EXECUTIVE SUMMARY

Seagrass

Supporting restoration through research

Seagrass is a unique & vital component of coastal waters in Scotland.

Seagrass has suffered significant loss in extent and distribution throughout the UK since the early part of the 20th century. The decline of seagrass has prompted multiple restoration efforts globally and in the UK.

SSEN Transmission are established leaders in terrestrial environmental sustainability practices and are now extending this leadership into the marine environment, supporting and pioneering new approaches to marine restoration. The business is actively seeking to deliver nature positive solutions to protect biodiversity, reverse biodiversity loss and enhance marine systems at scale.

Scottish & Southern Electricity Networks
TRANSMISSION

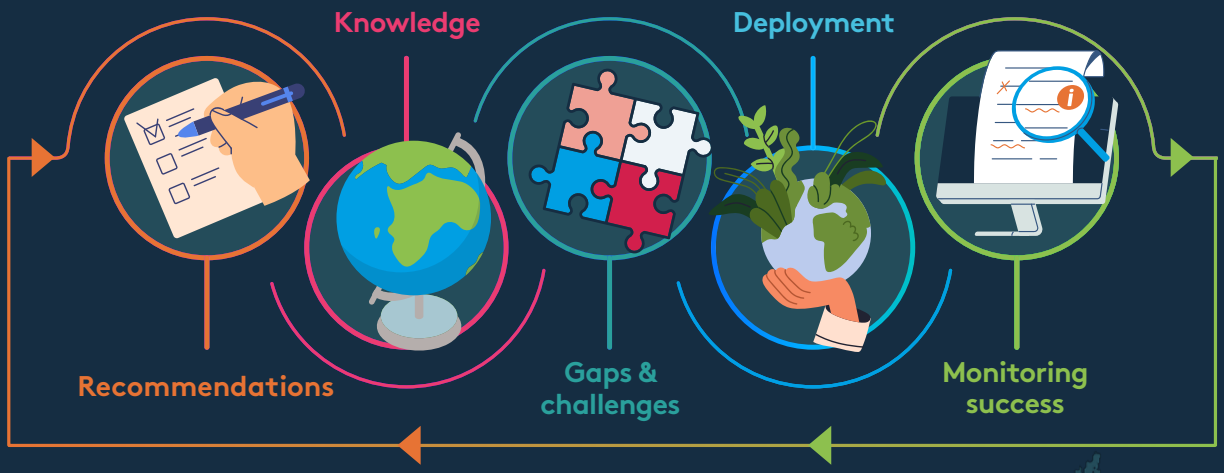
SAMS ENTERPRISE

Improving the outcome of restoration efforts is paramount if nature positive goals are to be met.

The current restoration efforts, techniques and research gaps are summarised in the following document, which is based on a wider review of the status of seagrass restoration in the United Kingdom. This summary is to highlight the key areas and opportunities that, if resolved, can facilitate the success of restoration through associated research.

SSEN Transmission's commitment to being industry leaders in marine habitat monitoring and restoration by 2030 is evidenced through publication of their 'Sustainability Strategy - Pathway to 2030' and a 'Sustainability Action Plan 2024-2031'. In relation to seagrass, these commitments will be implemented through research-led projects developing the skills and techniques necessary to deliver restoration at scale. The outcomes of these projects will support job creation in the marine sector, while meeting the targets outlined in the business strategy to deliver benefits for climate, nature, and communities.

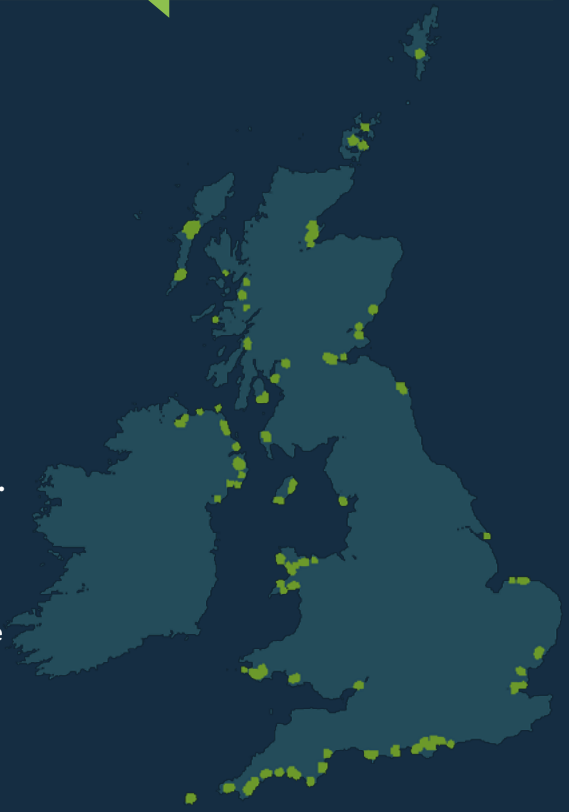
Process diagram



Extent & Distribution

The current extent of seagrass meadows has been estimated as 11 km² of *Z. marina* and 10 km² of *N. noltii* in Scotland roughly 32% of the known seagrass beds in the UK.

However, recent effort to improve knowledge of the distribution highlights how few meadows are mapped with an accurate surface area. This estimate is therefore suggested to be significantly under the true extent, particularly of the more commonly subtidal *Z. marina*.



A nudibranch feeding on a hydroid at the tip of a seagrass blade, potentially a route of pollen exchange in healthy seagrass meadows

Seagrass Biology

The two species of seagrass which are the target of restoration efforts in Scotland:

- *Zostera marina* - Forms meadows and patches of varying extent in subtidal, infralittoral muds and sands.
- *Nanozostera noltii* - Forms meadows in infralittoral muds and sands as well as intertidal muddy areas.

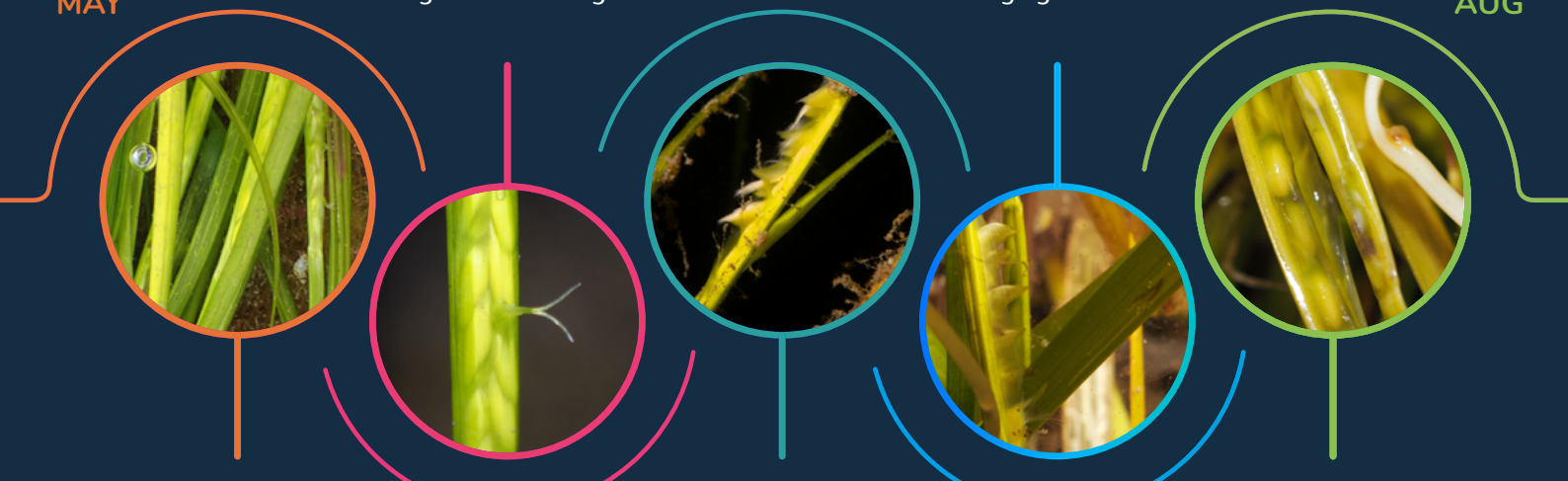
These marine flowering plants perform their entire life cycles in seawater producing seeds between May and August, relying upon currents and certain organisms to complete pollination, although both also grow vegetatively extending rhizomes horizontally to the substrate surface. Both species draw nutrients from their roots and leaves.

Seagrasses are adapted to grow in clear waters, however, macroalgae can smother and outcompete seagrass where there are high nutrient systems.

Flowering, pollination & seed formation in *Z. marina*

MAY

AUG



1. Inflorescence

Flowering part develops around May this is also called a spathe.

2. Protruding pistils

Female part erects at 90° to the ovary. Generally, happens before anthers are ripe to increase chance of genetic exchange.

3. Ripe anthers

Ripe anthers swell with pollen and burst once pollination of the styles is complete, *Z. marina* and *N. noltii* have filamentous, long pollen fibres.

4. Pollen released

Wispy strands of pollen are released into the water column to be carried to other individuals and to exchange genetic material.

5. Fertilised seeds

Seeds form after fertilisation, when all pollen has been released. A thin protective epidermis layer protects them until they are ready to be released.

Restoration Techniques

A thorough review of the literature suggests that there is currently no 'silver bullet' solution to restoration success.

The three main methods that have been applied to seagrass restoration in the UK are outlined below. Knowledge of success and challenges will inform seagrass restoration efforts in Scotland.

But the true test of these techniques will be seen into 2025 and beyond.

Seed harvesting & planting

1. Collection of fertilized seeds or flowers
2. Processing, cleaning and preparing
3. Re - planting

Seedling success rates are low in the wild, and this technique has had varying levels of success. Between 0-10% of seeds survive using these methods. Although limited attempts have been made in Scotland.

Rhizome transplanting

1. Collection of rhizome clods
2. Processing, cleaning and preparing
3. Re - planting

This method has seen more success than seedling gathering. Although recent sediment analysis suggests that plants may not survive if transplanted in very different sediments than they are used to.

Aquarium growth & out-planting

1. Collection of fertilized seeds or flowers
2. Growth in controlled conditions
3. Out-planting

Currently three seagrass (*Z. marina*) nurseries exist in the UK. Nursery growth shows much higher success rates than wild seedling attempts.

Challenges and solutions

There are critical research questions that remain and answering them could improve the success of seagrass restoration in the UK. Six key challenges to restoration were identified, each with associated unique research opportunities:

Environmental suitability 1

Seed based restoration success is low (0-10% success). Increasing the understanding of habitat preference, individual patch adaptations and the parameters needed for seeds to establish in unvegetated sediments is key. Research here could focus on sediment redox, microbiome, PSA, nutrients and the development of a toolkit to understand the differences in bare sediments (restoration areas) and seagrass meadows or patches.

Sourcing material 2

At the current scale of restoration in Scotland, source seeds and rhizomes are not a limiting factor. However, to upscale at a significant level, this may become a bottleneck. Research could focus on improved understanding of current extent (sources of seeds/rhizomes) or developing a clearer understanding of the impacts of harvesting. Solutions might also stem from aquarium cultivation, which has improved seedling propagation rates.

Cultivation 3

There are currently no operational seagrass nurseries in Scotland and only three in the rest of the UK which focus on small-mid scale restoration. Nurseries have increased seed survival rates compared to wild seed bag and other planting trials and have had some success in other parts of the UK. A dedicated seagrass nursery in Scotland has potential to address several of the challenges identified in this review, directly and indirectly.

Crop science 4

Optimising out-planting parameters remains a challenge and factors such as density, depth, hydrodynamics, sediment dynamics and seasonality are poorly understood. These factors have had significant effort applied to them in other fields (for example, agriculture). Research could focus on 'crop science', trialling different techniques, densities and seasonal approaches to seed, wild rhizome and nursery rhizome transplants.

Technologies 5

It is not yet clear whether technological approaches (such as robotics and ROV development) to seagrass restoration will significantly enhance the efficiency of seed collection and planting. This is mainly because testing is limited to a few studies globally and even fewer within the UK. Other technologies have the potential to significantly improve knowledge of extent and long-term monitoring such as AUVs and remote sensing options.

Genetics & resilience 6

It is integral that the adaptive capacity of restored seagrass is maintained. Seagrass propagate both sexually and clonally, meaning genetic isolations may occur, and genetic bottlenecks may arise in die-back events (i.e. due to seagrass wasting disease). Research here could focus on improving current understanding of genotypes, of gene pathways or expression and different population adaptations.

Ecosystem services of seagrass

Ecosystem services describe the benefits that humans derive from ecosystems, they are broadly categorised as regulating services, provisional services, cultural services and supporting services. Both *Z. marina* and *N. noltii* contribute significantly to each of these services in different ways. Restoration of *Z. marina* and *N. noltii* has potential to improve the delivery of ecosystem services in the following ways.

Provisioning

Biodiversity | Resources | Nursery

Cultural

Recreational | Social | Wellbeing

Regulating

Physical | Biogeochemical | Carbon

Coupling active restoration efforts with robust, cutting-edge science, will answer key questions around seagrass husbandry, challenges found through active restoration and maintain connectivity between nature, science, and communities.

Scottish & Southern Electricity Networks
TRANSMISSION

SAMS ENTERPRISE