Zostera seagrass beds of Kerry

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Recording Area Summary and Frequency

Kerry Seagrass beds mapped in 2022 are shown with a total of 529,959 square metres surveyed on 51 days. Four beds, names in bold, are considered to be complete in terms of extent, coverage and density measurements.

The Zostera marina (Zm) seagrass beds, also known as eelgrass, proved challenging to survey as they grow 1 to 5 metres underwater at lowest tides. Smithsonian protocols yielded estimates of the total number of plants growing in each bed and sufficient leaf measurements to establish their leaf area index. Observations from five transects were contributed to the global seagrass network. Epiphyte coverage on their leaves was recorded. Observations of sub-tidal coastal erosion and the interaction with Chorda filum (Mermaids' Tresses) were mapped in sufficient detail to measure change after future severe weather events.

Zostera noltei (Zn), dwarf eelgrass, form inter-tidal seagrass beds which are easier to survey except when quick-sand is encountered. Significant seasonal variation was recorded in several Zn beds.

Special attention was given to both male and female flowering of both Zm and Zn species.

Surveys, including areas void of seagrass, are summarised clockwise along Kerry's coasts:

Seagrass Bed Name	Species	2021	2022	2022 observations
Ventry Harbour	Zm	unk	**56,610**	Partial extent mapping April 2022.
Derrymore	Zn	1,312,740		(visits suggest little change in extent)
Inner Tralee Bay	Zn	683,425		**No north shore Tralee Bay seagrass beds** were found east of the Cuckoo Lane bed. Large amounts of ZnS are probably from beds to the south.
The Spa, Cuckoo Lane	Zn	**63,513**		**Partial extent mapping** suggests stable bed.
Locke's beach	Zm		**545**	Visibility is poor near this bed.
Fenit Island Tombolo, Zm	**Zm**	**80,343**	**106,545**	Improved **accuracy** of extent maps. One trial and **3 transects** established and surveyed. Initial observations on tidal **scouring**; mapped relationship with Mermaids' Tresses.
Cuan Eamon, Fenit Island	**Zm**	*20,000*	**7,997**	Accurate mapping; single transect; stingrays.
Saltwater Marsh, Fenit Island Tombolo	Zn	**5,146**		Under pressure from trampling; increase in Spartina anglica.
Fenit Island Tombolo, Zn	**Zn**	**132,440**	**76,746**	Significant **seasonal** and yearly variations. Pressure from trampling, hot weather events and algae blanketing were observed.
Barrow Harbour Chapeltown	Zn	**518,936**	**stable**	Partial extent mapping in March to capture seasonal variations and relationships with **water courses**; little change in healthy bed or extent.
Barrow House	Zn	**8,447**		
Currahane	**Zn**	**276,726**	**278,516**	Significant **seasonal variation** (reduced coverage in late winter); 4 beds when resurveyed; significant regrowth and extent similar by June
Banna Beach	ZmS	**0**	**0**	3 recons; no ZmG - bed still probable.

Associated extent maps are located in the appendix.

Zostera marina (subtidal eelgrass) Methodology

Locally, our seagrass meadows are rather flat and consist of sandy bottoms with a mixture of small stones and shell. We began our observations in an attempt to:

1. Observe Zm's natural ability to reduce erosion of our local dunes.
2. Estimate the total number of plants and their Blue Carbon potential.
3. Record with sufficient accuracy to observe year-to-year changes.
4. Promote the known benefits of seagrass beds and our surrounding Natura2000 sites to our local community, commercial fishermen and to our local tourism economy.

In an effort to achieve all these goals, we looked for a Citizen Science approach and eventually adopted global protocols provided by the Smithsonian Environmental Research Centre's MarineGEO.

This method involves establishing 50m transects and:

- Estimating coverage & density every 4m;
- Counting shoots every 8m.
- Use of a long 0.5mm mesh bag to collect a single shoot and associated biota every 8m;
- Removing sessile macro fauna as sheathes and leaves are measured;
- Scraping the remaining epiphytes into pre-weighed tinfoil-boats;
- Drying both seagrass and epiphytes at 60C for 48 hours.
- Recording weights to the nearest milligram in the Munster Technological University.

The MarineGEO protocols include data standards, guidelines, data recording sheets and spreadsheets which permit the automated submission of global seagrass observations.

Survey design methods require knowledge of each seagrass bed's extent. We intended to complete mapping using inflatable stand-up paddle boards (iSUPs), kayaks, swimmers, and snorkellers.

GPS Method for Extent Mapping and positioning of Transects

In 2021, using an older Garmin watch and a phone for backup resulted in numerous erroneous and inaccurate fixes. Our 2022 solution uses a Garmin Forerunner 935 with "GPS + GALILEO" enable. The latest GPS satellite data is downloaded immediately prior to each survey.

Removing the watch from the wrist and keeping it elevated 20cm above the water eliminated the need for using redundant devices and almost all post-processing adjustments to GPS tracks.

Tracks were recorded as the surveyor walked or cycled to each seagrass bed and post verification established an accuracy of a quarter of the width of the road (~1.3m).

Google Earth Pro (GEP is free GIS software) was used to record and display all seagrass boundaries and to store the associated original GPS data. The appropriate use of ArcGIS was considered to promote better exchange of data between Citizen Science groups and professionals.

Typically, GPS tracks are recorded at low tides while:

- walking (typically when observing ZmS (swept-up) on the beach),
- kayaking (fast coverage over large areas or to gain access to sites less accessible by bicycle),
- paddling while standing on an iSUP (shallow water observations),
- snorkelling while towing a beer float (ideal when the area is well-known).

Numerous GPS tracks were typically combined for seagrass beds with a boundary over 200m in length. Although the GPS data could be combined through editing ".txc" (sport activity-centric) formatted files, the final seagrass beds were generally displayed within a GIS and then hand-traced to produce a "polygon" or "shapefile". This approach allows total area and the perimeter of each seagrass bed to be observed in various units. For local presentations acres were the preferred units of area. For most other presentations meters/square meters were requested. Details of the surveyor, date and time, weather and sea conditions and general notes are recorded in the description field of polygons.

Transect Design and Considerations

Permanent transects should be selected and laid out perpendicular to the shore in order to detect year-on-year changes of the following areas:

- near-shore
- middle of the bed
- outer limits of the bed as water depth / light intensity becomes the limiting factor.

Surveyors require the following to establish a new permanent transect:

- GPS device (with predetermined latitude / longitudes for start/end points).
- Small anchor for iSUP,
- 2 weighted back-packs with line and float attached to mark ends of the transect.
- 2 seascrews
- 1 environmental sensor
- 2 field flags, float or bright material to help relocate each seascrew.
- 50m field-tape with quick release carabiners attached by 20cm of bungie cord.
- 1 magnetic compass.

Approach the start-point in a straight line and drop immediately when the GPS location has been reached to allow easiest relocation during future visits to the transect!

- Be prepared to drop the weighted back-pack immediately. The scope of the float's line should be equal to the current water depth so that this line is vertical to the surface.
- Paddle upwind/current to drop the boat anchor with sufficient scope for the boat to drift back to the back-pack's float.
- Snorkel to confirm that the area is appropriate:
    - Check for "ranges" to help relocate end points.
    - Adjust compass bearing slightly to lay the transect to a specific easily-observable land feature if possible.
    - Confirm the appropriate amount of seagrass along the proposed transect.
    - Two swimmers with diving masks can easily tension the 50m tape in a straight line, dropping the second bag with the handle of the field-tape attached after it has been adjusted on the surface.
    - Seascrews are difficult to install by a snorkeller and a diver should complete this task after completing their underwater survey. This is also an appropriate time to replace the eye of one end of the transect with the environmental sensor to record seawater temperature until the next survey.
- Efficient use of divers is achieved when all 3 transects are prepared in advance of the divers' arrival onsite.

Transect Surveys for Zostera marina

Fixed transects are important at reference sites to establish key characteristics for a group of similar Zostera marina seagrass beds over multiple years of surveys including:

- Total number of Zostera shoots using the Modified Braun-Blanquet scale;
- Leaf Area Index (LAI) by recording the lengths from each shoot;
- Above-ground seagrass mass;
- Blue Carbon sequestration rates estimations in below-ground rhizomes.
- Coverage by flowering plants.
- Amount and type of epiphyte coverage.
- Water quality measurements (dissolved O2 and salinity for this study).
- Depth and water visibility.
- Broader observations of subtidal marine ecosystem;
- Boundary observations (to a smaller degree).
- Seagrass pressures (including sub-tidal erosion events in this study).

Data Handling

Numerical and text data for Zm and Zn are submitted to Coastwatch for verification. A spreadsheet of all seagrass beds mapped by Coastwatch volunteers was last presented in July 2022.

Smithsonian protocols require submission of the appropriate spreadsheet template via a data management portal. Citizen Science contributors are provided significant assistance and advice.

Work is progressing to allow the submission of accurate 2D extent maps to Coastwatch, the National Biodiversity Data Centre and to Smithsonian's MarineGEO. We are also participating in the creation of a seagrass traits database. Work has begun on providing 3D visualisations.

Seasearch provides excellent support for SCUBA divers and we hope to contribute to their habitat mapping efforts.

Google Earth Pro is currently our main GIS and allows for enhanced visualisation of Irish seagrass beds. Work has begun to port data, including transect data, to ArcGIS to allow for greater analysis of change over time of Zostera seagrass beds and their Blue Carbon value in Ireland.

In addition:

- Samples from each seagrass bed are pressed and labelled to allow comparisons with future variations over time and between sites.
- Underwater photographs at 1m intervals of each transect survey were taken with an Olympus TG6.
- Sessile animals are removed from sample shoots and photographed using a D90 camera permanently attached to a Motic SMZ-171-TLED dissecting microscope and post-processed with Nikon's NX Studio.
- Photographs of most sample shoots, their epiphytes and also their flowers were taken at magnification up to 28x using an Olympus TG6 and post-processed using OM Workshop.
- A Sony Experia smartphone was used to record cross-sections of various Zostera structures to aid in classification of each species. Photographs were taken through the eye-piece of a Swift SW380T compound microscope.
- All images are stored online to allow year-on-year comparisons and future classification.

Results and Observations

Classification of Zostera species initially seemed easy, as Zostera marina has rounded tips and are subtidal, whereas Zostera noltei are shorter with narrower leaves and are an intertidal species. However, historical records suggest that Zostera angustifolia (Za) grows locally, local vegetive plants have been provided, and samples from other areas were obtained at a seagrass conference in July.

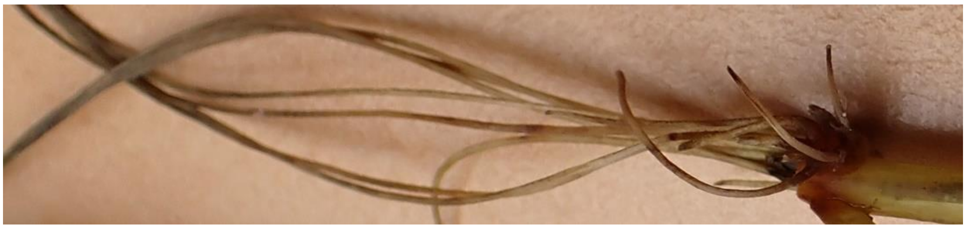
This led to an in-depth review of taxonomies and how they change over time. JSTOR proved to be a good source for a variety of interesting articles, classification keys, guides and historical archives of original Zostera observations.

Although most seagrass observed is vegetative, observations of flowering plants are summarised below as a partial effort to assist Citizen Scientists in the classification of Zostera using photographs. Seagrass local to Fenit was photographed by the author of this report in 2022.

Zostera marina flowering plants

Flowering plants are generally the tallest shoots observed in Zm meadows. Fertile shoots are easy to spot as they have brighter green colours and often appear golden around the borders of the seagrass beds. In September, they may begin to bend over and are more frequently observed closer to the seafloor as in the image below:

This plant has a single node with the roots to the left.



The sheath has patches of rust-coloured growths:

The stem is observed to the right where it has split out of the surrounding sheath. Stems are round and are light-green compared to Zostera leaves which are darker.

Stems are smooth and lack the ribs and distinct vascular bundles seen on infertile leaves.

Stems seem more resistant to epiphytes than sheathes. *Labyrinthula zosterae* is a black slime mould known to have severely impacted seagrass beds in the 1930s.

The stem from each flowering shoot may have many clusters:

Each cluster may have several inflorescences.

Each inflorescence consists of a:

- Peduncle connecting to the stem
- Spathe containing both male and female flowers
- Blade extending skywards.

The **peduncle** …

… as it branches downwards from the stem

… as it flattens out

… connects to the spathe.

The peduncle joins the spathe at an intersection called a ligule.

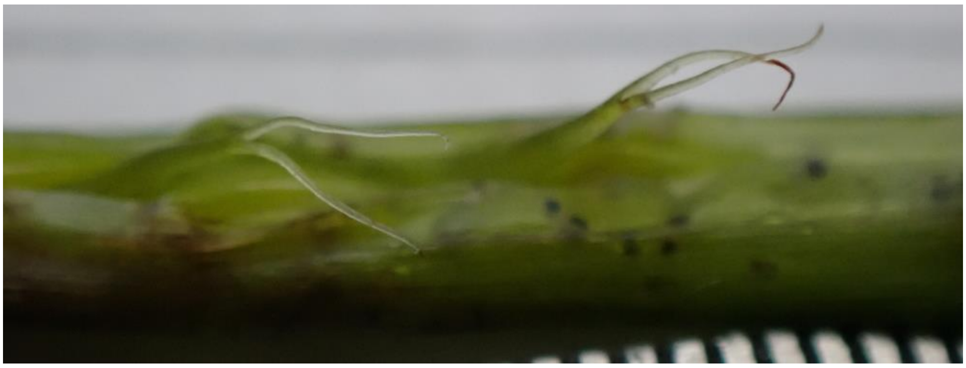
The **Spathe** is an area that is much thicker than a leaf.

One side of the spathe (the darker spathe in the image above) is very similar in structure to a leaf. It contains vascular bundles and provides structural support for the Spadix. Veins run along its length. The other side of the spathe (lower spathe in image above) consists of two overlapping translucent membranes. The developing flowering plants are clearly visible through these membranes. Eventually, the female flower will emerge through this membrane and then retract. The male flower will also emerge through this membrane, release its pollen and wither away.

The blade continues from the apex ligule of the spathe and continues to a rounded tip.

The spadix is held within the spathe and contains both male and female reproductive parts.

The **female flowering** begins when female stigmata are raised through the thin overlapping membranes of the spatha. While they are outside the spathe, it is likely that male pollen from another plant will collect on each stigma.



A complete female flower is known as the Pistil.

"Carpel" is also used to refer to a female flower at any stage of its development.

Each stigma is raised when the style bends (over several hours) almost 90 degrees. Once pollinated, the style unbends retracting into the spadix, each stigma detaches, and the ovary becomes fertile.

A pistil contains an ovary, style and stigmata.

The Zm ovary and style are about 6mm in width. Both stigmata detach, leaving a dark scar, after fertilisation.

Male flowering commences shortly after female flowering to prevent self-pollination.

The thecae which were clearly visible in alternating rows through the spathe's membrane prior to female flowering are raised through the membrane. Release of Zm pollen was not captured in the wild during 2022 but Zn photos taken in the lab show how tightly pollen is packed inside the thecae sacs and how it adheres to the female stigmata.

To the left are 3 empty thecae sacs.

The thin pollen strands have already been released.

There is now sufficient room within the spadix for the ovaries to fully develop and for their seeds to ripen.

Ovary development and seed Dispersal

The ovule within each ovary develops into a seed.

An immature seed is shown being measured (out-of-focus top).

The remains of a brown-coloured theca may be wrapped around the ovary's wall (middle).

A style (bottom) with characteristic scar in the area where its stigmata detached.

Following is a fully developed seed and its connection within the ovary.

Notice the well-defined ridges on this Zostera marina seed as they may help in classifying the seagrass species.

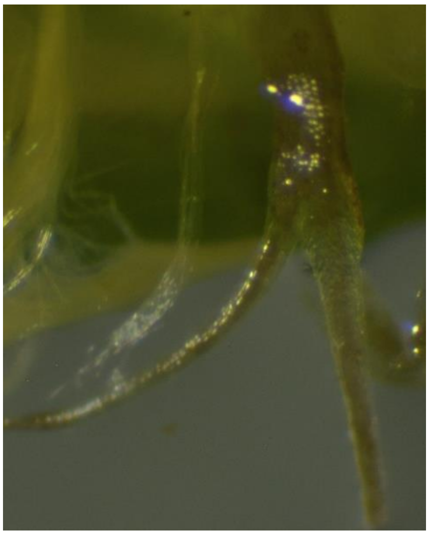
This is the last seed remaining within a spadix washed ashore.

Note its darker brown shading.

Other seeds from this plant were possibly deposited in the soft sand offshore.

Further surveys may observe regrowth of the seagrass bed as they begin to germinate.

Zostera noltei Flowering



A very fresh sample (only minutes delay prior to dissection) resulted in accidental puncture of the male pollen sac near a female stigma.

Even though the Zn flowering parts are smaller than Zm flowers, the thin pollen threads and the manner in which they were packed into the theca were quite interesting.

Over several minutes, there was noticeable darkening of the stigmata as self-pollination appears to have taken place!

Very fine threads visible in the upper-third of the photo may show actual pollen in the wild.

Although this is a vegetative plant, it was in a bed with significant numbers of Zn flowering plants.

One lesson learned was to photograph Zn shoots with the tide covering the plants!

Lowest tides are best for mapping but there is greater excitement with a bit more water.

The lack of observable **retinaculae** (“regularly spaced flaps”) on any of the flowering plants observed may suggest a local Zn variation, an incorrect Zn classification by the author, or an issue with Zn classification keys.

Zostera Epiphytes

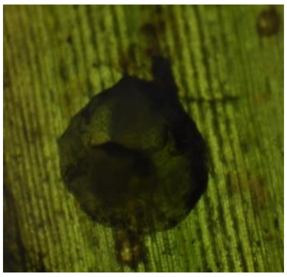
Older seagrass leaves and sheaths are likely to be covered by a variety of seaweeds and both mobile and sessile animals. This biomass, although small, is weighed separately from the seagrass.

This is a Zm sample prior to scraping off the epiphytes including filamentous seaweeds, encrusting organisms, rust and hydroids.

Seagrass and epiphytes are then dried at 60C for 48 hours and weighed separately.

Encrusted organisms are often no more than a smear!

Animals such as these bryozoa, molluscs, amphipod and isopod (*Idotea balthica)* were removed and photographed for future identification:



The use of a dissecting microscope improved this surveyor's ability to classify Amphipoda and similarly-sized organisms such as this (possibly) *Platorchestia platensis* (female) found on the beach while observing Zostera marina swept ashore (ZmS):

Various Ulva were noted blanketing Zn. The seagrass often appeared healthy even when totally hidden from sight at low tides. Surveyors may have to spend extra time lifting the Ulva blankets to inspect for rooted Zn (ZnG) plants while extent mapping. Areas with both seagrass and seaweeds often supported huge numbers of very small snails (possibly *Peringia ulvae*).

Seagrass beds certainly provide significant food stock for the wintering-over bird populations!

Two varieties of Ulva blanketing Zn hosting a very rich ecosystem including hundreds of gastropods per square meter.

Trampling

Vehicles have left noticeable tracks in many of our local Zostera beds.

Some are limited to areas where vehicles are parked (picture to the left).

Our Atlantic Saltwater Marsh has seen tracks turn into roads.

Other areas suitable for Zn appear to have been completely ploughed.

Zostera & Coastal Erosion

An interesting underwater observation took place in April 2022 when a large number of completely intact Zm plants were found on the seafloor and throughout the water column at the south end of the FIT Zm bed. Further snorkelling investigations discovered the source of plants at the edge of a newly scoured bank about 20 cm high and several meters wide.

This bank contained a large clump of seagrass with most of its roots exposed by subtidal currents.

This clump was photographed fully detached the next day 44m from the eroded bank.

A narrower erosion event scoured 23cm of sand south of the 16m mark of Transect 1.

An interesting relationship in the early regrowth of Mermaids' Tresses (Chorda filum) was observed as they established holdfasts prior to Zm regrowth. Extent mapping of Chorda filum was completed in August and continued observations of the interaction of these two species is merited.

These early observations suggest that seagrass contribute to the development of their habitat as they bind a significant amount of sand just seaward of the Fenit Island Tombolo.

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Appendix of 2022 Extent Maps

Zostera marina beds present interesting subtidal challenges and these 2022 maps are more accurate.

The coloured lines show the location of transects used to conduct shoot counts and measurements.

Efforts to understand Zn seasonal variation include the following which showed winter reductions.

The northern Currahane Zn bed showed great variation in total area. By August the bed showed little difference from 2021 measurements. Smaller beds appeared and one "hole" in the southern bed appears to be healthy with various Ulva dominating an area which was covered by Zn last year. Thick Ulva blankets are frequently observed in various parts of the Currahane beds.