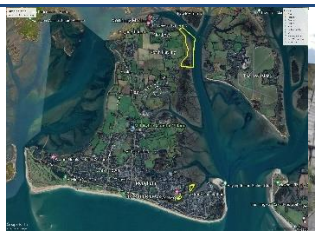
INTERTIDAL SEAGRASS RESTORATION IN THE SOLENT

First steps with the dwarf seagrass *Zostera noltei*

19/11/2024

A report for the Solent Forums Natural Environment Group



PREPARED FOR	PREPARED BY
Solent Forum c/o Hampshire County Council Universal Services The Castle, Winchester Hants SO23 8UD	Fathom Ecology 39 Maisemore Gardens Emsworth Hampshire PO10 7JX
https://www.solentforum.org/	www.fathom-ecology.com
Phone: +44 (0) 370 779 5206 Email: solentforum@hants.gov.uk	Phone: +44 (0) 2394 352962 Email: info@fathom-ecology.com

Document Release and Authorisation Record			
Job Number	J2024_0140_NEG_Seagrass		
Client Name	South Downs National Park Authority		
Client Contact	Karen McHugh		
Date Draft Issued	20/11/2024		
This Version Authorised By	**Name**	**Date**	**Signature**
Draft	Rayner Piper	20/11/2024	

Table of Contents

Table of Figures

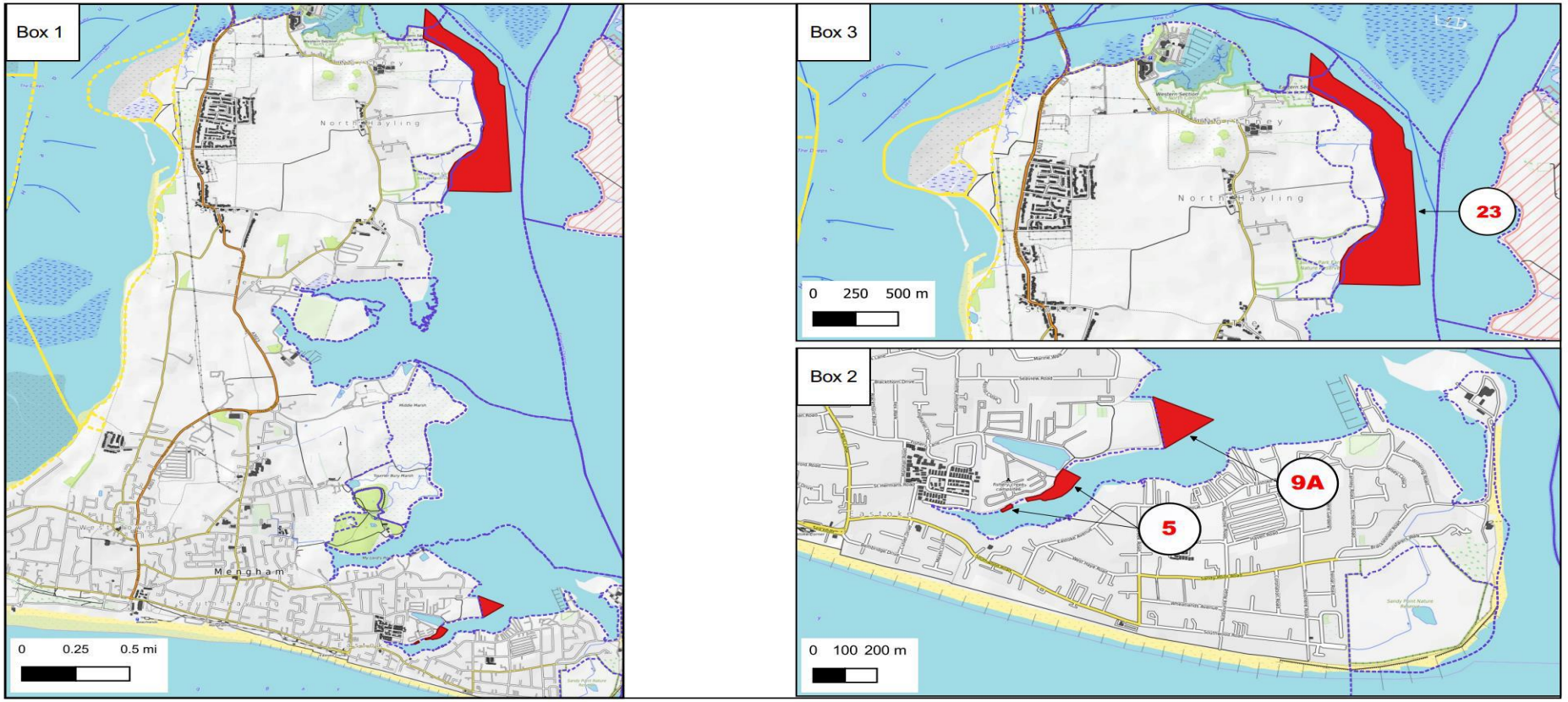


Figure 1. Sites investigated for their potential as seagrass restoration sites

1.1. Company Background

Fathom Ecology Ltd www.fathom-ecology.com a small consultancy advising on fit for purpose environmental data for infrastructure projects in or adjacent to marine, estuarine and freshwater environments. The company provides specialist advice on the assessment of the effects of disturbance on aquatic environments and on mitigation and compensation measures required in the reduction of risk to both the developer and the environment.

1.2. Introduction

Fathom Ecology Limited submitted a funding application for the amount of £2,950 to the Solent Forums Natural Environment Group (NEG) in March 2021. The application was successful and was awarded on the 14th of April 2022. The project experienced delays as contracts postponed during lockdown had to be delivered by Fathom Ecology. This report describes the methodologies, findings and outcomes of the project: Intertidal Seagrass Restoration In the Solent: First steps with the dwarf seagrass *Zostera noltei*. The original funding application submitted to NEG is provided in **Appendix A**.

1.3. Site Selection

Contact was made with Chichester Harbour Conservancy to discuss the merits of the project. The newly formed *Chichester Harbour* Protection and Recovery of Nature (*CHaPRoN*) were highly supportive of the project.

The east coast of Hayling Island had been previously identified as the ideal location for the restoration of Zostera noltei given the:

1. Thriving beds known to occur in nearby Mill Rythe from where seeds and plugs may be gathered.
2. The sheltered location of the east coast of the harbour being mostly protected from the prevailing south-westerly weather systems.
3. The area is protected from the worst effects of eutrophication, being located some distance from each of the three Wastewater Treatment Works at Appledram, Bosham & Thornham, that discharge effluent into the harbour (although discharges from Budds Farm in the nearby Langstone Harbour are occasionally evident on the east coast of Hayling).
4. The Conservancy owned areas of the intertidal that may be suitable for the project. This was hugely important as the proposed east coast of Hayling was within Chichester Harbour SSSI and the landowner's permission was required for the SSSI license application that had to be agreed with Natural England.

Figure 1 shows the 3 parcels of land under the ownership of Chichester Harbour Conservancy (CHC) that were identified as possible project sites for the project.

1.4. Site Selection Survey

Three sites were identified as having potential for the project. These were:

- Northney (Site 23, Figure 1);
- Mengham (Site 9A, Figure 1); and
- Lakeside (Site 5, Figure 1).

Each of the three sites was first visited between the 18th and 21st of March 2023 and were surveyed between the 7th and the 14th of April 2023. At each sampling site redox potential was measured and sediment samples were collected for Particle Size Analyses (PSA) and Total Organic Carbon Content (TOC) analysis.

Figure 2. Sediment sample collection

Surveyor towing sediment samples on sledge

Sediment core and seagrass

1.5. Survey Results

1.5.1 Redox Potential

Redox potential or oxidation-reduction potential measures at mV ORP is an important parameter to measure as it influences the chemical and biological processes in the sediments where seagrass roots grow. The redox potential determines whether the sediment environment is oxygen-rich (oxidising) or oxygen-poor (reducing), and this has direct consequences for the health and survival of seagrasses.

Previous studies on dwarf seagrass identified that a redox potential of between 185-331 mV was considered necessary for Zostera noltei to thrive (Valle et al., 2009). All sites were sampled at low tide for their redox potential using a Hanna instruments HI 9829 multiparameter probe (Table 1). The sites at Northney and Mengham had suitable Redox potential for Z.noltei at the time of the survey, whilst the redox at Lakeside was below the recommended values for dwarf seagrass.

Table 1. Redox Results from the 12 sampling sites.

Site	Redox (mVORP)
Northney 1	225.0
Northney 2	235.6
Northney 3	298.9
Northney 4	321.9
Northney 5	211.5
Northney 6	274.4
Mengham 1	249.5
Mengham 2	310.7
Mengham 3	191.0
Lakeside 1	185.3
Lakeside 2	127.4
Lakeside 3	142.8

1.5.2 Particle Size Analyses (PSA)

A 0.1 m^2 sediment core was collected from each of the twelve sites and sent to a UKAS accredited laboratory for particle size analyses (PSA) and Total Organic Carbon. The PSA analysis identified the sediments to be variations of gravelly muds at Northney and Mengham and muddy sands at Lakeside according to the Folk Classification 1954 (Figure 4).

Fathom Ecology: Particle Size Results - Chichester Harbour

Station ID	Date Sampled	Visual description pre-analysis	Blott & Pye (2012) classification	Folk (1954) classification	BGS (1982) cl (modified fron
Northney1	07/04/2023	Sandy mud with a few shell fragments	Very slightly gravelly sandy mud	Slightly Gravelly Sandy Mud	Slightly Gravell
Northney2	07/04/2023	Sandy mud with very small shells, shell fragments and organic fragments	Sandy mud	Slightly Gravelly Sandy Mud	Sandy
Northney3	07/04/2023	Gravelly sandy mud with shell fragments	Gravelly sandy mud	Gravelly Mud	Gravelly
Northney4	07/04/2023	Sandy mud with a few shells and shell fragments	Very slightly gravelly sandy mud	Slightly Gravelly Sandy Mud	Slightly Gravell
Northney5	07/04/2023	Sandy mud	Sandy mud	Sandy Mud	Sandy
Northney6	07/04/2023	Sandy mud with very few gravel particles, small shells and shell fragments	Slightly sandy mud	Slightly Gravelly Sandy Mud	Sandy
Mengham1	14/04/2023	Muddy sand with a few gravel particles, small shells and shell and organic fragments	Muddy sand	Slightly Gravelly Muddy Sand	Muddy
Mengham2	14/04/2023	Sandy mud with very few small shells, shell fragments and organic fragments	Sandy mud	Slightly Gravelly Sandy Mud	Sandy
Mengham3	14/04/2023	Sandy mud with very few small shells, shell fragments and organic fragments	Very slightly gravelly sandy mud	Slightly Gravelly Sandy Mud	Slightly Gravell
Lakeside1	14/04/2023	Muddy sand	Muddy sand	Muddy Sand	Muddy
Lakeside2	14/04/2023	Sandy mud with a few shell fragments and organic fragments	Very slightly gravelly sandy mud	Slightly Gravelly Sandy Mud	Slightly Gravell
Lakeside3	14/04/2023	Sandy mud with one gravel particle, a few shell fragments and organic fragments	Slightly gravelly sandy mud	Gravelly Mud	Gravelly

Figure 3. PSA Results.

Valle et al., 2015 provided evidence that the ideal particle size for Z. noltei was between 1.47 to 5.9 phi. Table XX presents the findings from the PSA for the 12 samples analysed. All sites fell within the ideal parameters as described by Valle et al., 2011 and 2015.

SAMPLE	PHI	Sorting
Northney1	2.142	Very Poorly Sorted
Northney2	2.344	Very Poorly Sorted
Northney3	4.672	Extremely Poorly Sorted
Northney4	2.928	Very Poorly Sorted
Northney5	2.489	Very Poorly Sorted
Northney6	2.384	Very Poorly Sorted
Mengham1	2.054	Very Poorly Sorted
Mengham2	2.622	Very Poorly Sorted
Mengham3	2.366	Very Poorly Sorted
Lakeside1	2.185	Very Poorly Sorted
Lakeside2	2.583	Very Poorly Sorted
Lakeside3	3.592	Very Poorly Sorted

1.5.3 Total Organic Carbon (TOC)

Valle (2009) reported that the ideal Total Organic Carbon content of sediments in which *Z.noltei* grows is between 1 and 10%. Table 2 below presents the TOC results from the 12 sediment samples taken at Northney, Mengham and Lakeside. All sites had TOC levels within the parameters set out by Valle et al.,2015.

Table 2. TOC Results

SAMPLE	DATE	Total Organic Carbon Content (%)
Northney1	07/04/2023	6.09
Northney2	07/04/2023	6.16
Northney3	07/04/2023	7.68
Northney4	07/04/2023	8.64
Northney5	07/04/2023	4.91
Northney6	07/04/2023	10.43
Mengham1	14/04/2023	2.54
Mengham2	14/04/2023	5.81
Mengham3	14/04/2023	12.78
Lakeside1	14/04/2023	3.14
Lakeside2	14/04/2023	9.59
Lakeside3	14/04/2023	8.67

The sediment sample and redox analysis identified that both Northney and Mengham were potentially suitable for the site of a seagrass restoration project. Lakeside was deemed unsuitable as the redox values were below those identified as suitable for *Z. noltei*.

1.5.4 Findings following sample analysis and site visits

The redox potential (mVORP) at Northney and Mengham were within the preferred values of Z.noltei, whilst those measured at Lakeside fell below the recommended levels. As a result of these findings Lakeside was rejected as a potential site for the seagrass trails.

On the second visit to the sites in April 2023 Mengham was shown to have existing healthy beds of both dwarf seagrass Z. noltei and the narrow leaved intertidal variant of common seagrass Zostera marina (var angustifolia). This ruled out the site being used for the restoration trails.

This left Northney as the best available site for the project. Figure 4 below shows the approximate location where the sediment samples were collected (N1-N6) and the site where the trails were carried out. The site was especially important having been a site where seagrass was previously known to occur but where none had been reported since before 2015. See Figure 5 (Marsden and Scott., 2015).

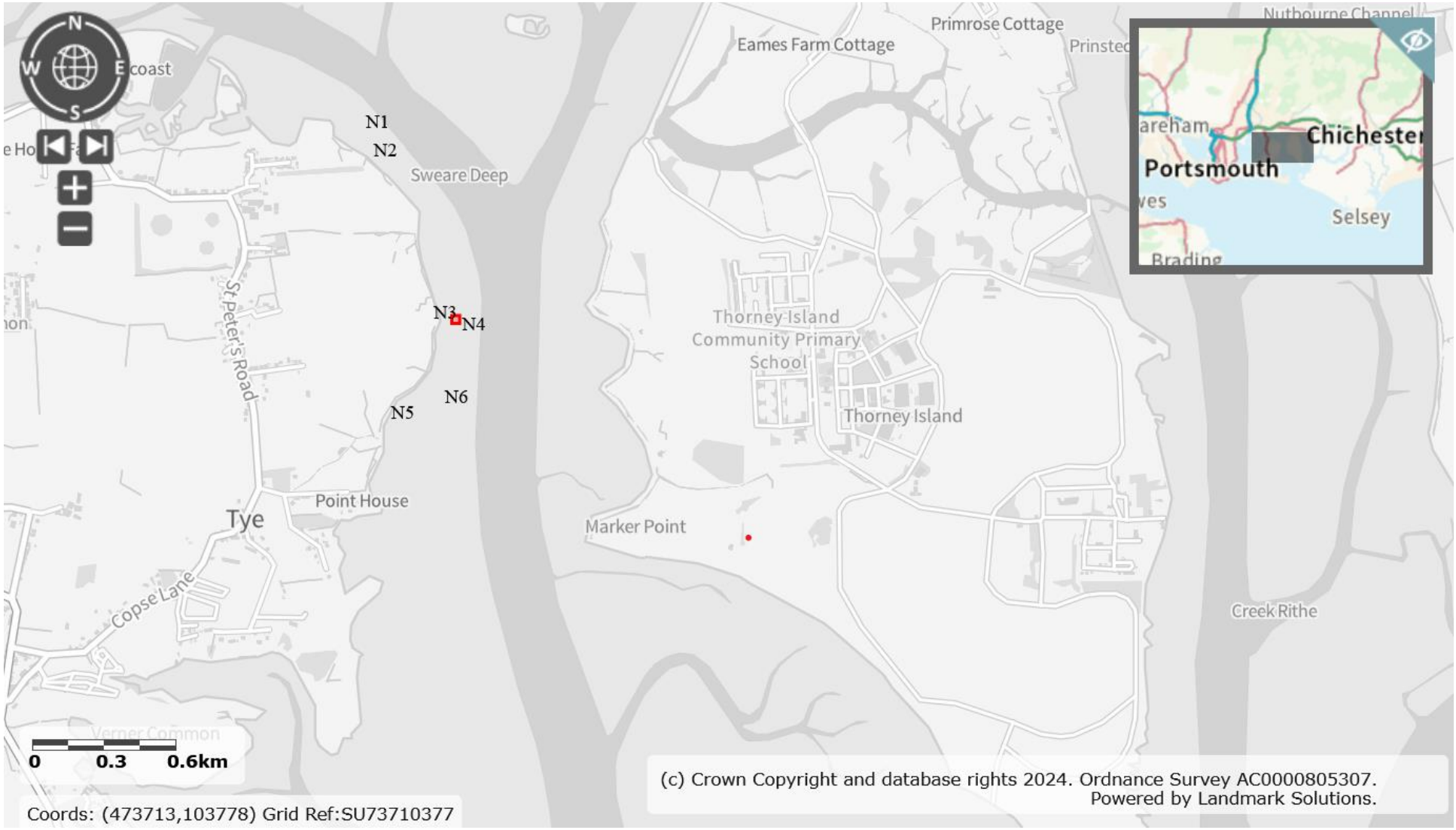


Figure 4. Locations of the six sites sampled at Northney and the restoration site (red). Image taken from https://magic.defra.gov.uk/

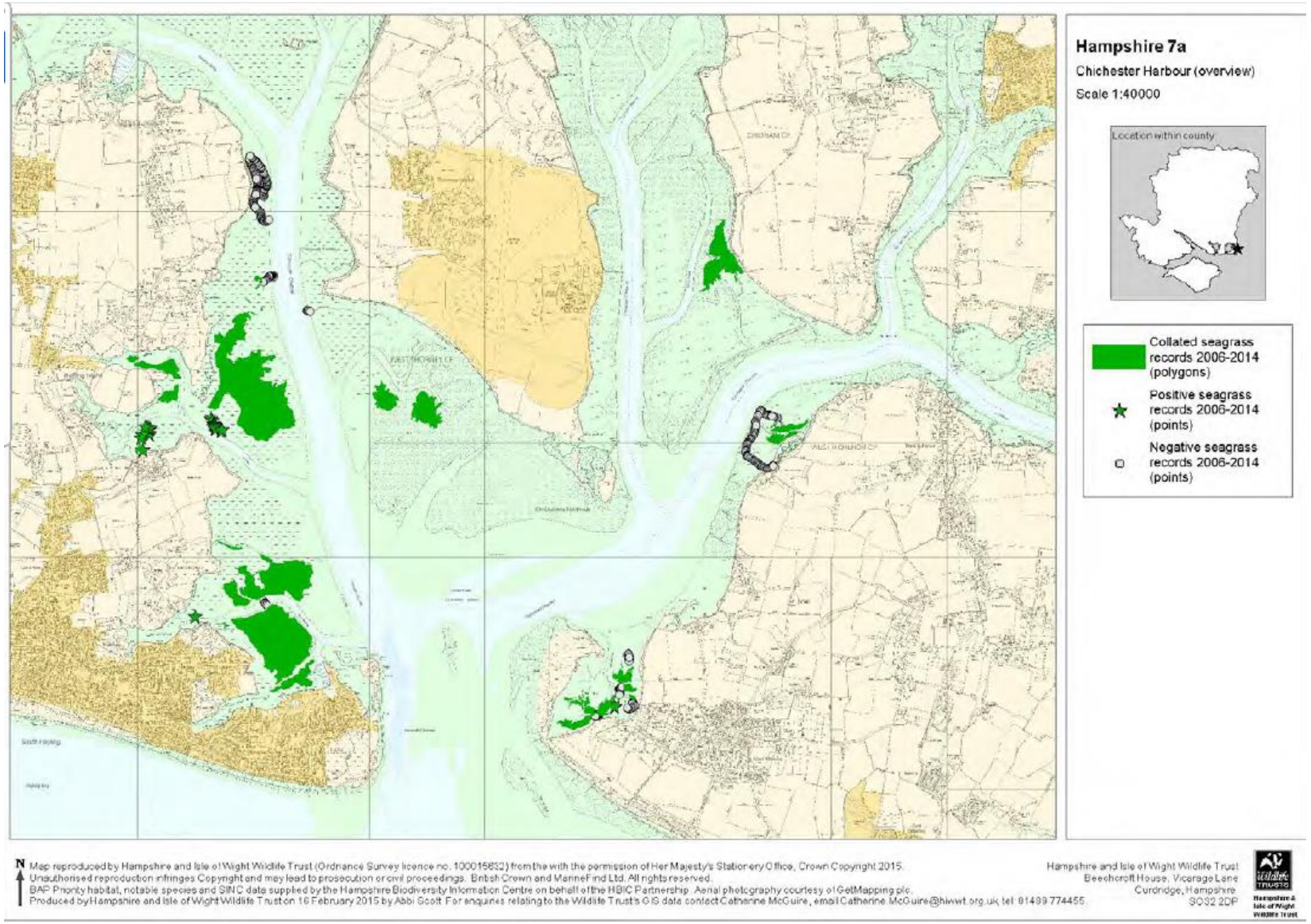


Figure 5. Marsden & Scott. 2015. Inventory of eelgrass beds in Hampshire and the Isle of Wight 2015, Section Two: HIWWT

1.6. Consultation with Natural England

Once the site at Northney had been identified a SSSI consent was submitted by CHAPERON to Natural England (NE).

The original intention of the seagrass trials was to investigate 3 methods for restoration. These were:

- Collection of seeds from existing beds at Mill Rythe during the summer. Seeds would be placed into small hessian bags filled with sand. The bags will be staked to the seabed using hazel stakes.

- Plugs of 7.5 cm diameter will be collected from seagrass bed at Mill Ryther. The plugs will contain shoots, roots, rhizomes and associated sediments. The plus will be extracted from Mill Rithe at low tide and transported to their new location for planting.

- Rhizomes will be removed from intertidal mudflats at Mill Rythe, placed in hessian sacks filled with inert sand. These bags will be placed upon the surface sediments of plot 3.

Following discussions with NE it became apparent that a license would not be granted for the collection of plugs or rhizomes, which had proved the most successful methods for restoration in Europe and North America, and so would need to focus upon seed collection.

Rather than gather seeds from existing beds at Mill Rythe it was decided to trail the collection of seeds from storm washed seagrass from the strandline around Chichester Harbour.

A total of five techniques would be trailed at Northney. It was envisaged that each of the techniques below would require a 10 x 10 m plot on the intertidal. This turned out to be a highly optimistic intention as it was reliant on both seed collection and most importantly successful germination of the collected seeds. The five techniques licensed by Natural England to be trailled were:

- Plot 1. Control – Ephemeral algae removed. No planting
- Plot 2*. Seagrass seeds collected from rotted seagrass, stored in cold saline water over winter then freshwater shocked and germinated in harbour mud before planting out.
- Plot 3**. As plot 2 but shoots held in place with iron nail anchors
- Plot 4***. Seagrass seeds previously ingested by ducks (Brent goose substitutes) injected into sediment along with duck faeces.
- Plot 5****. Planting of seagrass seeds that had been stored dry over the winter.

*Plot 2 had been previously trialled with some success in nearby Langstone Harbour by the Hampshire & the Isle of Wight Wildlife Trust (HIWWT). **Iron nails had been shown to greatly improve the chances of successful restoration by Tan et al 2020. *** The use of ducks was inspired by a paper by Tol et al 2021; Mutualistic relationships in marine angiosperms: Enhanced germination of seeds by mega-herbivores. ****Plot 4 using dried seeds was a new technique not known to be trailed previously, that was inspired by seagrasses evolutionary links to terrestrial plants, and the storage of terrestrial seeds in dried paper packets.

2. Seed Collection

Before any of the aforementioned techniques could be trialled it was necessary to collect seagrass seeds. Given the late season – August 2023 it was decided that the best approach for seed collection would be to trail collecting viable seeds from seagrass washed up in the strandline. Initial investigations showed that both viable seeds and sometimes plants with rhizomes were washed on to the shore. The question was how to collect large enough quantities to collect sufficient seeds for the proposed trails.

It was decided that members of the public would be encouraged to help, volunteering as citizen scientists gathering seagrass from the strandline. Chichester Harbour Conservancy's CHaPRoN team invited Fathom Ecology to promote the project at the Emsworth Green Fair held at the Emsworth Sailing Club. A poster was produced entitled "Seagrass Needs You!" (Figure 6). The poster encouraged citizen scientists to act as Seagrass superhero's collecting seagrass and depositing it in strategically placed wheely bins around the harbour (Figure 7).

Seagrass bins were placed at a number of sites around the harbour, with their locations regularly updated. Four sites were used in all. These were CHC's Itchenor office, Prinsted Sea scout hut, Emsworth Yacht Harbour and Emsworth Sailing club.

A social media campaign was launched by Chichester Harbour Conservancy and to a lesser extent by Fathom Ecology promoting the campaign and encouraging "Seagrass superheroes" to collect seagrass from the strandline and place it in the strategically placed bins (Figure 8). The social media campaign was a great success and reached hundreds of people via the CHC website and CHaPRoN's and Fathom Ecologys social media posts on facebook & Instagram.

The response to the project was encouraging with much local media interest, with articles written in the Ems, and also used as promotion for the Green Party who encouraged both their members and those standing for council to get involved with the project (Figure 9).

CHICHESTER HARBOUR SHORELINE SEAGRASS SAFARI

CAN YOU HELP US RESTORE SEAGRASS WITHIN CHICHESTER HARBOUR?

We need your help to collect seagrass washed ashore this October.

Seagrass Bins will be placed at Emsworth Sailing club and Chichester Harbour Conservancy's Itchenor Office between the 21st and 31st of October.

Whilst walking along the harbours beautiful coastline please keep your eyes open for seagrass in the strandline.

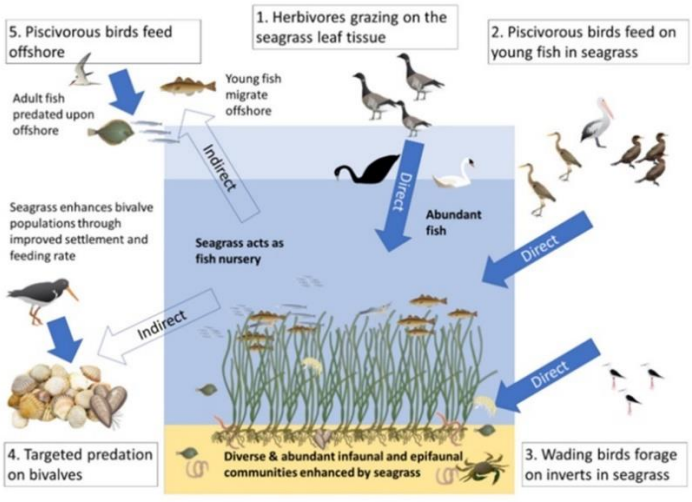
If you are lucky enough to find any please collect it, pop it into a plastic bag, then deposit the seagrass, minus the bag, in one of our two seagrass bins.

Seed will be harvested from the seagrass bins and used to restore a seagrass bed at Northney next spring. Next Your help will be vital for our efforts.

SEAGRASS WASHED UP ON THE MILL RYTHE & EAST HEAD STRANDLINE, CHICHESTER HARBOUR.

WHY IS SEAGRASS IMPORTANT?

- Seagrass is food to internationally important populations of wintering wildfowl;
- Seagrass acts as a nursery ground to seabass and other commercially and ecologically important fish species;
- It is habitat to some of our rarest marine invertebrates;
- Although seagrass accounts for 0.2% of the worlds oceans it sequesters ~10% of the carbon buried in the ocean!



WITH THANKS TO THE NATURAL ENVIRONMENT GROUP OF SOLENT FORUM FOR THE FUNDING AND TO THE OTHER ORGANISATIONS FOR THEIR SUPPORT:

SOLENT FORUM · CHICHESTER HARBOUR · University of Brighton · Fathom Ecology

FOR MORE INFO PLEASE CONTACT: info@fathom-ecology.com

Figure 6. Seagrass Needs You Poster exhibited at Emsworth Green Fare, September 2023.

Figure 7. Map of Seagrass Bin Locations.

Seagrass bin placed at Emsworth Yacht Harbour	QR Code leading to: https://www.conservancy.co.uk/save-our-seagrass-be-a-seagrass-superhero/

Figure 8. Seagrass bin and QR code located on the bins lid.

A total of 8 bins full of strandline -deposited seagrass was collected with help from over 40 seagrass superhero's. This was encouraged by various local media (Figure 9).

EMSWORTH
GREEN NEWS
WINTER 2023 Issue 7

CLLR Grainne Rason

Reuben Mychaleckyj

HAPPY NEW YEAR

Green Reuben Mychaleckyj: photos of Reuben with Rayner collecting seagrass

Photo of Reuben in lab growing seagrass

Photo of Reuben monitoring seagrass

SEAGRASS SUPERHERO

Our Green Campaigner Reuben Mychaleckyj is working hard with Chichester Harbour conservancy and Hampshire Wildlife Trust to save the seagrass in the Solent. **"Seagrass is an amazing tool to combat the damage to our harbours,"** says Reuben. **"It cleans the water, stores carbon dioxide 35 times faster than a rainforest and it provides a wonderful nursery for baby fish"** The recent storms means lots of the seagrass is collecting on the shoreline. Reuben is helping Rayner to collect the seagrass in bins placed around Emsworth coastline, for planting next spring when he will donning his waders to help plant the new seagrass.

FINAL STRAW MAKE A CLEAN SWEEP

Cllr Rason and Green Reuben joined The Final Straw foundation Beach clean in November with almost **80 people involved and 50kg of rubbish collected.** And the beach cleans are working as the volume collected is decreasing. And Cllr Rason met with Havant Borough Climate and Environment Lead and Final Straw Foundation to work together to produce a plan to grow awareness and positive action around plastic with our schools and colleges.

CLLR GRAINNE & GREEN REUBEN : WORKING ALL YEAR ROUND IN EMSWORTH

Environment

Be a Seagrass Superhero! Chichester project looking for citizen scientists to help

Seagrass meadows are one of the most productive ecosystems in the world, but around the UK they have declined by 95% in the last 100 years. Work is taking place across the Solent to restore this precious habitat, and your help is needed here in Chichester Harbour! Read on to find out more...

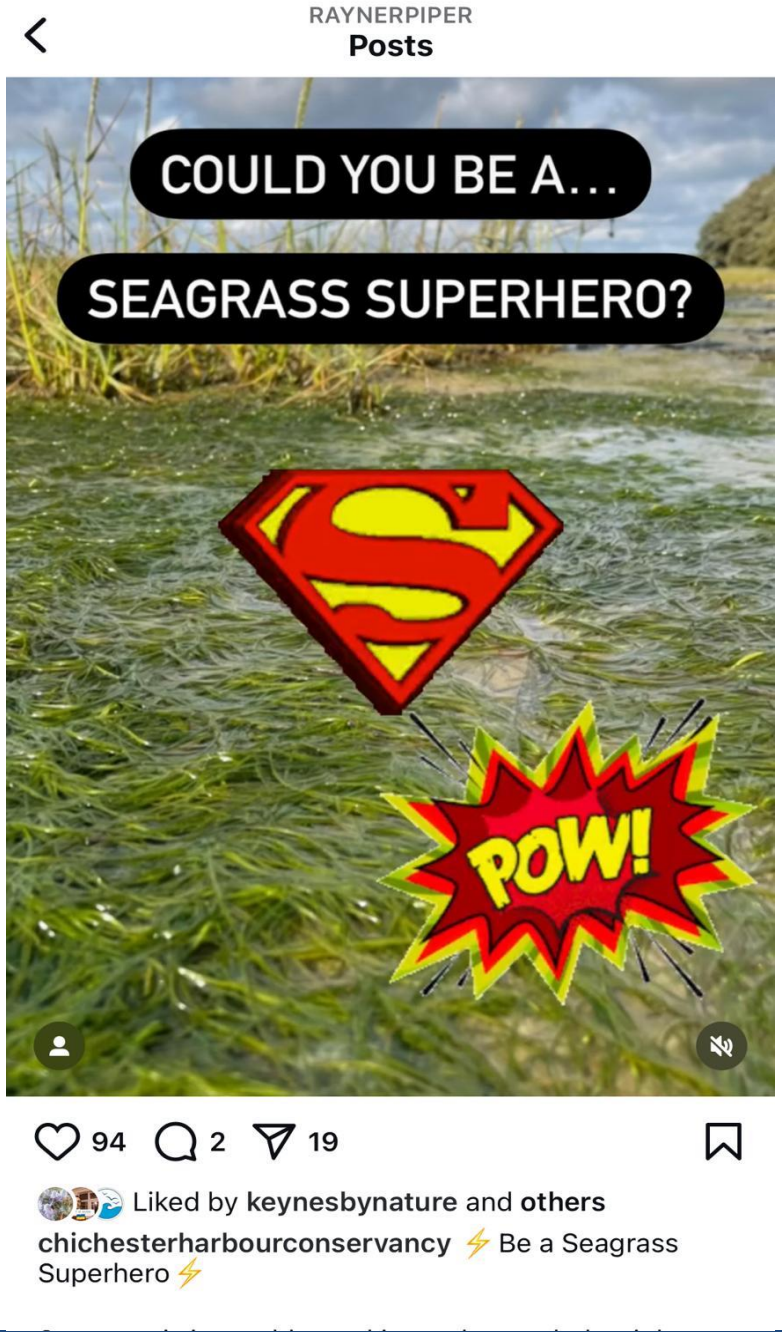


Figure 9. Local media coverage for the project

Processing and Storage of Seeds

Once the seagrass had been collected it was transported to a shipping container and placed in Vats and bins containing oxygenated seawater. The seagrass was regularly raked and overturned during this period. This disturbance encouraged the depositing of seeds and prevented stagnation. The seagrass was left in the vats from September until late December 2023. The seawater was siphoned off and replaced at 7-to-10-day intervals, a hugely labour intensive and smelly procedure! (Figure 10)

Figure 10. Processing the seagrass with help from Team *CHaPRoN!* (Photo's courtesy of Will O'Hea).

Once the seagrass had rotted down sufficiently the remaining seagrass was removed and the detritus was sieved using a 0.5µm sieve. Individual seeds were removed from the sieve using sharp nosed forceps. The removal of seeds took weeks and was undertaken for at least one hour each night for the last 2 weeks of December and into January. A total of 1788 seagrass seeds were removed from the Vat and bins. The seeds were divided into three 0.5 litre buckets and covered with approximately 2 cm of seawater and stored in the refrigerator with loosely fitted lids until early March 2024.

The seeds were inspected weekly and any with signs of fungus were removed to prevent further contamination of viable seed. May seeds did succumb to fungus and were discarded.

Whilst the seagrass was in the process of rotting and once the seagrass bins had been removed from around the harbour, keen friends and members of the public continued to collect seagrass for the project. Three carrier bags of which were subjected to an alternative processing method. The seagrass was placed in small cotton drawstring bags and placed on a heated clothes heater to dry. The seagrass turned black, dry and crispy after a week of drying. It was then crumbled and the detritus sorted and the seeds removed. Just 23 seeds were found from the dried seagrass – potentially as a result of the late season (December) when it was collected. The seeds were placed in a paper envelope and stored at room temperature for the remainder of the winter.

Figure 11. Drying seagrass and *Zostera noltei* seeds after drying (Seed photo courtesy of Will O'Hea).

Planting and germination of Seeds

Despite the vast amount of seagrass collected from the strandline very little seed was collected and not all of the seed collected survived processing and storage. Rather than the five 10 x 10 m plots envisaged at the start of the project, five 1 x 1 m plots were used within a single 10 x 10 m area.

Of the four planting methods trailed, three methods, trail 2, trail 3 and trail 4 successfully germinated (Figure 12). In total just 17 seedlings germinated from the planting of 1,811 seeds – a success rate of 0.1%! Eleven seeds germinated from trail 2 – seeds injected into the mud. Four plants germinated from trail 3 which replicated trail 2 with the addition of an iron nail inserted into the substrate. Two plants germinated from the Trail 4 the seed of which had been fed to domesticated ducks as a proxy for brent geese – Chichester Harbours answer to mega-herbivores. None of the seeds which had been previously dried germinated.

Trail 2. Seed injected into sediment

Trail 2. Seed injected into sediment

Trial 2 – Seed injected into sediment

Trial 3. Seed with nails

Trial 4. (ducks)

Trail 4 (ducks)

Figure 12. Successfully germinated seeds at Northney Restoration Site.

By late August 2024 the trail site and indeed the entire mudflat at Northney had become overgrown with seagrass – and not as a result of the restoration trails. Seagrass in particular *Z. marina var angustifolia* had germinated across the Northney mudflat and had inundated the trail area (Figure 13). This intertidal seagrass was widespread across the mudflat despite having been all but absent during 2023. *Zostera noltei* was also present on the upper shore particularly either side of a shallow

Figure 13. Trail site showing ephemeral algae and small patches of Zostera marina var angustifolia

Zostera marina var angustifolia at trail site

Zostera noltei either side of channel

Discussion

None of the methods trailed were particularly successful in germinating seed. Of the methods trailed, Trail 2 was the most successful. Trail 3 which used the same methods with the addition of iron nails was less successful. Trail four successfully germinated seeds but was less successful than trail 2 but caused considerable extra processing! In total just three plants germinated from the seed which had been previously ingested by ducks. None of the dried seeds germinated.

Despite the discouraging results of the trails, they showed that methods 2,3 and 4 could successfully germinate seagrass. It is possible that better results could have been gained using more controlled conditions. Rather than planting the seeds on the mudflat where they are subject to the weather, tide and predators, future efforts should focus upon planting the seeds in a mixture of harbour mud and silver sand at approximately 50/50 mix. The seeds should be covered in seawater and placed in shallow trays, preferably within a greenhouse to encourage growth. Once germinated the seedlings should be hardened off and then translocated to the intertidal for planting out.

Lessons learned

- The licensing process is long and convoluted. Start your application as soon as you have identified your site.
- Encourage Natural England to allow the small-scale trail of plugs and rhizomes from healthy beds.
- Rather than rot seagrass down and remove the seeds which is an arduous and highly labour-intensive process it might be better to just plant the seagrass collected at the trail site. It could then decompose in the mud and the seeds would be in place to germinate the following spring.
- The feeding of the seagrass seeds to wildfowl had some success, again this may have been better achieved by feeding the collected seagrass and seeds to the many swans that gather near the Emsworth Slipper Sailing Club and let them redistribute their “seed bombs” around the harbour. Whilst this may be more difficult to monitor it would likely be more successful.
- There was considerable interest in the seagrass project and a number of organisations were keen to get involved and expand on the project despite its limited success.
- Expansion of the project was discouraged as the recent survey of Chichester Harbour by Ocean Ecology (2024) showed that seagrass had a successful year in 2024 and was present at all intertidal sites under the ownership of CHC.
- The presence of seagrass at Horse Pool, Itchenor a site that had been previously identified as a potential site for the expansion of the project, meant that there were no suitable sites available within the harbour owned by CHC. This meant that a new license application would need to be submitted to NE if another site and landowner could be found.
- The seagrass in Chichester Harbour seems to have had an exceptional year in 2024 despite the highly publicised water quality issues. It is sometimes best to let nature take its course rather than interfere, and with dwarf seagrass this seems to be the most successful approach!

References

Leach, S.J. 2019 The Vascular Plant Red Data List for Great Britain: a summary of amendments in years 12 and 13 (2017-2018) of the annual amendments process. BSBI News 141.

Leschen, A.s., Ford, K.H. and Evans, T.N (2010) Successful Eelgrass (Zostera marina) Restoration in a Formerly Eutropic Estuary (Boston Harbour) Supports the Use of a Multifaceted Watershed Approach to Mitigating Eelgrass Loss. Estuaries and Coasts DOI 10.1007/s12237-010-9272-7.

Marsden, A. L. and Chesworth, J. C. (2014). Inventory of eelgrass beds in Hampshire and the Isle of Wight 2014, Section One: Report. Version 6: May 2014. Hampshire and Isle of Wight Wildlife Trust, Hampshire.

Marsden, A. L. and Scott. A. L, 2015. Inventory of eelgrass beds in Hampshire and the Isle of Wight 2014, Section Two: Data. Version 7: May 2015. Hampshire and Isle of Wight Wildlife Trust, Hampshire.

Renton, M., Airey, M., Cambridge, M.L., Kendrick, G.A., 2011. Modelling seagrass growth and development to evaluate transplanting strategies for restoration. Ann. Bot. 108, 1213–1223.

Valle, M., Borja, A., Chust, G., Galpasoro, I., & Garmendia, J.M, (2011) Modelling suitable estuarine habitats for Zostera noltei, using Ecological Niche Factor Analysis and Bathymetric LiDAR. Estuarine, Coastal and Shelf Science 94, 144-154.

Valle, M., Garmendia, J.M., Chust, G., Franco, J., & Borja, A (2015) Increasing the chance of a successful restoration of Zostera noltei meadows. Aquatic Botany 127 12-19.

van Katwijk, M.M., Bos, A.R., de Jonge, V.N., Hanssen, L.S.A.M., Hermus, D.C.R., de Jong, D.J., 2009. Guidelines for seagrass restoration: importance of habitat selection and donor population, spreading of risks, and ecosystem engineering effects. Mar. Pollut. Bull. 58, 179–188.

Appendix A – NEG Funding Application

Solent European Marine Sites

Natural Environment Group (NEG) Project Bidding Pro Forma

Please complete all sections and read the eligibility criteria and timescale at http://www.solentems.org.uk/natural_environment_group/NEG_Projects/**.**

Project Title:	INTERTIDAL SEAGRASS RESTORATION IN THE SOLENT: First steps with the dwarf seagrass *Zostera noltei.*
Project Sponsor/Lead (and full contact details):	Rayner Piper – Fathom Ecology Limited www.fathom-ecology.com email: rayner@fathom-ecology.com Mob: +44(0)7546510008 Tel: 01243 276817
Project Description and Objectives:	The dwarf seagrass *Zostera noltei* is an ecological engineer providing a wealth of ecosystem services including: • Providing food and nursery grounds to ecologically and commercially important fish species. • Supporting rare and protected bird species notably Dark Bellied Brent Geese *Branta bernicula*, a feature of the Solent SPA. • Stabilising sediments, preventing erosion and playing an important role in coastal protection. • Improving water quality by removing excess nutrients; and • Sequestering carbon thus helping to combat the climate emergency.

	Despite providing physical, biological, economic, and social benefits, the dwarf seagrass has suffered worldwide declines because of habitat loss and eutrophication (Valle et al, 2011). In the Solent dwarf seagrass habitat continues to be lost and fragmented (Marsden & Chesworth 2014, Fathom Ecology Limited 2020). As seagrasses decline, their importance is being increasingly recognised by conservationists and restoration efforts are being attempted worldwide. To date restorations in the UK have focused on eelgrass; *Zostera marina*, a closely related larger species of seagrass that typically grows beneath the low tide mark. This project aims to take the first steps in the restoration of the Solent's dwarf seagrass, by identifying locations within Chichester harbour where restoration could be attempted, and the species thrive. According to literature, optimal survival of transplants mainly depends on sediment type and the transplant site selection (Renton et al 2011, Valle et al 2011, Valle et al 2015). Suitable locations will be identified using topographical, sedimentological and hydrographical variables which are known to influence the distribution of dwarf seagrass. Sheltered locations are considered essential for the long-term survival of transplanted seagrass (van Katwijk et al., 2009, Valle et al 2015), as such efforts will be focused upon the east coast of Hayling Island. The east coast of Hayling is both sheltered from the prevailing winter storms and from the worst effects of eutrophication, being located some distance from each of the three Wastewater Treatment Works (Appledram, Bosham & Thornham), that discharge effluent into the harbour. A total of twelve sites will be samples and at each site a core sample will be taken to measure particle size distribution (PSD) and organic content. Redox potential of the sediment and slope will also be measured at low tide. Locations that will be considered suitable for a translocation effort must score within the preferred tolerances of dwarf seagrass, those being sediments of between 1.47 to 5.9 phi, organic material of 1-10%, a redox potential of 185-331 mV and a mudflat between 0.5 and 1.5 CD, large enough to support a restoration trial (>120 m^2) (Valle et al 2011). If a suitable location is identified, then this

	project intends to trail 3 different restoration techniques to understand which is best suited for dwarf seagrass. Three 10x10m^2 plots adjacent to one another will be marked out at the suitable location. Each plot will trial a different planting technique to test the success and efficiency of each: a. Seeds of the dwarf seagrass collected during the summer 2021 will be placed in small hessian bags filled with sand. The bags will be staked to the seabed using coir roles and hazel stakes. b. Plugs of 7.5 cm diameter will be collected from seagrass bed at Mill Ryther. The plugs will contain shoots, roots, rhizomes and associated sediments. The plus will be extracted from Mill Rithe at low tide and transported to their new location for planting. c. Rhizomes will be removed from intertidal mudflats at Mill Rythe, placed in hessian sacks filled with inert sand. These bags will be placed upon the surface sediments of plot 3. Each of the above methods has been used, with varying degrees of success, for the restoration of other seagrass species. Each plot will be monitored for survival, shoot density and epiphyte abundance at monthly intervals. The donor site at Mill Rithe, will also be monitored using field photographs for a period of 12 months. Based on results at the restoration site, a subset of areas will be chosen for medium and large scale test transplants, partnering with the HIWWT, to create ongoing monitoring and restoration efforts at further sites throughout the Solent.
What is the value of the project to the Solent European Marine Sites (SEMS), other designated sites or areas of conservation interest?	The east coast of Hayling island lies within the Solent Maritime SAC, Solent & Southampton Water SPA and Ramsar site. Seagrass beds (*Zostera* biotopes) have been recognised by the European Union as a 'subfeature' within Special Areas of Conservation (SACs) under the EU Habitats Directive, 1992 (Council Directive 92/43/EEC). The Habitats Directive states that habitats, e.g. **estuaries**, lagoons and reefs, must be maintained in their present state, **or where possible, restored to a more favourable state.**

	Dwarf seagrass are further included as sites of Community importance in the in the Habitats Directive. Dwarf seagrass are also of high relevance in the Water Framework Directive, as one of the five biological quality elements (phytoplankton, macroalgae, **angiosperms**, benthos and fishes) to be included in the ecological quality assessment of estuarine waters. Dwarf seagrass are listed on the Vascular Plant Red Data List (Leach 2019).
Project Outputs:	Baseline mapping, prioritised initial site, field trials for restoration efforts and follow up monitoring surveys at months 3, 6, 9 and 12. If the restoration proves successful, then subject to available funding, the methods could be expanded to include intertidal habitats within Langstone, Portsmouth, Newtown and Beaulieu harbours where *Z.noltei* has been recorded previously (Marsden & Scott, 2015).
Project Timescale and Milestones:	1 year period, survey, monitoring, management and field report. • March / April 2022 – baseline survey for restoration site location(s); • April 2022 – data analysis, trial site selection; • April / May 2022 – initial placement of Seagrass seeds, plugs and sods. • Ongoing monitoring for algal smothering and retention structure integrity, initial monthly checks to extend as appropriate; • Monthly collection of plant growth data and visual assessment of morphological change; • 1 year end project report and feasibility consideration for dwarf seagrass restoration within Chichester harbour and the wider Solent.
Overall Project Cost (£): *Please detail other funding sources secured/sought.*	>£5000. Match funding will be in the form of time and effort of Fathom researchers.
Funding contribution sought from NEG (£):	£2,980

The amount requested should be match funded.	
Will the project still go ahead without NEG funding?	Should this bid be unsuccessful then funds will be sort elsewhere
Geographical coverage of the project: *The project must cover some aspect of the coastal or marine environment of the Solent.*	Chichester Harbour (part of the Solent Maritime SAC)
Please list any project partners:	Chichester Harbour Conservancy
Additional information to support the Bid:	HIWWT are keen to trial seagrass for the ReMEDIES project. This trial would benefit any future restorations they attempt and is supported by the Trust.

Submission date: Please email completed forms to info@solentforum.org by the 28 February.