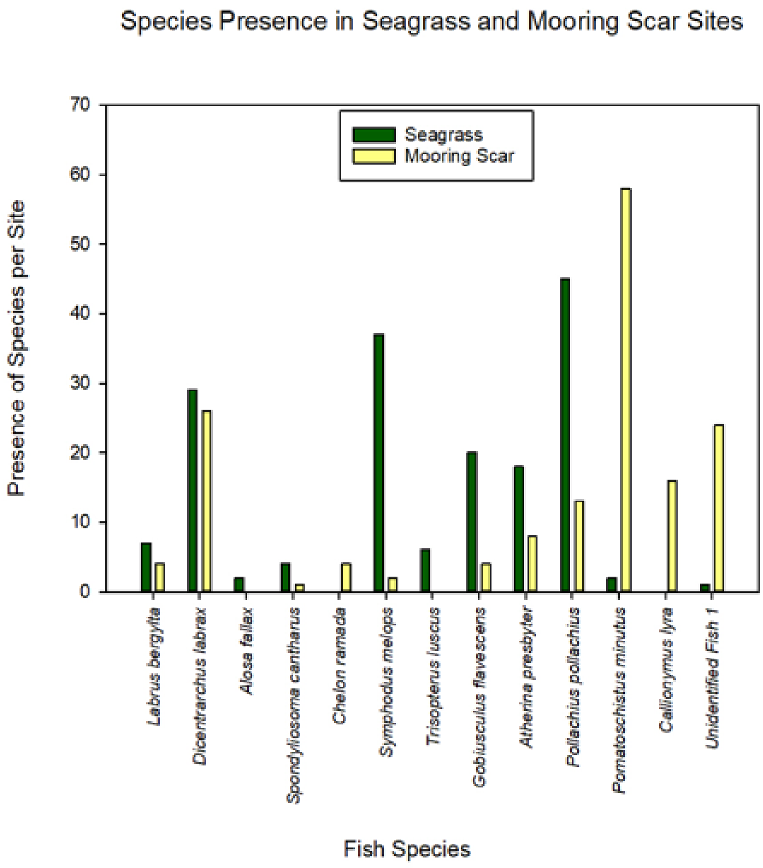

Figure 3: The number of videos each fish species was present in seagrass (green) and mooring scar (yellow) sites of Studland Bay, Dorset.

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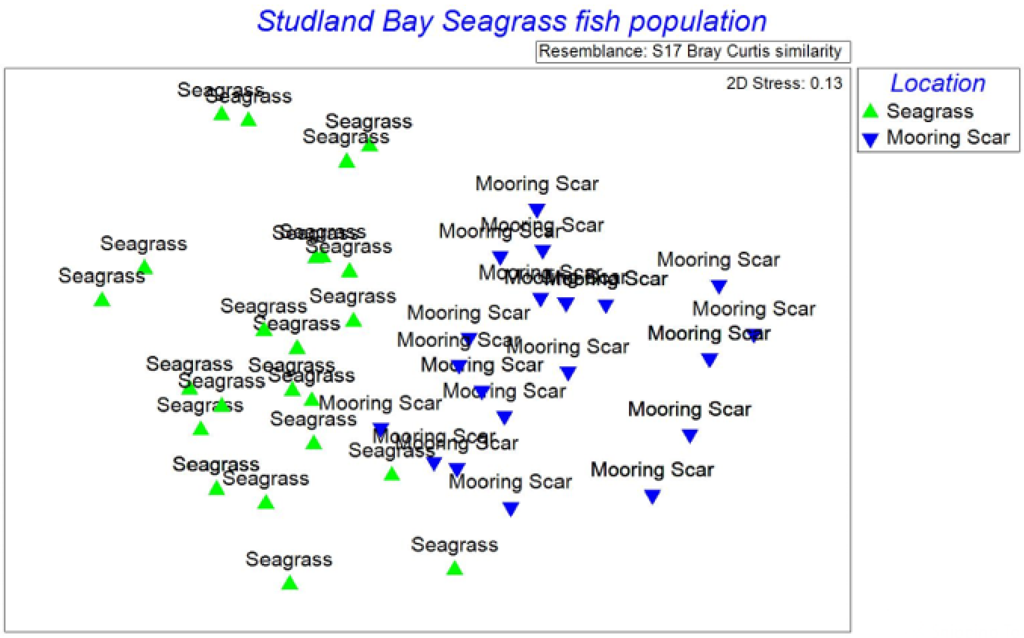

Figure 4: Nonmetric MDS scaling configuration of the fish assemblage between seagrass and mooring scar sites in Studland Bay, Dorset, UK. Green triangles represent seagrass sites and blue triangles represent mooring scar sites.

Table 1: List of the 13 identified species in the seagrass and mooring scar videos in Studland Bay, Dorset, UK.

Observation List of Species		
Common Name	**Latin Name**	**Authority**
Ballan Wrasse	*Labrus bergylta*	Ascanius, 1767
Bass	*Dicentrarchus labrax*	Linnaeus, 1758
Twaite Shad	*Alosa fallax*	Lacepède, 1803
Black Sea Bream	*Spondyliosoma cantharus*	Linnaeus, 1758
Thin-lipped Grey Mullet	*Chelon ramada*	Risso, 1827
Corkwing Wrasse	*Symphodus melops*	Linnaeus, 1758
Pout	*Trisopterus luscus*	Linnaeus, 1758
Two Spotted Goby	*Gobiusculus flavescens*	Fabricius, 1779
Sand Smelt	*Atherina presbyter*	Cuvier, 1829
Pollock	*Pollachius pollachius*	Linnaeus, 1758
Sand Goby	*Pomatoschistus minutus*	Pallas, 1770
Dragonet	*Callionymus lyra*	Linnaeus, 1758

Discussion

Analysis of the videos showed an equal number of species in seagrass sites and mooring scar sites, which appears to be inconsistent with past studies. Studies comparing fish assemblage in seagrass and sand habitats have provided evidence of a greater number of species in seagrass compared to sandy habitats [32-34]. Similarly, Collins et al. [19], found there was a three times greater number of infauna in seagrass compared to the mooring scars in Studland Bay. Bertelli & Unsworth [23] found motile macro-fauna in *Z. marina* in seagrass (n = 26) and sand sites (n=23) in North Wales which is greater than the present study of n =11 in both the seagrass and mooring scar sites. However, their methodology utilized a beach seine net which is known to capture a greater number of species than a video system [35]. Theories for their higher species number in seagrass included the seagrass's physical structure that creates food and shelter [34,36].

The fish assemblage in both sites was contrasting and likely each species utilizes different ecological niches. The species that were found in only one of the habitats include *Callionymus lyra* (seagrass) and mooring scar sites *Alosa fallax* and *Trisopterus luscus*.

These species show specialist species characteristics as they require specific environmental and habitat conditions [37]. As a mooring chain destroys the seagrass habitat species that were originally inhabiting the seagrass decrease and an increase of species that display generalist traits like the *Dicentrachus labrax*, *Labrus bergylta, Atherina presbyter* are seen as they can tolerate a wider range of environmental conditions [37]. In Studland Bay *Pomatoschistus minutus* dominated the mooring scar sites, this is possibly due to *P. minutus* being a demersal species and the 1m high camera placement in seagrass sites is most likely the reason the *P. minutus* sightings were fewer. However past studies have shown them to be a more generalist species [38]. Changes in habitat and species composition can cause cascading effects, as the original predation or food source changes, which in turn may create a change in community structure [39]. Previous studies have found that seagrass hosts juvenile commercial species, acting as a nursery [23,29]. The presence of *P. pollachius* in this study indicates that Studland Bay seagrass provides a nursery ground for this commercial species [40].

It has been suggested that seagrass provides a lower-energy environment that is of importance for pollack fry [41]. The results and analysis suggest there was a notable difference in the fish community between seagrass and mooring scar sites within Studland Bay. One major difference is the habitat types, mooring scars are described as sandy bottoms and seagrass is characterised as a three-dimensional habitat [41]. For example, *G. flavescens* was most frequently found in seagrass compared to the mooring scars and this supports past literature that suggests this species prefers complex three-dimensional seascapes [42]. Furthermore, the change between the seagrass and sandy patches (mooring scars) produces a boundary with a change in environmental variables like water flow and sediment size that may be specific requirements for fish species [43,44]. The mooring scars in Studland Bay can be characterised as fragmentation; described by Fahrig [45], as the process where a habitat is disturbed, creating smaller areas of that habitat like a matrix. Furthermore, the results in Figure 3 present a lower presence of small juvenile fish including *P. pollachius* and *S. cantharus* in the mooring scars compared to the seagrass, which supports the findings of Jackson et al [16].

Their argument explaining these results is that the seagrass has a stable environment, and the fragments lack protection from predators. Fragmentation of the Studland Bay seagrass habitat is hopefully being averted by the declaration of a voluntary no-anchor zone [46] and an increasing installation of eco-moorings with elastic rodes overseen by the Studland Bay Marine Partnership [46].

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