



A Comparison of the Carbon Sequestration Potential of Vegetation Types in an Irish Salt Marsh.

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What is a salt marsh and why are they important?

Salt marshes are vegetated regions which are periodically flooded by the tides. They are highly effective at sequestering carbon in their sediments.

Salt marsh soils become depleted in oxygen due to their saturation with water which inhibits the decomposition of organic matter. Therefore, much of the carbon held within the plant matter is maintained in the soils. In addition, sediments containing carbon can be washed in by the sea, trapped by the vegetation and settle in the soils. However, salt marshes are increasingly under threat. Dramatic sea level rise could increase the time spent underwater sufficiently to effectively drown these habitats. Once the habitat has died it no longer sequesters carbon. The carbon stored in the soils is eroded by the ocean and may then be outgassed into the atmosphere. They have also been frequently converted, through drainage and barriers, into agricultural land. When drained and converted the soils begin to decay and much of the carbon is released as gas into the atmosphere.

Aims of the Project

1. To measure the average amount of carbon stored per unit area of the salt marsh.
2. To compare the carbon sequestration of the various vegetation types in the marsh. Particularly between native and non-native species.
3. To compare the amount of carbon stored in the salt marsh to other terrestrial and blue carbon environments.

The Site

The site studied at the mouth of the Baldoyle Estuary in North Co. Dublin. The marsh is a nature reserve and contains a high variety of plant, bird and marine species. It serves as a winter nesting place for Brent geese as well as Curlews, Godwits and Redshanks.

The marsh contains four main vegetation types. The native communities are Atlantic Salt Meadow (ASM), Mediterranean Salt Meadow (MSM) and mosaic regions. These regions are the oldest part of the marsh, the soils are peaty like those of a bog and extremely rich in organic carbon.

In the lower elevations exists a much larger area of salt marsh which primarily consists of *Spartina Anglica*, a non-native species which has colonised the lower mudflat area which previously was uninhabited by the other, less salt tolerant species. The soils in the *Spartina* swards are less densely compacted than the ASM and MSM regions and contain less organic sediments. However, they cover a much larger areas and are often have much deeper soils.

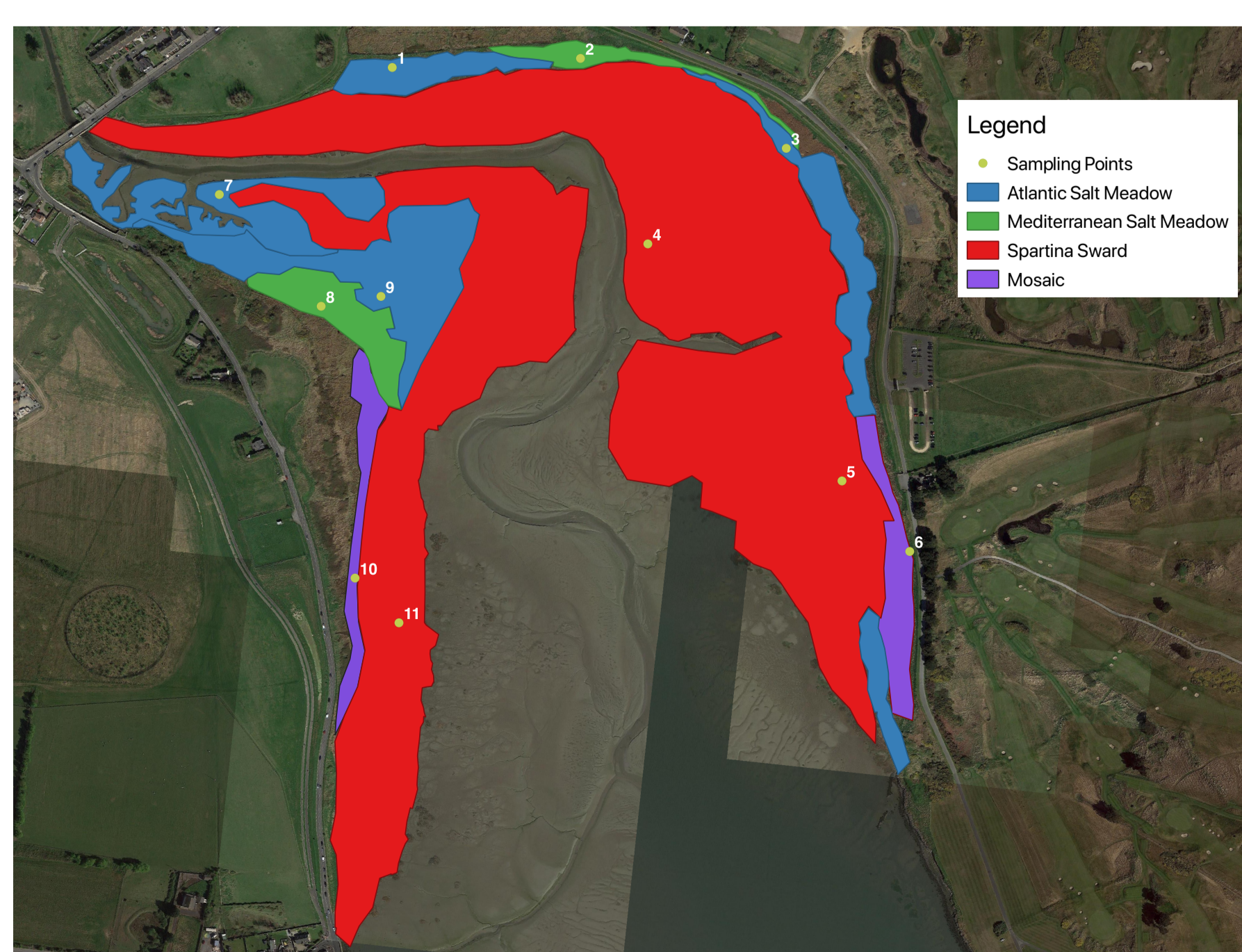


Figure 1: Map made in QGIS of the salt marsh at Baldoyle Estuary showing the extent of the different vegetation types and the sampling points.

Quick Blue Carbon Facts

> Blue carbon environments occupy only 0.2% of the ocean surface but they contribute 46.9% of carbon burial in marine sediments (Duarte et al., 2013).

> Roughly 12-20% of CO_2 emissions worldwide come from the loss of natural carbon sinks (Duarte et al., 2013).

> Freshwater marshes, such as bogs, release high amounts of methane. Methane release in saline marshes is inhibited by the sulfate in seawater (Fonseca et al. 1993).

> 25-50% of vegetated coastal habitats worldwide have been lost in the past 50 years (Duarte et al., 2013).

Mapping

The first step was to map the extent of the different vegetation types. A map of the vegetation types was found in a survey of the marsh created by the National Parks and Wildlife Service in 2011. This was then recreated using QGIS (a geospatial information systems software). Random points were generated using QGIS within each of the different vegetation types (figure 1) and the location of these points was used as a sampling regime.

Fieldwork

At each sample point a sediment core was taken. Coring involves inserting and retrieving a metal half cylinder (called a gouge auger) into the soil. The cores were then separated into sections based on the composition of the soil. 5cm subsamples from each section were retrieved and placed in sample bags for transport to the laboratory.

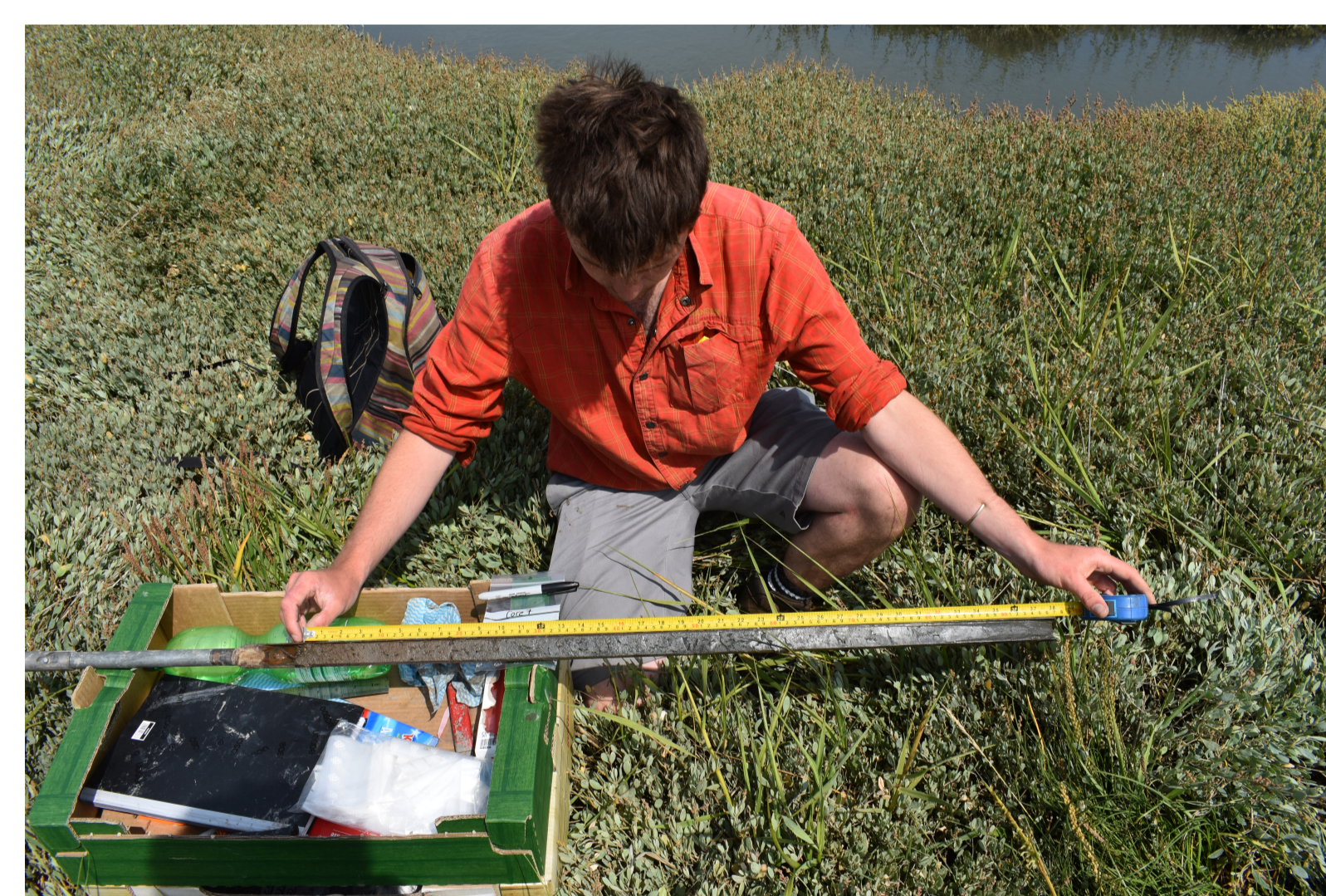


Figure 2: Rory Staines (a helping friend) measuring a retrieved core from the Atlantic Salt Meadow region of the marsh.

Laboratory Work

The laboratory work involved two processes: loss on ignition (LOI) and elemental analysis (EA). Both methods produce a measurement of organic carbon. LOI is cheap and easy to run on a large number of samples but is less accurate. Elemental analysis is more accurate than LOI, however only a third of the samples were elementally analysed due to the cost and restricted access to the machinery.

All the samples were dried overnight in an oven and weighed. For loss on ignition the samples were heated to 500°C for 4 hours and then weighed again. At this temperature the organic matter is released as CO_2 and other gases. The change in weight represents the total loss of organic matter. Elemental analysis involves heating the samples to 1000°C and measuring the amount of CO_2 produced.

Calculations

Once a measure of organic carbon had been obtained a series of calculations were carried out to obtain an average carbon density for each section of the core. Summing these gave the amount of carbon per hectare found in each core. The cores were averaged across each vegetation type. The amount carbon per hectare was multiplied by the area covered by each vegetation type which gave an estimate of the total carbon stock of the salt marsh. Uncertainties were calculated using standard deviations.

Results

The results showed that while the older, native communities did sequester more carbon per unit area, the non-native species *Spartina* sequestered the most in total. The total amount of carbon sequestered in the marsh was calculated at $12827 \pm 8696 \text{ MgC}$. The average amount of carbon sequestered per hectare by the varying vegetation types was found to be $514 \pm 442 \text{ MgC Ha}^{-1}$ by the Atlantic Salt Meadows, $375 \pm 21 \text{ MgC Ha}^{-1}$ by the Mediterranean salt meadows, $458 \pm 38 \text{ MgC Ha}^{-1}$ by the mosaic region, region and $237 \pm 160 \text{ MgC Ha}^{-1}$ by the *Spartina* swards. The average amount of carbon sequestered beneath a hectare of the marsh was estimated to be $396 \pm 138 \text{ MgC Ha}^{-1}$.

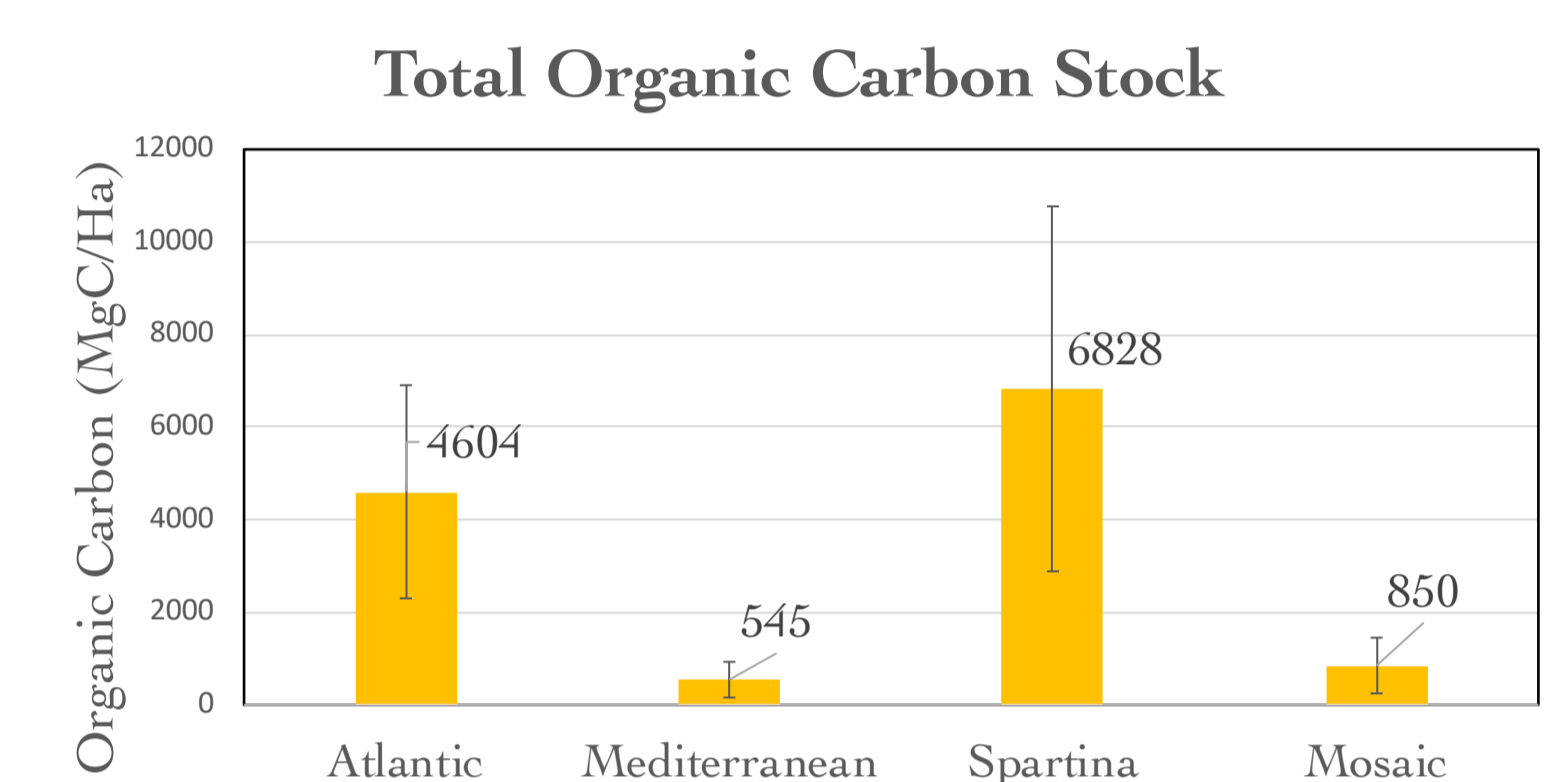


Figure 3: Graph showing the total amount of carbon stored beneath each vegetation type. Error bars represent standard error.

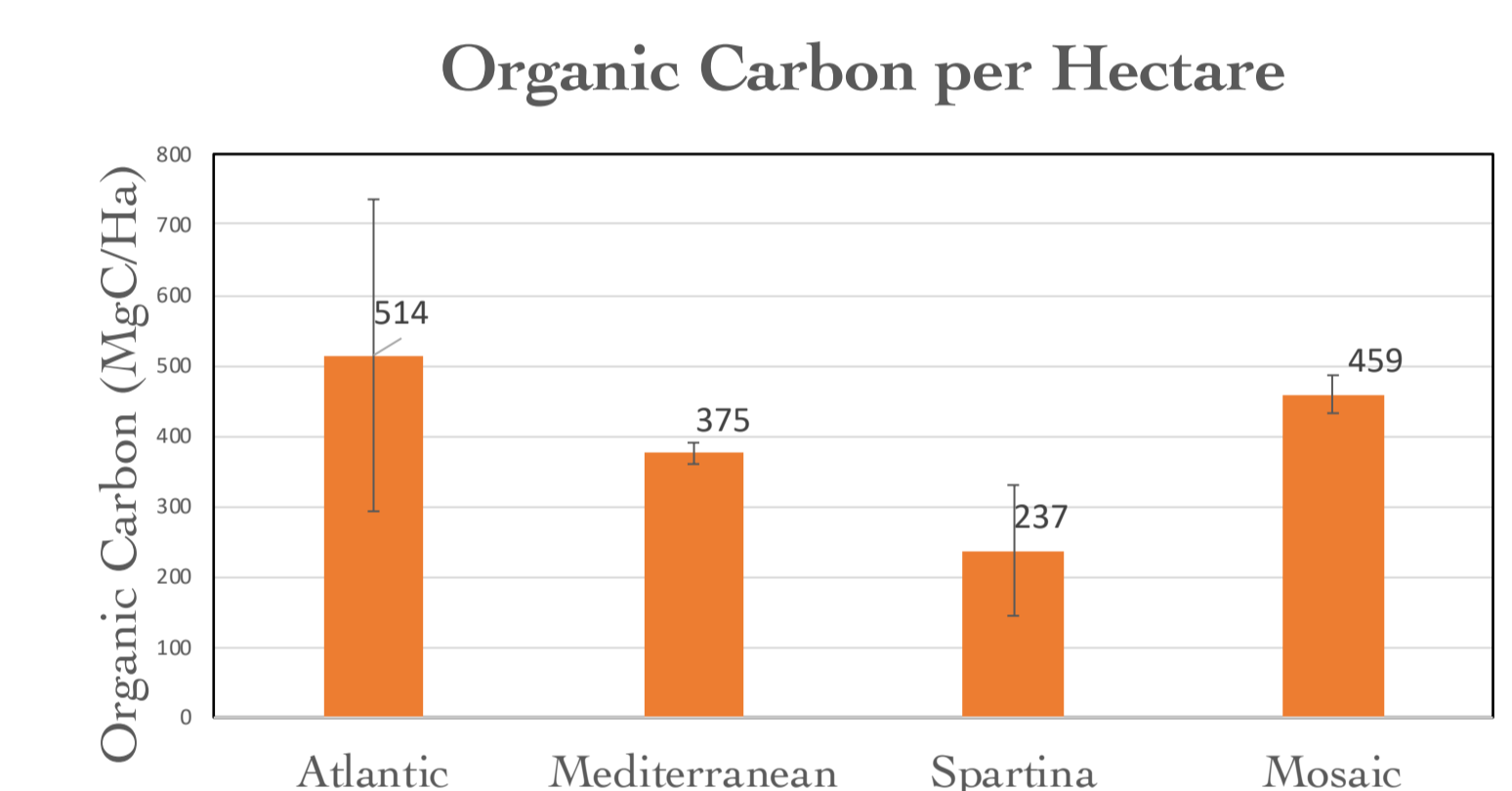


Figure 4: Graph showing the average amount of organic carbon per hectare stored beneath each vegetation type. Error bars represent standard error.

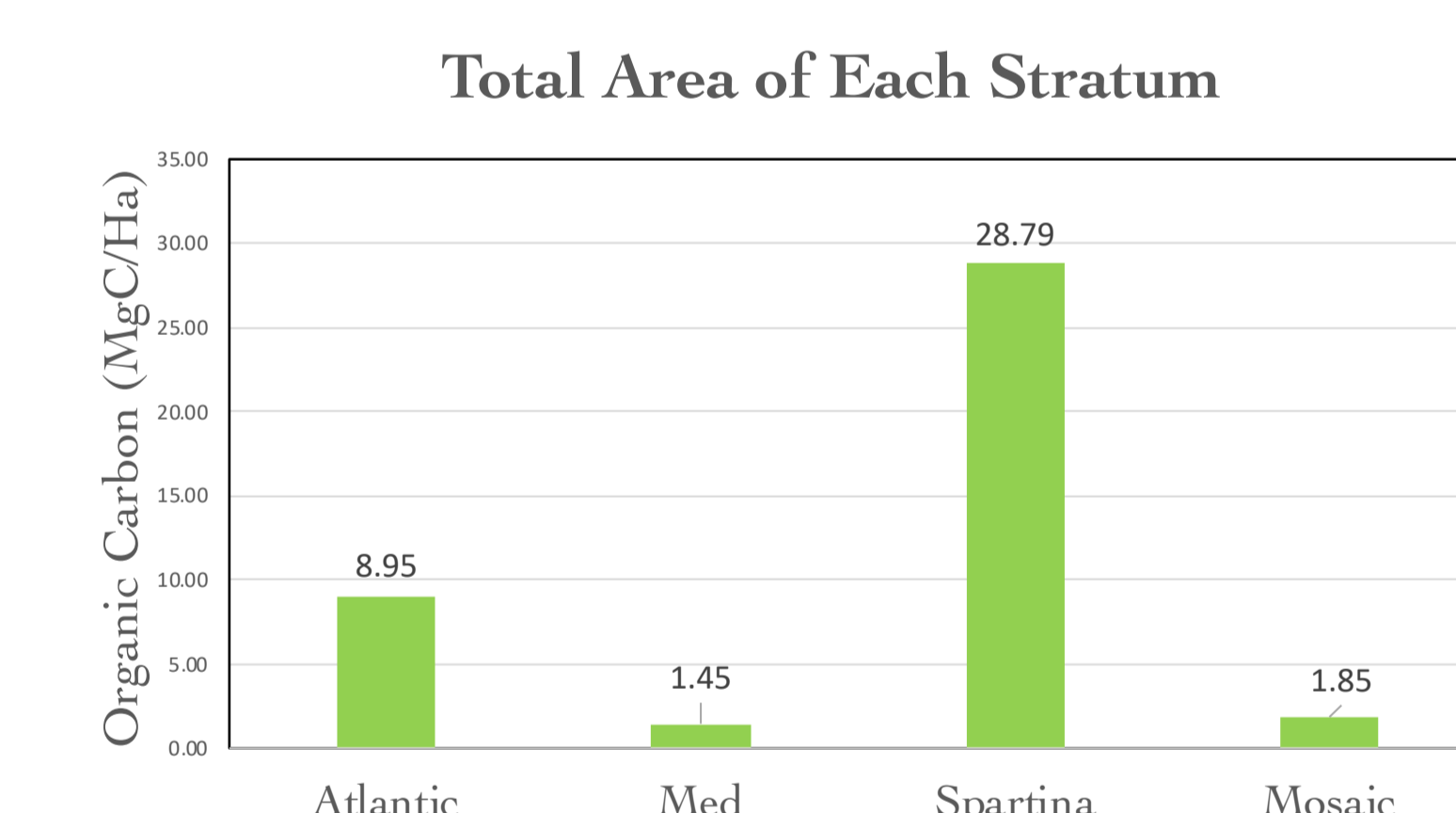


Figure 1: The area of each vegetation type across the salt marsh.

Conclusions

The results show that most of the carbon sequestered in the marsh is found beneath the *Spartina* swards. This is particularly significant as the *Spartina* swards represent the youngest region of the marsh. It shows that although *Spartina* is a non-native species it has more than doubled the carbon sequestration ability of the marsh over a short time span.

Although *spartina* sequestered the largest total carbon, it had the lowest organic carbon per hectare. The reason it sequestered the most carbon in total was not due to effective carbon storage but merely due to covering a larger area. *Spartina* covered 70% of the total area of the marsh. Much of this area was previously uncolonised mudflat.

Acknowledgements

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