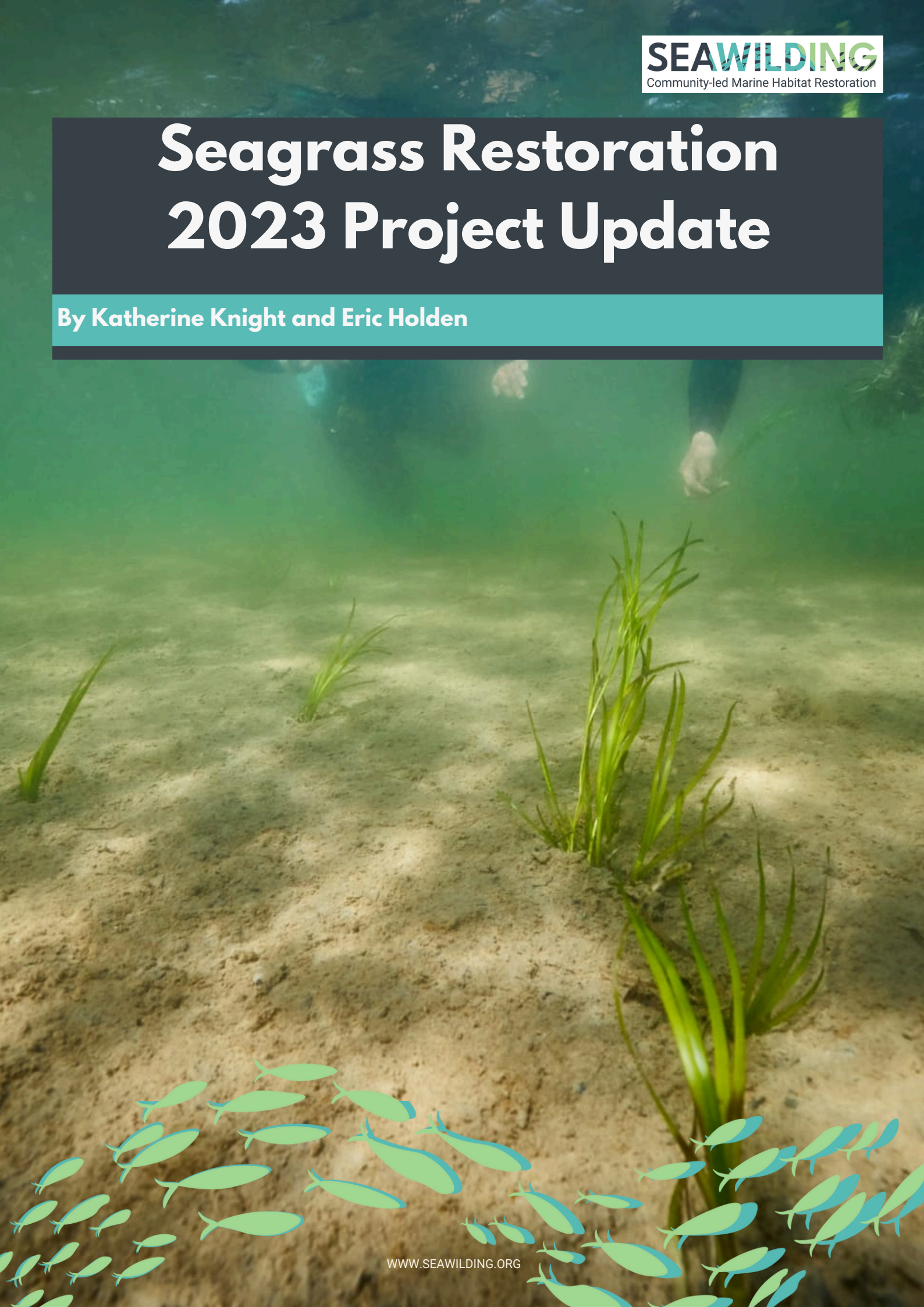
SEAWILDING
Community-led Marine Habitat Restoration

Seagrass Restoration 2023 Project Update

By Katherine Knight and Eric Holden



SEAWILDING
Community-led Marine Habitat Restoration

This report contains a summary of the seagrass restoration activities undertaken by Seawilding during 2023.

Images by Philip Price & Katherine Knight courtesy of Seawilding

This project is supported amongst others by:
The NatureScot Biodiversity Challenge Fund.
The Scottish Government's Nature Restoration Fund, managed by NatureScot.
Patagonia Environmental Grants Program Fund
The Crown Estate Scotland
Esmée Fairbairn Foundation
Brian D Newman
Steppes Travel
Bayesian Shift
John Ellerman Foundation
Lucion Group
Beco Pets
Rebel Restoration
True Travel Foundation
Weatherbys Bank
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HP

NRF NATURE RESTORATION FUND | Net Zero Scotland Scottish Government | LET'S DO NET ZERO

Rhizome Transplantation

Rhizome transplantation has been used successfully by many restoration projects around the world, notably in Canada and Scandinavia. Katherine and Eric from the Seawilding team visited Canada and learnt the techniques for this method. On their return, Seawilding embarked on the first such rhizome transplantation project in the UK.

10,000 seagrass shoots with rhizomes were transplanted

5,000 using the Canadian 'Bundle method'

5,000 using the Swedish 'Single shoot method'

Transplanting the rhizomes required a snorkel team of 4 people and a shore processing team of 4-6 volunteers per day and 18 days to complete.

All of the rhizomes were transplanted into the lagoon area of the loch. This area is sheltered from wave activity and has a seabed made of fine, soft muddy sediment where the anoxic zone is close to the surface.

Survey of survival at 4 months

Bundle method
4 month survival 90%

Single shoot method
4 month survival 1%

The bundle method was much more successful in this context.

A rhizome bundle with a newly moved in long legged spider crab

Effect on the donor meadow

All 10,000 shoots were harvested from the donor meadow in Dunvullaig Bay which has an estimated shoot count of over 8 million. Shoot densities were measured before and after rhizome collection.

Before rhizome collection shoot density
= 212/m2

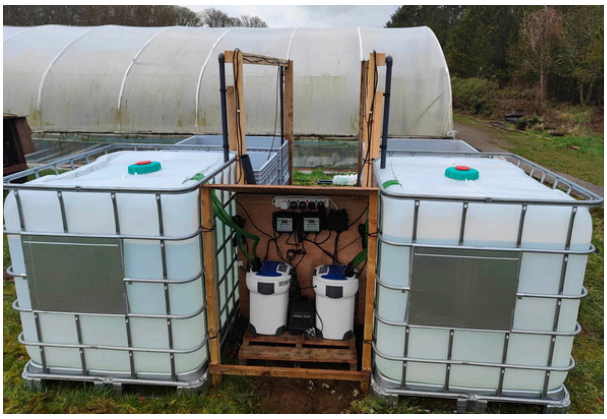
After rhizome collection shoot density
= 637/m2

We can report that the seagrass meadow in areas that we harvested was more robust following collection than prior to collection, with higher shoot densities recorded. This could be due to rhizome collection having stimulated growth, or natural processes of growth throughout the season.

Seagrass Nursery

In 2023 Seawilding set up two, small nursery systems, one ‘Open’ system using pumped, untreated sea water and one ‘Closed’ system using artificial sea water‘.

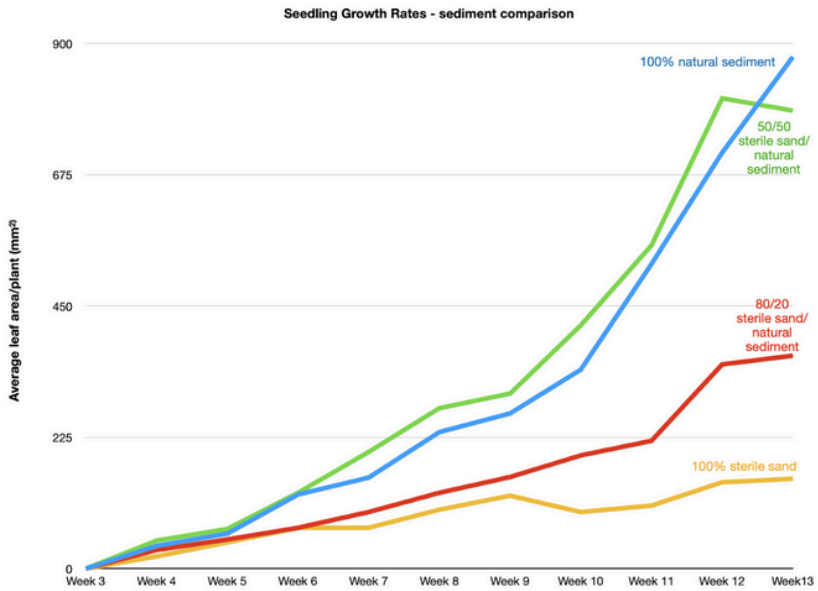
Open system



Closed system

The open system was more successful than the closed system. The closed system was discontinued and the tanks moved to the open system.

Different growing mediums were used in the nursery. Trials were too small to show a significant difference in germination based on sediment type. While all sediments used showed some germination, the sterile sand was significantly lower than other sediments.



Seedling growth rates

One noticeable hinderance to germination was the use of hessian bags. This method has now been discontinued by the originators, Project Seagrass, and will not be used by Seawilding going forwards.

51% germination rate for seeds not in hessian bags

3% germination rate for seeds in hessian bags

We saw germination within the open system nursery across a wide variety of sediments. Demonstrating that seagrass seeds can be germinated successfully in a simple, low cost, nursery system requiring only pumped, untreated seawater.

Seedlings germinating in the nursery

Following strong germination in the open system nursery, shoots struggled to establish into young plants, reaching a maximum size of ~10cm.

This may be due to lack of nutrient availability in the water / sediment among other factors.

The seedlings were planted out into the restoration area. The coir seed trays proved to be a practical way of moving the seeds from the nursery to the seabed. The seedlings will be surveyed in the spring of 2024 to determine their survival.

Nursery seedlings planted out on the sea bed

Seeds harvested in 2022

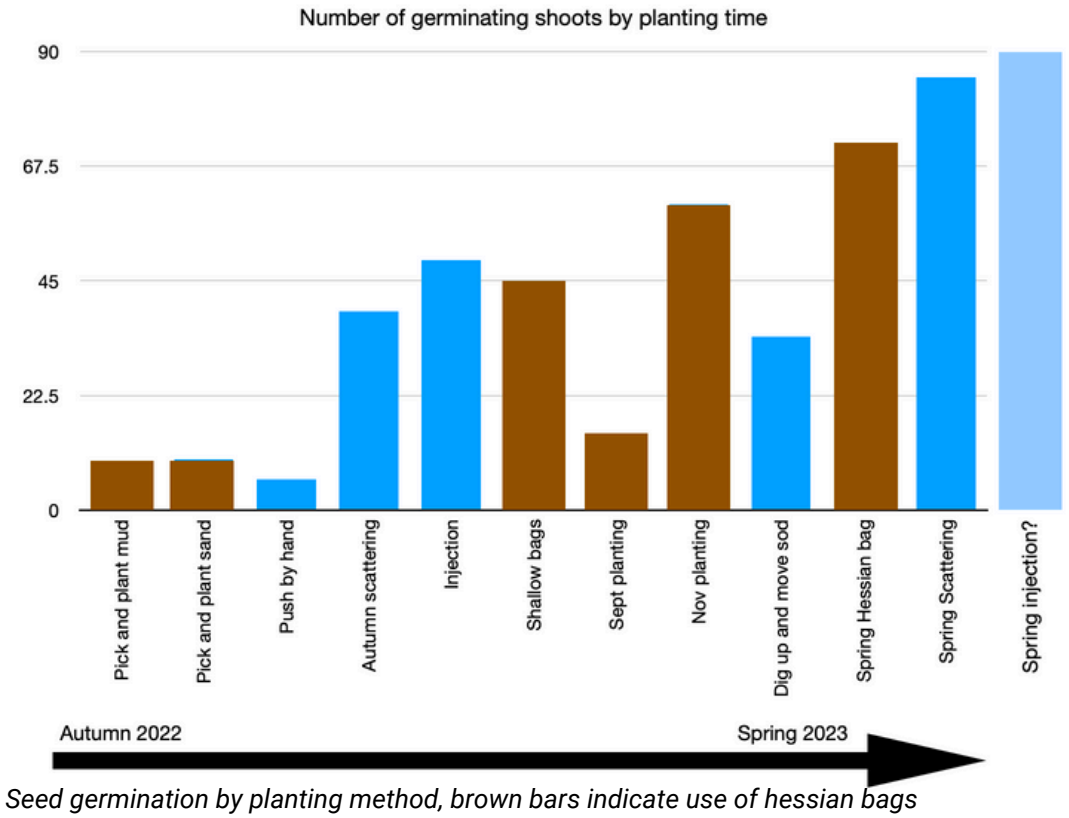
A total of 250,000 seeds were harvested in 2022

A total of 250,000 seeds harvested in 2022 were entered into a number of planting trials using different planting methods. Some were planted in autumn of 2022. The others were planted in the spring of 2023.

A variety of planting methods were used including: scattering, injection, pick and push, hessian bags and shallow planting.

Seeds being planted by injection

Seeds being planted by scattering



Seed germination by planting method, brown bars indicate use of hessian bags

Statistical analysis was conducted on germinating shoot numbers (Students t-test). Seeds planted in the spring showed statistically significant increased germination rates compared to those planted in the autumn (0.05 confidence level). Therefore the majority of seeds harvested in 2023 were kept in the chiller for spring planting.

Scattering in the spring showed the highest germination rate with 85 (0.85%) shoots germinating. Scattering in general showed no statistical difference in germination rates compared with all other methods, (Students t-test, 0.05 confidence level). Due to its ease, scattering would be the preferred method going forwards. It is possible that if injection had also been trialled in the spring better results may have been obtained. This is will be an interesting trial to conduct going forwards.

Seeds planted in the spring showed increased germination rates than those planted in the autumn.

Scattering in the spring showed the highest germination rates

Seagrass seeds germinating

Despite this promising germination in June, by the end of the summer most of the new seedlings had failed to establish and perished. The area of the lagoon where the restoration was undertaken is highly anoxic, as evidenced by the black gloopy sediment and the visible geysers of escaping gases. Anoxic sediments with high sulphide concentrations are negative stressors of seagrasses. The magnitude of this effect is just starting to be quantified in laboratory based studies such as that carried out by Hasler-Sheetal H (2023). Gaining a better understanding of the sediments through a collaboration with SAMS and selecting sites based on oxygenation levels will be an important part of our plans for 2024 as outlined below.

The challenges of seed based restoration

Zostera marina is considered to be an r-selected species, ie it produced are large number of seeds, few of which will go on to grow into adult plants. It has been estimated that in a natural setting only 1 seed in every 10,000 will go on to establish. Seed based restoration projects have seen germination rates higher than this, between 1-5% (*Unsworth 2024)*. The following illustrates some of the factors that can negatively impact seed survival in relation to our restoration work.

100,000

Seeds collected - mixed ripeness

These will be of mixed ripeness and viability. 30% fail the initial viability test

70,000

Of these only 50 % of these germinated in the nursery showing further reduction in viability

35,000

40% of these eaten by crabs
(20-60% Unsworth 2024)

21,000

72% of these washed away (72% or bags were lost, likely higher for seeds)

5880

This gives an initial emergence of 5.8%. The most successful projects in Europe are seeing ~ 5%, UK projects between 1 - 4% *(Unsworth 2024).* We are observing ~1% initial emergence. Following emergence the young shoots face a variety of challenges including sediment sulphide toxicity, smothering by drift algae and further predation by crabs. To make meaningful progress seed based restoration needs to address these challenges of planting seeds in a sufficient density that 1% germination rates are acceptable. Seawilding plans to address these challenges in 2024 in the following ways:

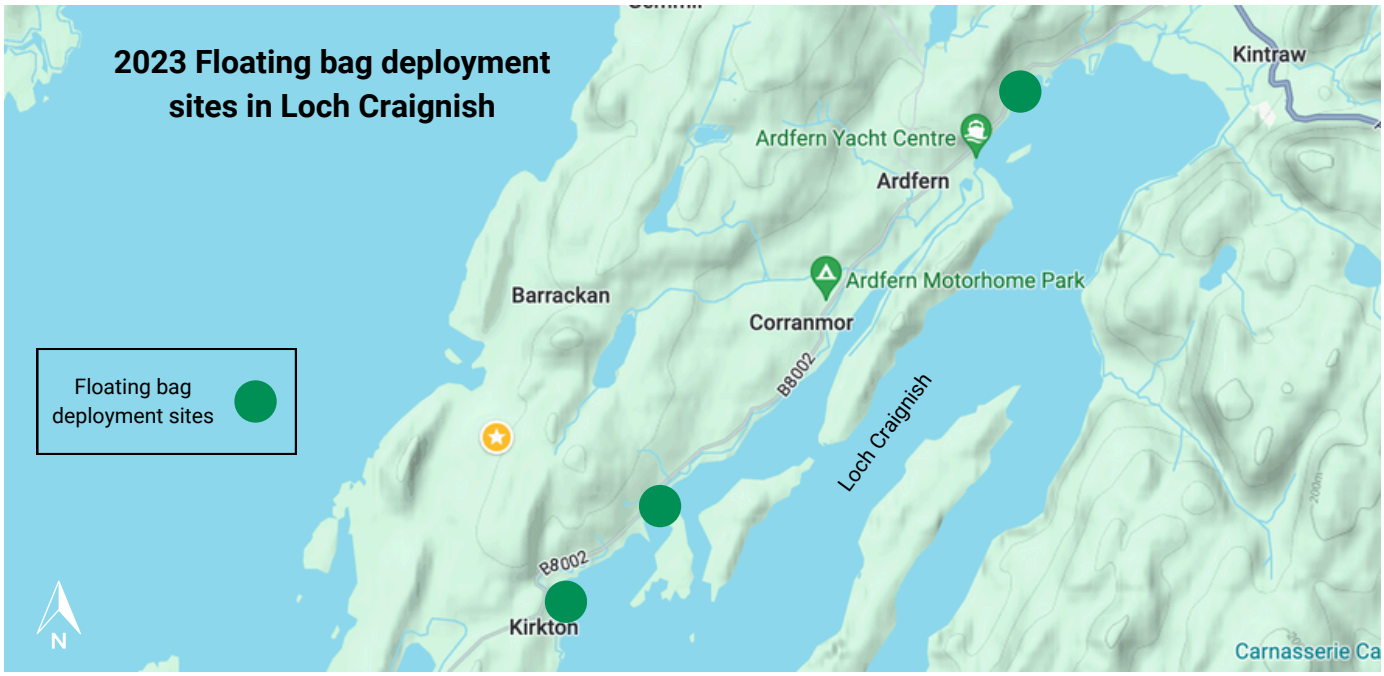
- **Seed planting density** - seeds planted at a density that 1% survival would establish a healthy bed.
- **Sediment toxicity / loss of seeds** - collaboration with Van Oord to investigate sand capping techniques.
- **Drift algae** - Periodic assessment and removal of drift algae.
- **Crab predation** - assessment of extent of crab predation.

Seeds harvested in 2023

125,000 seeds were harvested in 2023.

125,000 seeds were harvested in 2023. This took 12 days to complete. The seeds were harvested by the Seawilding snorkel team of 4 plus 3 interns and 8 volunteer divers from BSAC. Due to the improved germination seen when planting seeds in the spring, 100,000 seeds were stored over winter. Some seeds were deployed immediately using the floating bag technique. This has been very successful in the USA. The method is very low in cost and labour and hence is very accessible to community groups.

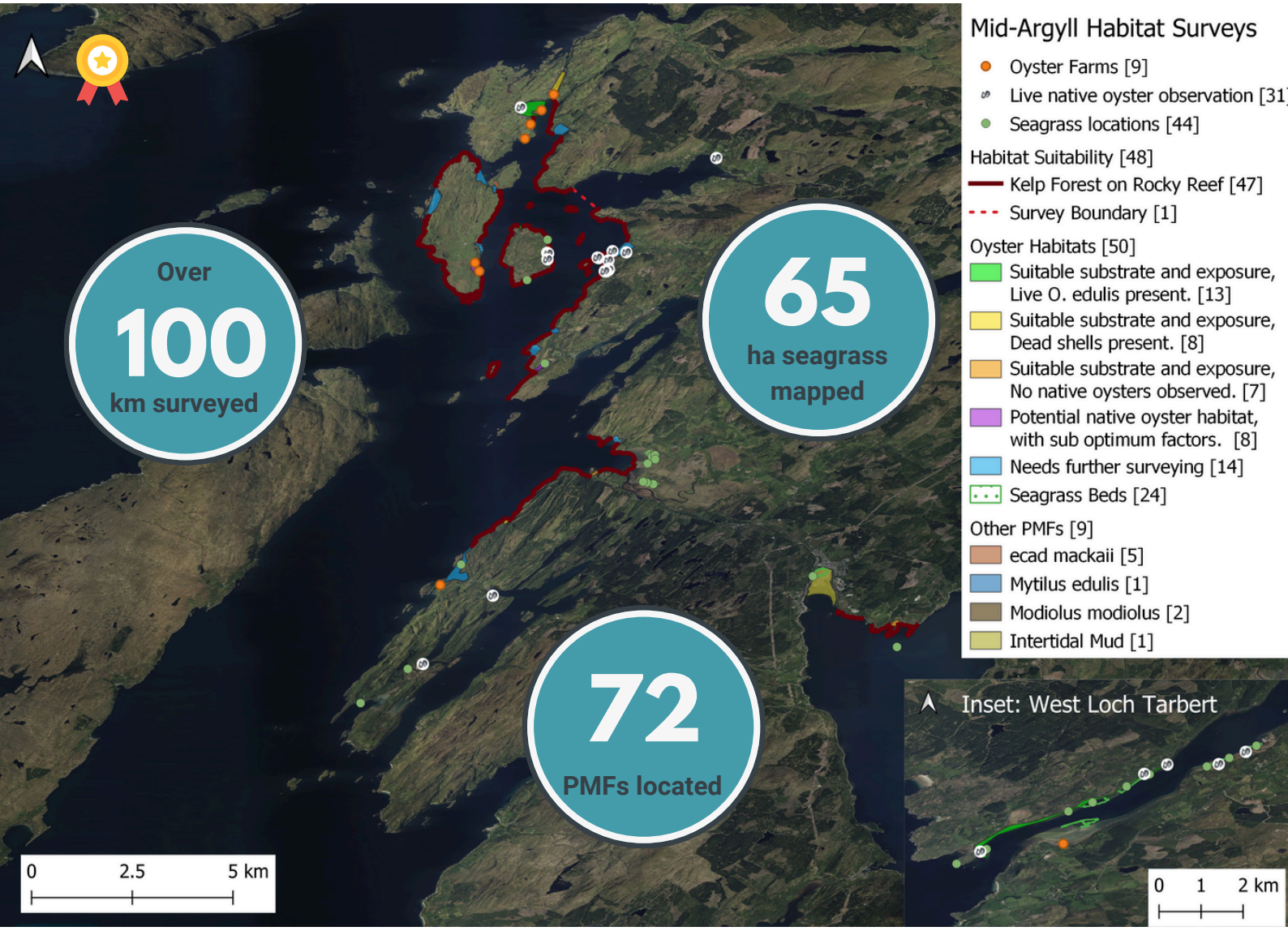
Floating bags were deployed across 3 sites in the loch, avoid the area of anoxic sediment in the lagoon.



Floating bag deployment locations

Connected habitats

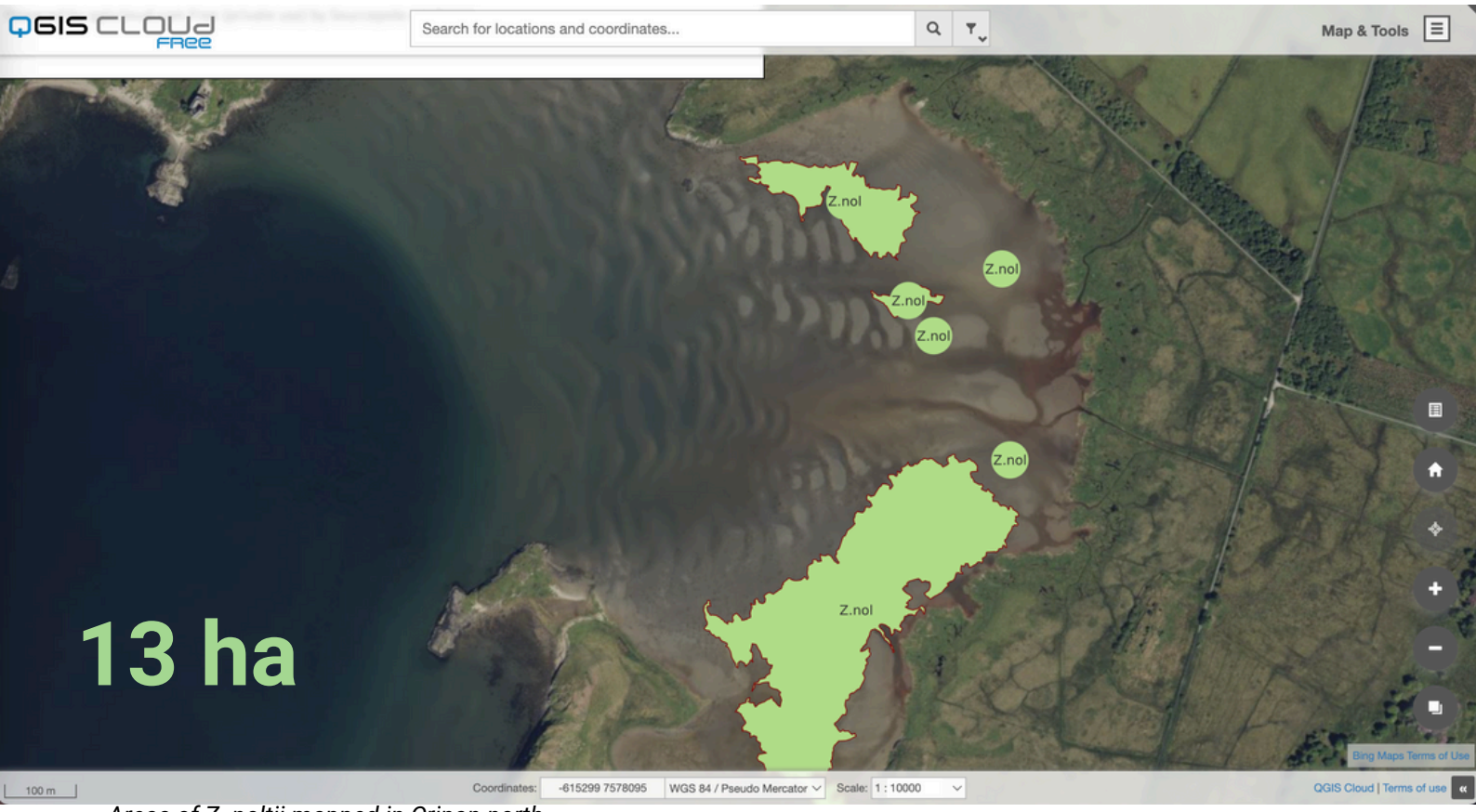
As part of the project, Seawilding surveyed nearby coastal habitats for shallow water PMFs in Argyll, mostly within a 25km radius of Loch Craignish. The areas covered included Loch Shuna/Shuna Sound, Sound of Jura, Sound of Luing, Cuan Sound, Loch Sween, Loch Crinan, Loch Gilp and Lower Loch Fyne.



Areas with restoration potential for either seagrass or native oysters was recorded along with the following PMFs:

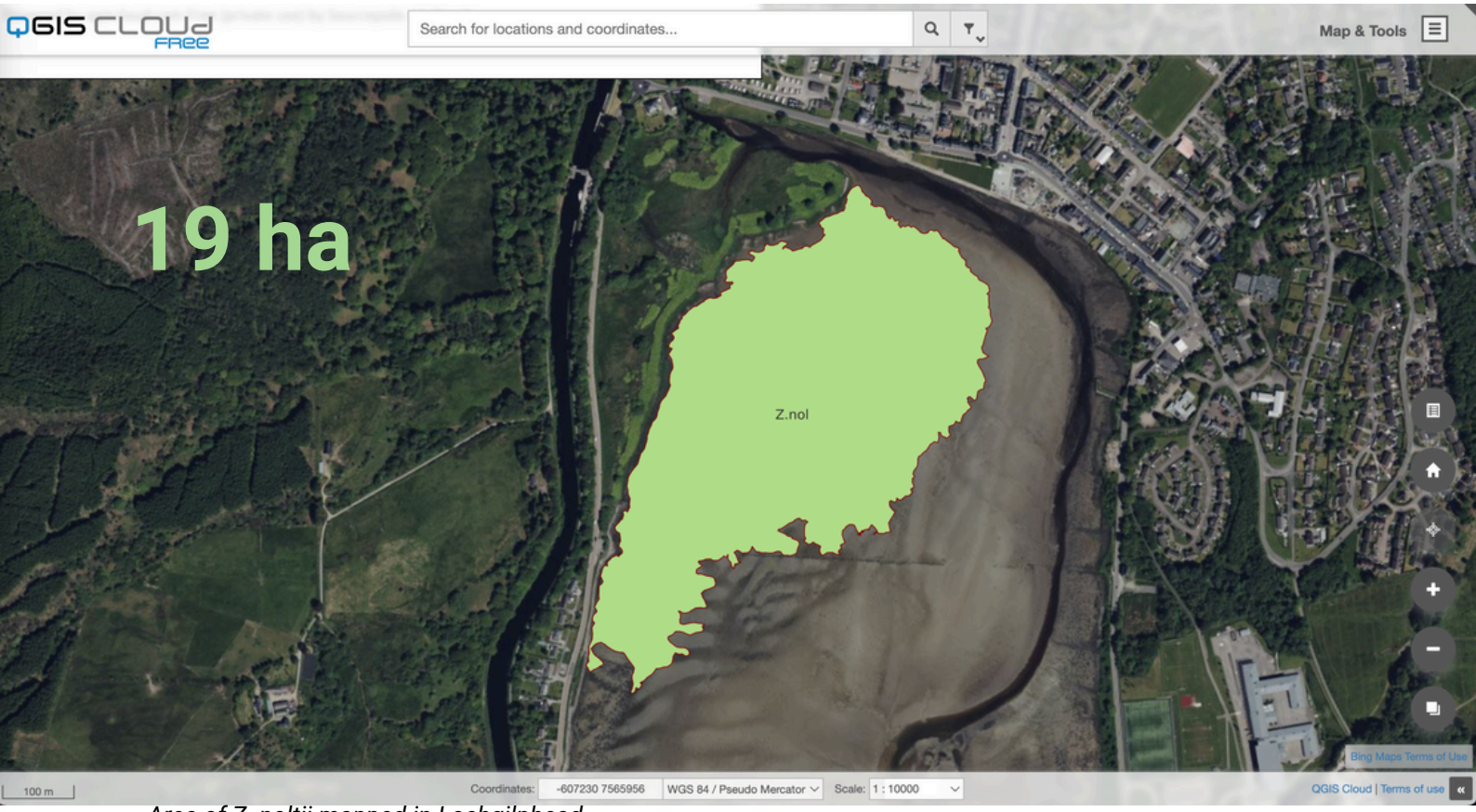
Description	JNCC Biotope code	Number located	Area mapped
Zostera noltei beds in littoral muddy sand	LS.LMp.LSgr.Znol	10	33.5 ha
Zostera marina beds on lower shore or infralittoral clean or muddy sand	SS.SMp.SSgr.Zmar	17	32 ha
Intertidal mudflats	LS.LMu		
Mytilus edulis on littoral sediments	LS.LBR.LMus.Myt	1	700m2
Sea loch egg wrack beds	LR.LLR.FVS.Ascmac	12	1.5 ha
Kelp beds	IR.MIR.KR.Lhyp		85km
Horse mussel bed	SS.SBR.SMus	1	4.5 ha
Native oyster - Ostrea edulis		31	

13ha of Z. noltei in nearby Crinan and a further 19ha in Lochgilphead were located and mapped by the Seawilding team.

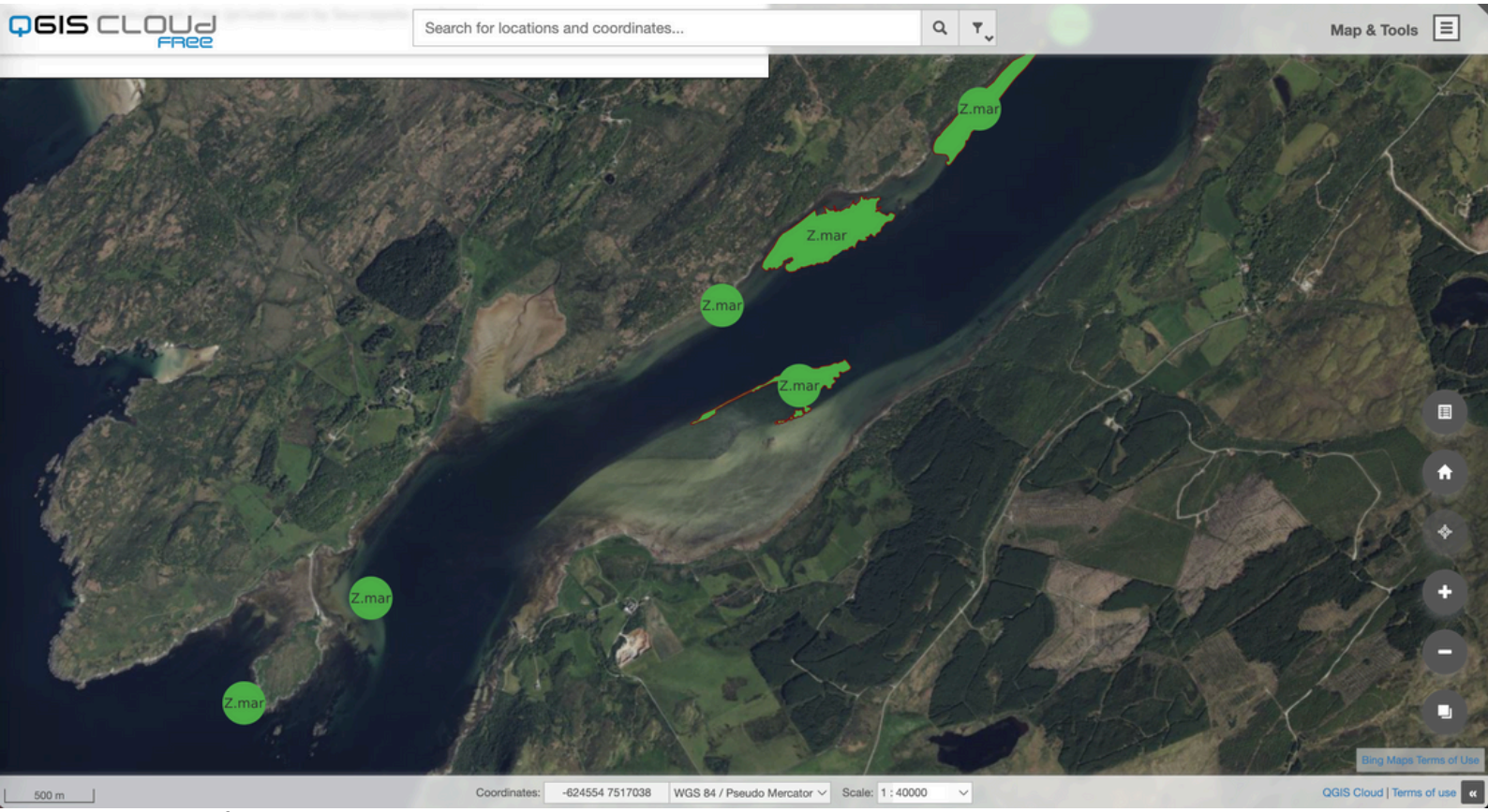


Areas of Z. noltii mapped in Crinan north

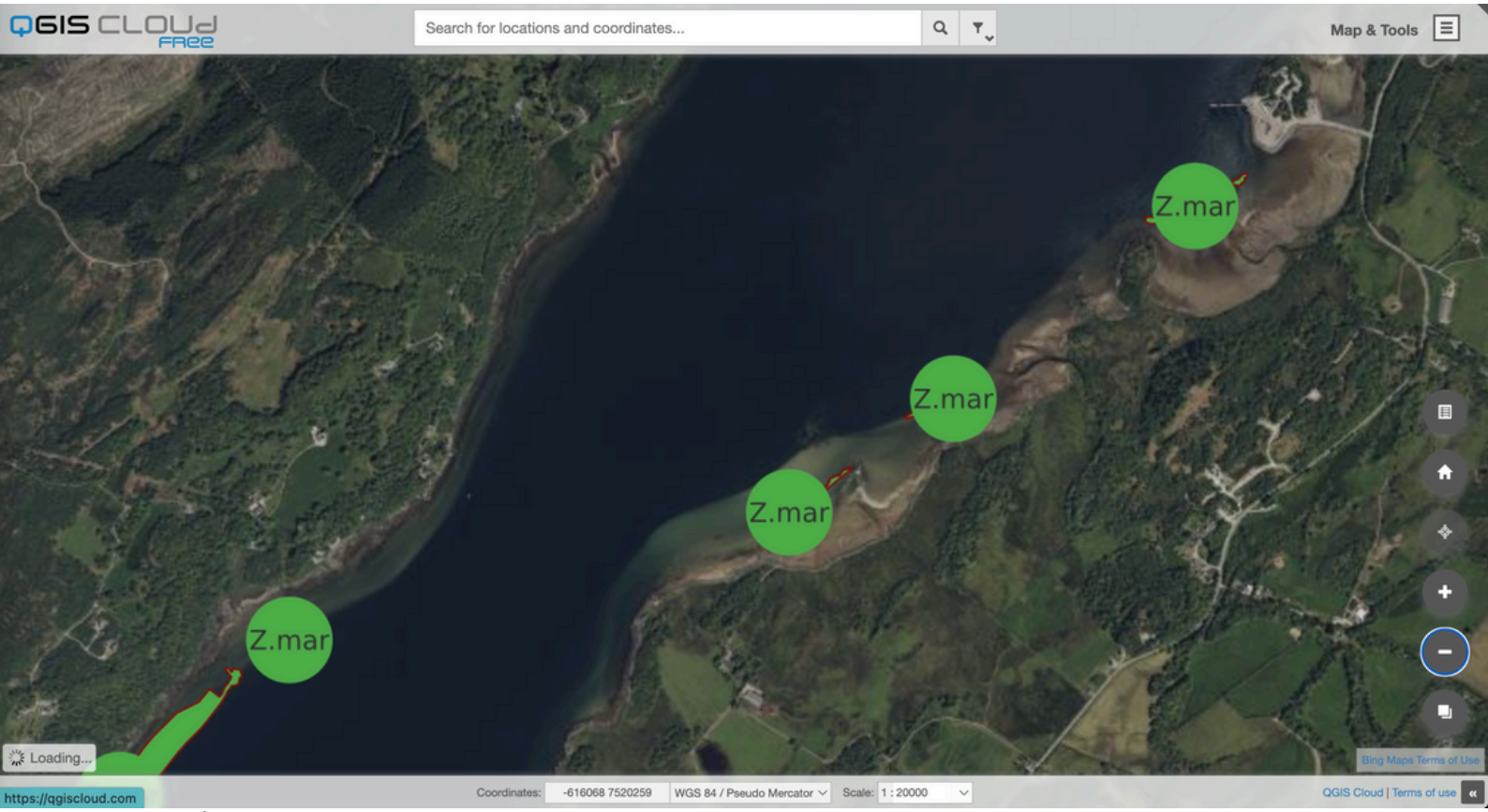
Areas of Z. noltii mapped in Crinan south



Area of Z. noltii mapped in Lochgilphead



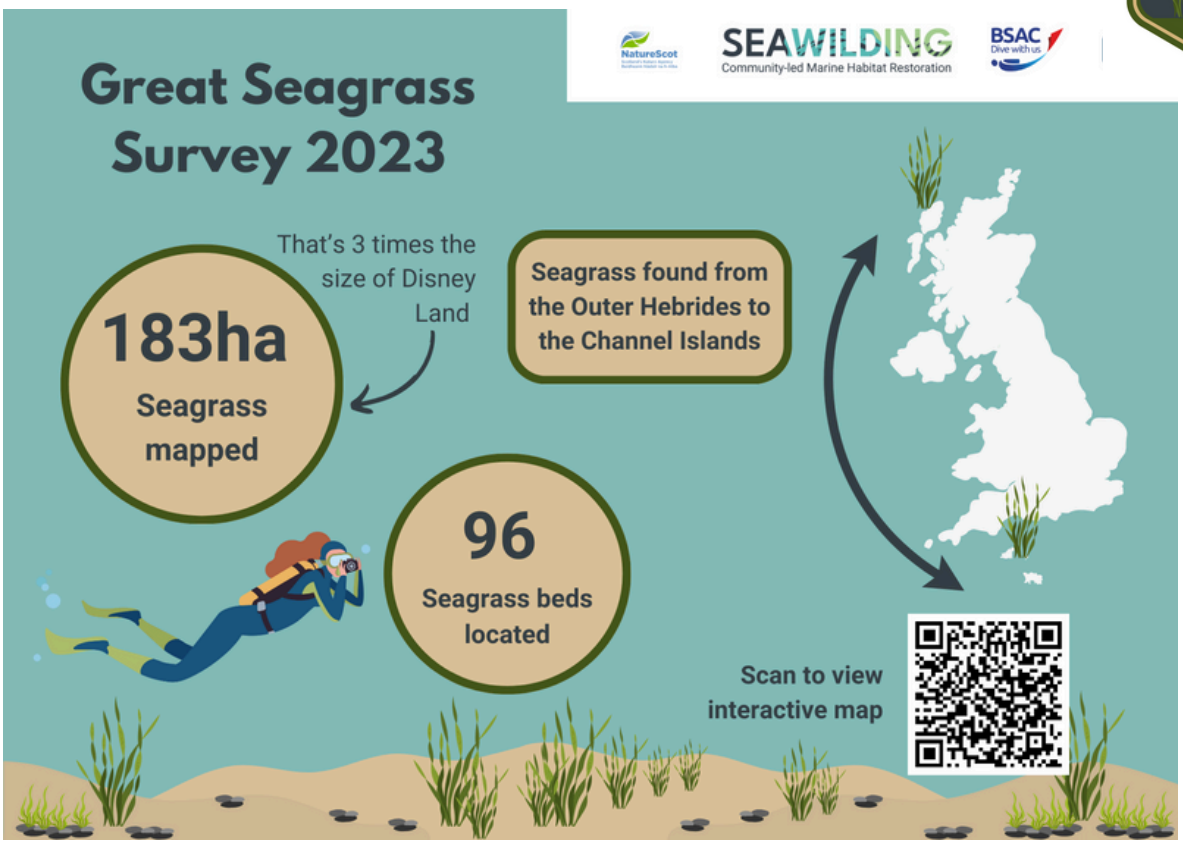
Area of Z. marina mapped in W Loch Tarbet outer area



Area of Z. marina mapped in W Loch Tarbet Kennacraig area

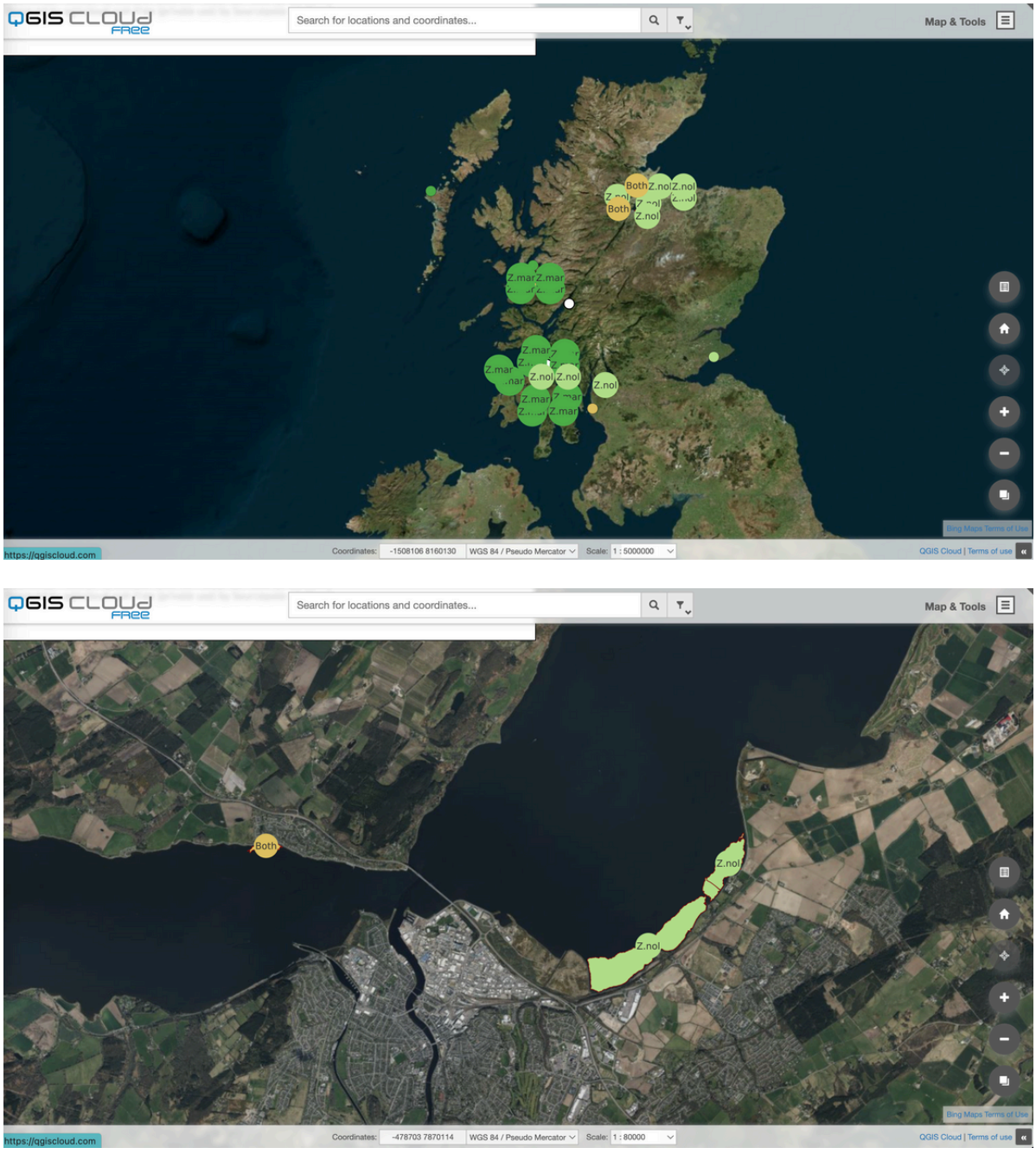
Great Seagrass Survey

The Great Seagrass Survey is a nationwide citizen science initiative set up in 2023 in partnership with BSAC. In its inaugural year, volunteers mapped 185 hectares of previously unmapped seagrass meadows.



"Seagrass is notoriously hard to restore once it is lost, so these new beds are incredibly valuable for both biodiversity and carbon capture," said Danny Renton, CEO of Seawilding. "We hope that these patches of endangered and unmapped seagrass - and the ones that the survey will reveal in the future - can be the cornerstone of new restoration projects inspired and driven by coastal communities."

All of the data collected can be viewed on an interactive map:
https://qgiscloud.com/eric_seawilding/Great_Seagrass_Survey_2023/



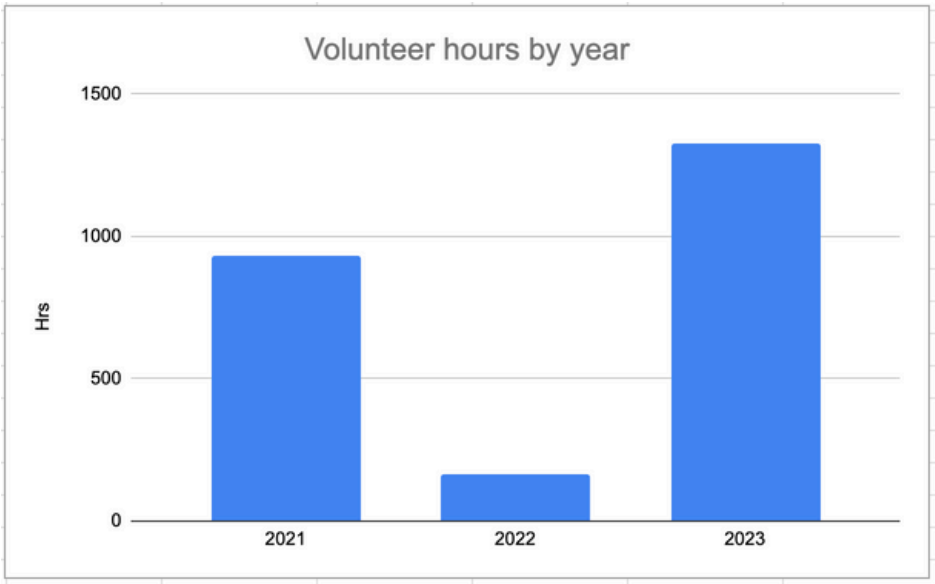
Great Seagrass Survey interactive map

The Great Seagrass Survey will take place again in 2024. The 2024 project has already begun to take submissions. Scan to learn more and take part.

Volunteering

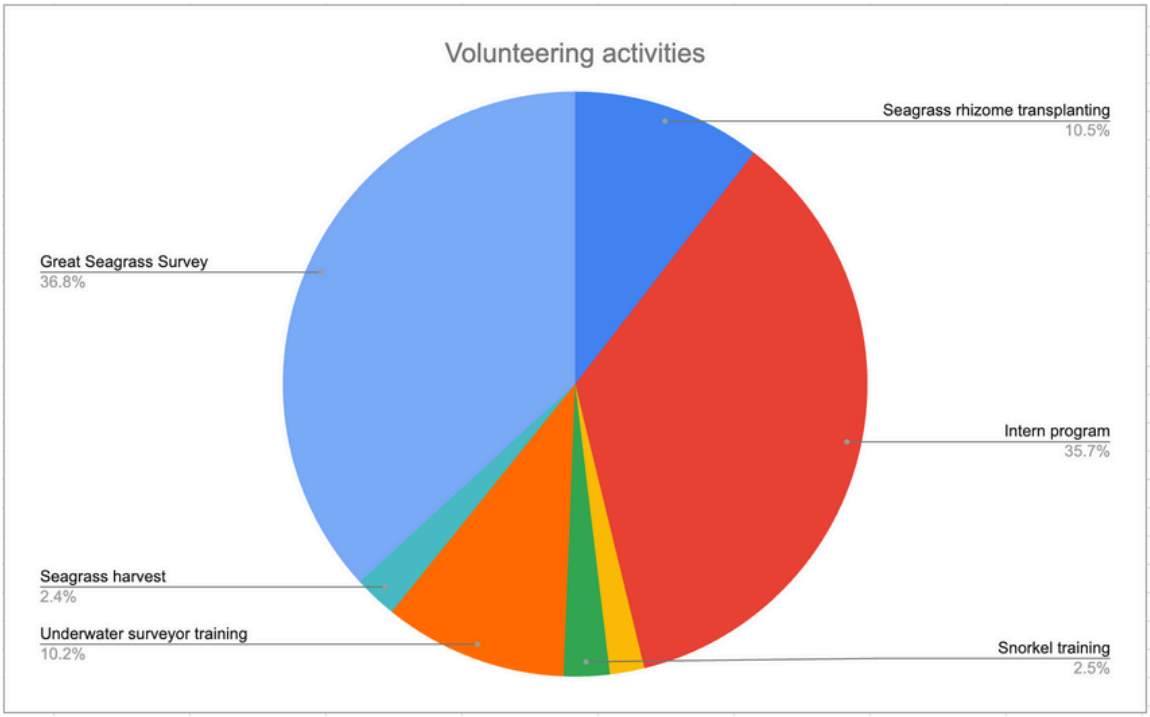
Community volunteering is at the heart of Seawilding's activities.

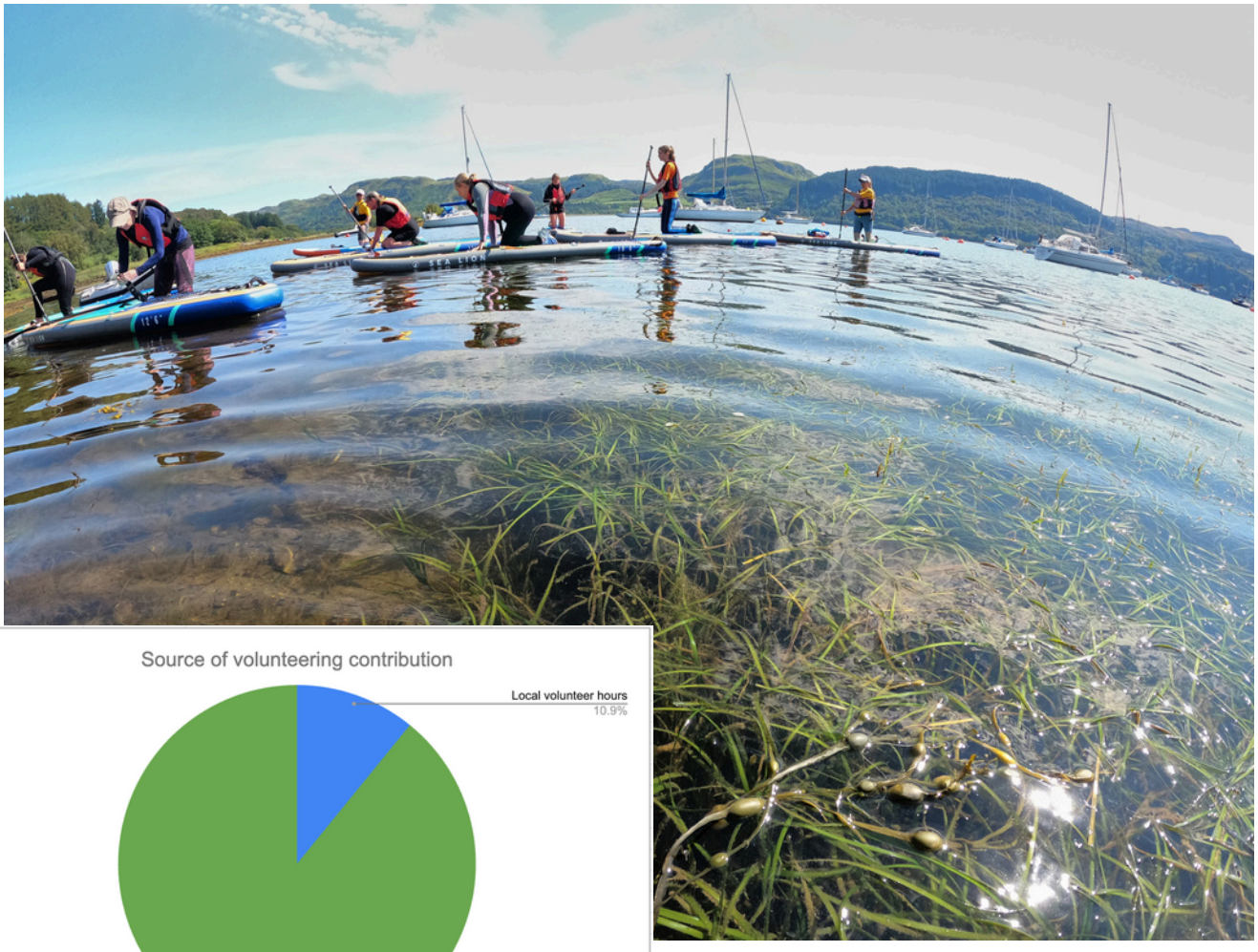
2023 saw an increase in volunteering hours, with a total of 1327hrs. This was mainly due to the Great Seagrass Survey and interns program.



Volunteers processing rhizomes into bundles

Volunteer hours by activity





Wild Seas Weekend outreach activity

Priorities for 2024

Investigate effects of anoxic sediment

We have been collaborating closely with our academic partners at SAMS and are developing protocols to establish optimum site selection parameters. This will involve a combination of in situ oxygenation measurements using a waterproof Redox probe, and core samples analysed for sulphur-reducing bacteria using eDNA techniques. Our preliminary surveys have highlighted four potential sites in addition to our current restoration site.

Build on rhizome transplantation

Following on from the exciting results from our surveys into the survivability of the rhizome bundle method, we will further trial this method in 2024. With efficiency improvements learned from last season, we plan to transplant 20,000 rhizomes, in 5x5m plots or ‘nucleus beds’, within the sites identified as having favourable sediment from the above mentioned site suitability study. Trials of the Swedish single shoot method will be discontinued due to its poor survivability within the context of Loch Craignish.

Donor meadow monitoring

With an abundance of caution in mind, in 2023 we limited rhizome collection from the donor bed to 1 per m2, (0.2%). Measurement of seagrass health variables showed no detrimental effct on the donor bed 3 months after rhizome collection. This will be monitored again in the spring of 2024 to ensure no longer term issues are notice.

Continue to research seed based restoration

Alongside the success of the rhizome bundle method, we have made gains in germinating seagrass seeds. We would like to continue to pursue and trial seed based restoration in areas that are less impacted by the negative pressure of anoxic sediments. The most successful methods from the 2023 trials will be the methods of focus, ie seed scattering and injection undertaken in the spring, and floating bag deployment. Although germination rates of seeds may be low in comparison with survivability of rhizomes, seed based restoration has a number of benefits. It is less intensive in time and expertise than rhizome transplantation and so is well suited to use by small community groups. It also ensures a degree of genetic variability and therefore resilience within the restored seagrass bed.

Anoxic sediment mitigation

In efforts to improve seagrass restoration success in anoxic conditions Van Oord in partnership with the University of Groningen, TU Delft, and HAN Arnhem is researching sand-capping as a method to improve seed survivability. In consultation with Seawilding, the Loch Craignish lagoon has been identified as a site of interest for a small-scale (3mx3m) sand-capping trial. This method has already shown to be successful in Sweden as part of the Zorro project* by reducing turbidity, stabilising and protecting from muddy sediments and reducing seed predation.
*https://www.gu.se/en/news/successful-sand-capping-and-eelgrass-restoration-in-swedish-bay-area

Mycorrizal research

As with terrestrial plants, there is international interest in mycorrhizal fungus that may associate with seagrass in a way that could enhance restoration success. Seawilding and Moray Ocean Community are working together with the international organisation SPUN (Society for the Protection of Underground Networks) to advance this research.

Seawilding would like to say a big thank you to all of our supporter, volunteers, donors and funders. Your help and support is integral to the success of the project.

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