Solway Firth Partnership

Swansea University Prifysgol Abertawe

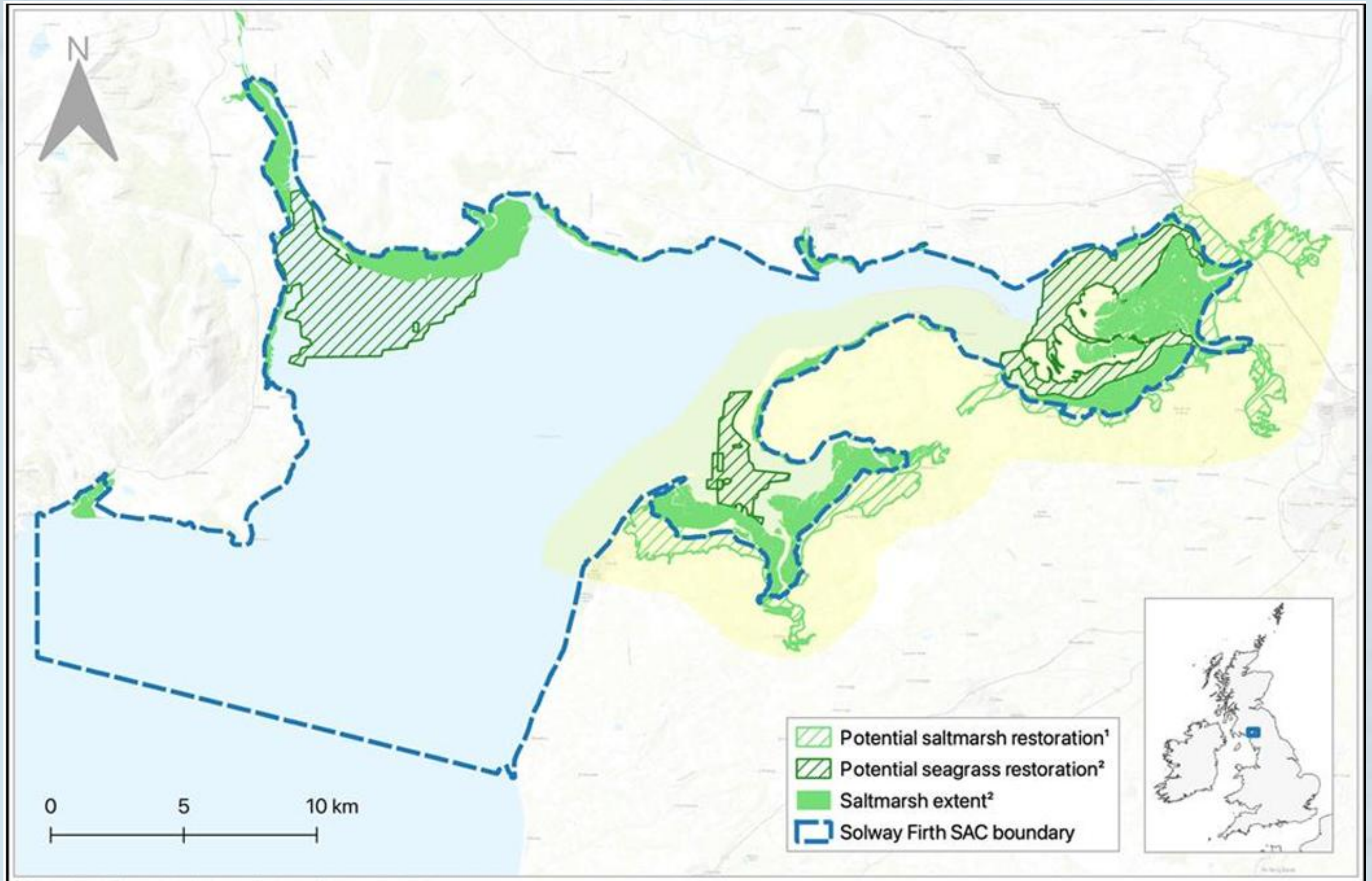
Cumbria Wildlife Trust

CLEAR coasts

The Mission

"to combine local knowledge with field surveys to enhance and restore saltmarsh, seagrass, and reef habitat in the Cumbrian Solway Firth."

CLEAR coasts | Solway Firth Partnership | Swansea University Prifysgol Abertawe | Cumbria Wildlife Trust



[1]Source: Marine Management Organisation
[2]Source: Environment Agency

CLEAR coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust

Phase 1

- Established a steering group with key partners and created a focus group to discuss restoration opportunities and challenges.
- Saltmarsh restoration identified as the most viable option; seagrass restoration faces hydrodynamic challenges.
- Secured monitoring equipment and received broad support to continue into Phases 2 & 3.

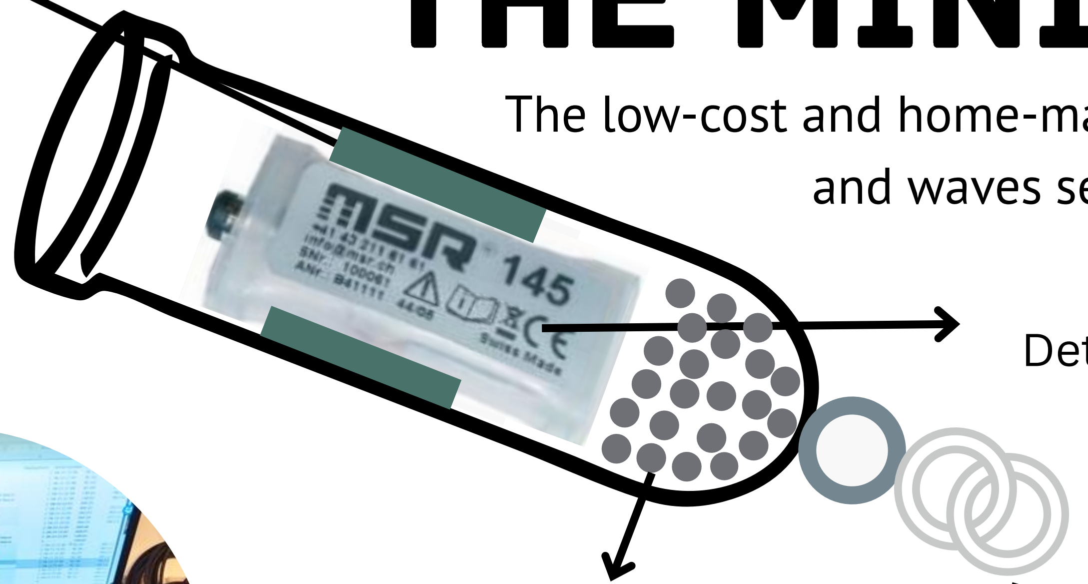
Key Outputs

• establishment of coastal champions to develop and maintain restoration programmes,
• development of methods to select optimal intertidal areas for restoration,
• training of local stakeholders in the Mini Buoy tool, to locally assess habitat suitability at low cost

THE MINI BUOY

The low-cost and home-made tides, currents, and waves sensor

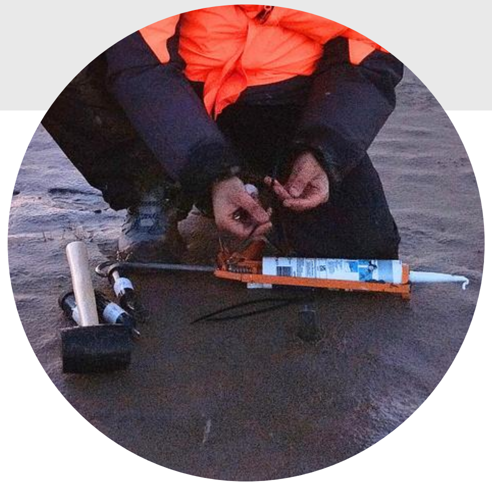
Floral Foam
Keeps it secure.

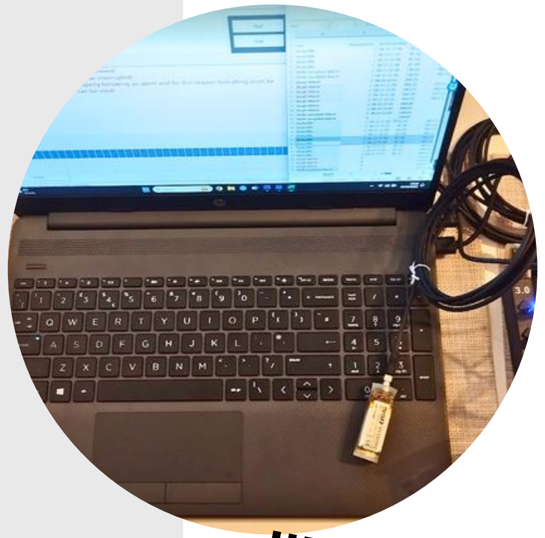


Data Logger
Detects movement.

Steel Shot
Increases sensitivity.

Wire Loops
For free movement.





Programming the Data Logger:
Use the MSR software to set the logger to record data every few seconds along the y-axis.

Get Your Mini Buoy Ready:

- Place the logger in the tube, held firm with floral foam.
- Seal the lid of the tube using silicone sealant.

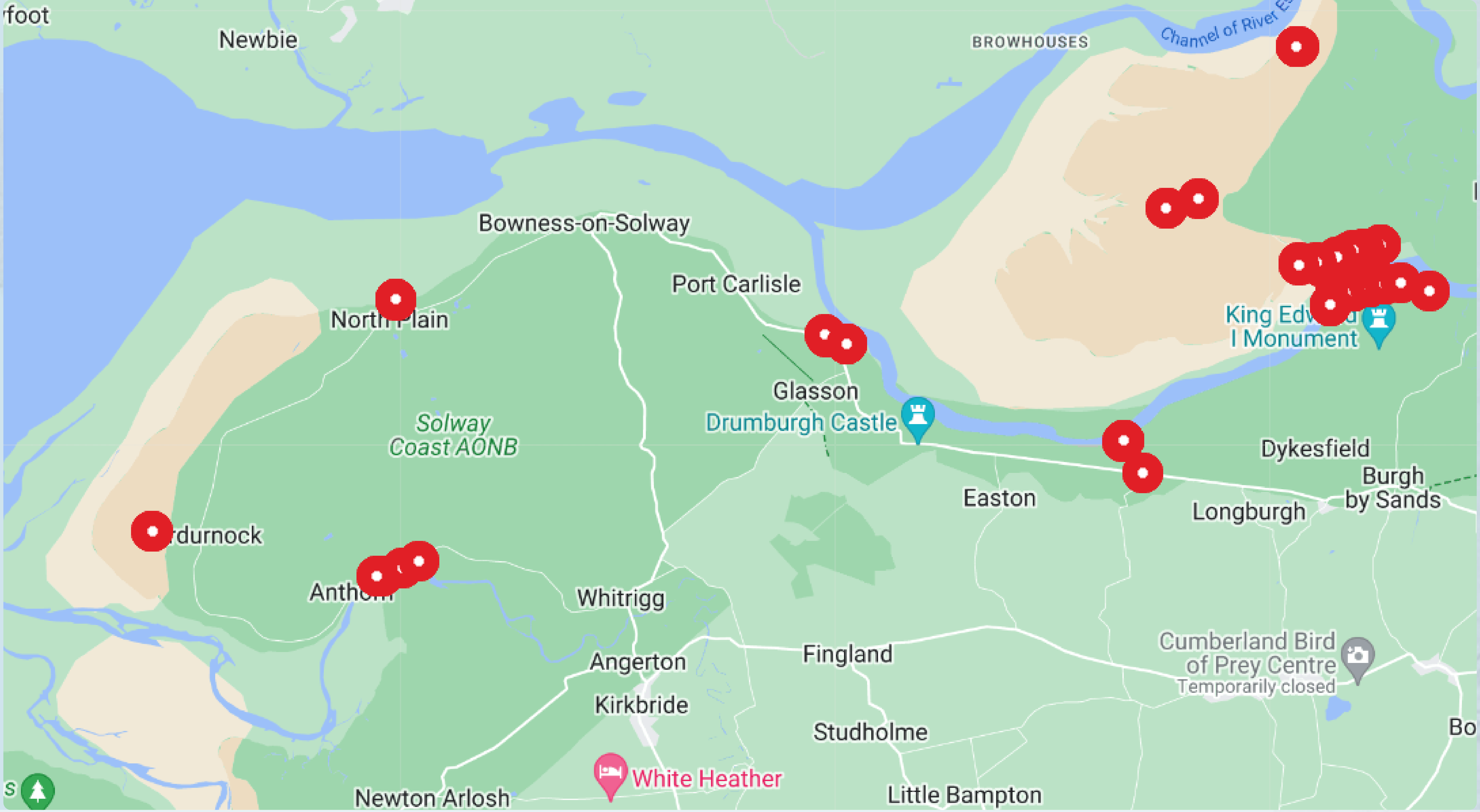
Deploy in the Field:

- Place a stake in the ground, attach the Mini Buoy using cable ties, and ensure the swivels can move freely.
- Retrieve the Mini Buoy ideally after 15 days or more to capture a full Spring-Neap cycle.

Data Collection and Analysis:
Download the data using the MSR software and analyse it using the Mini Buoy App.

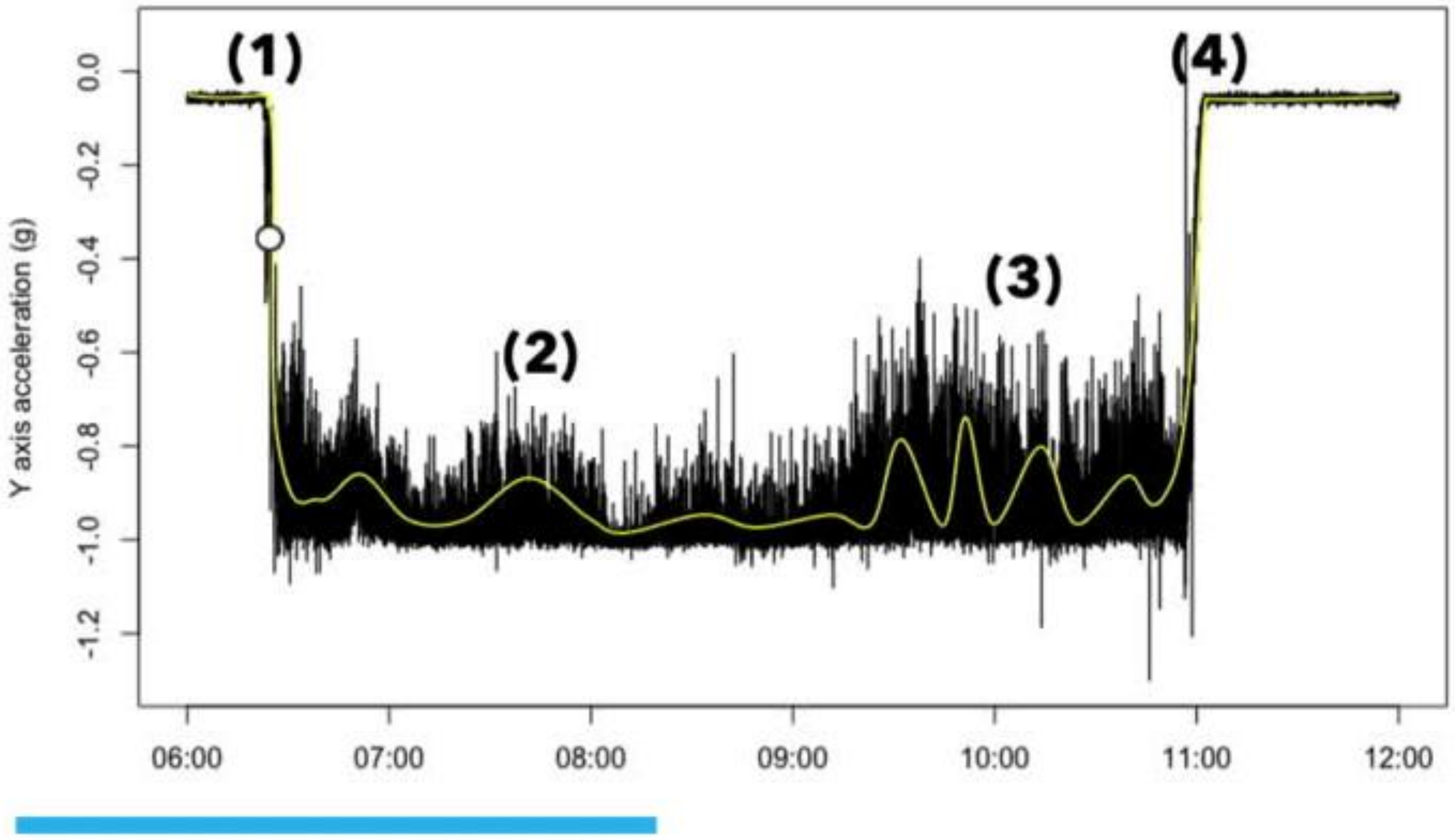
By monitoring potential sites for coastal habitat restoration, the Mini Buoy supports healthier, more resilient coastal ecosystems.

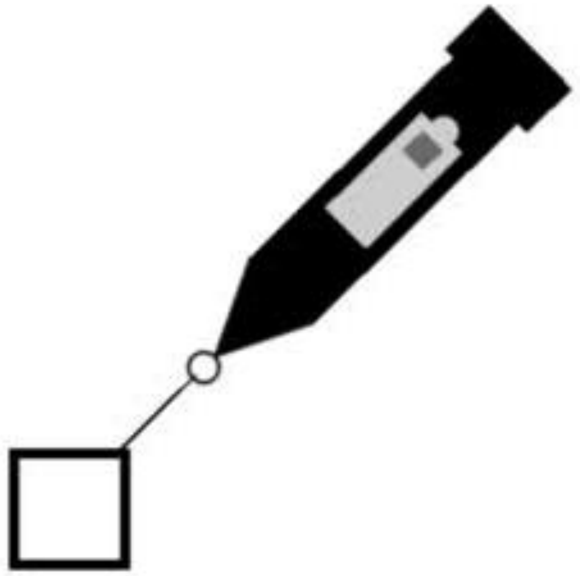
CLEAR COASTS
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust



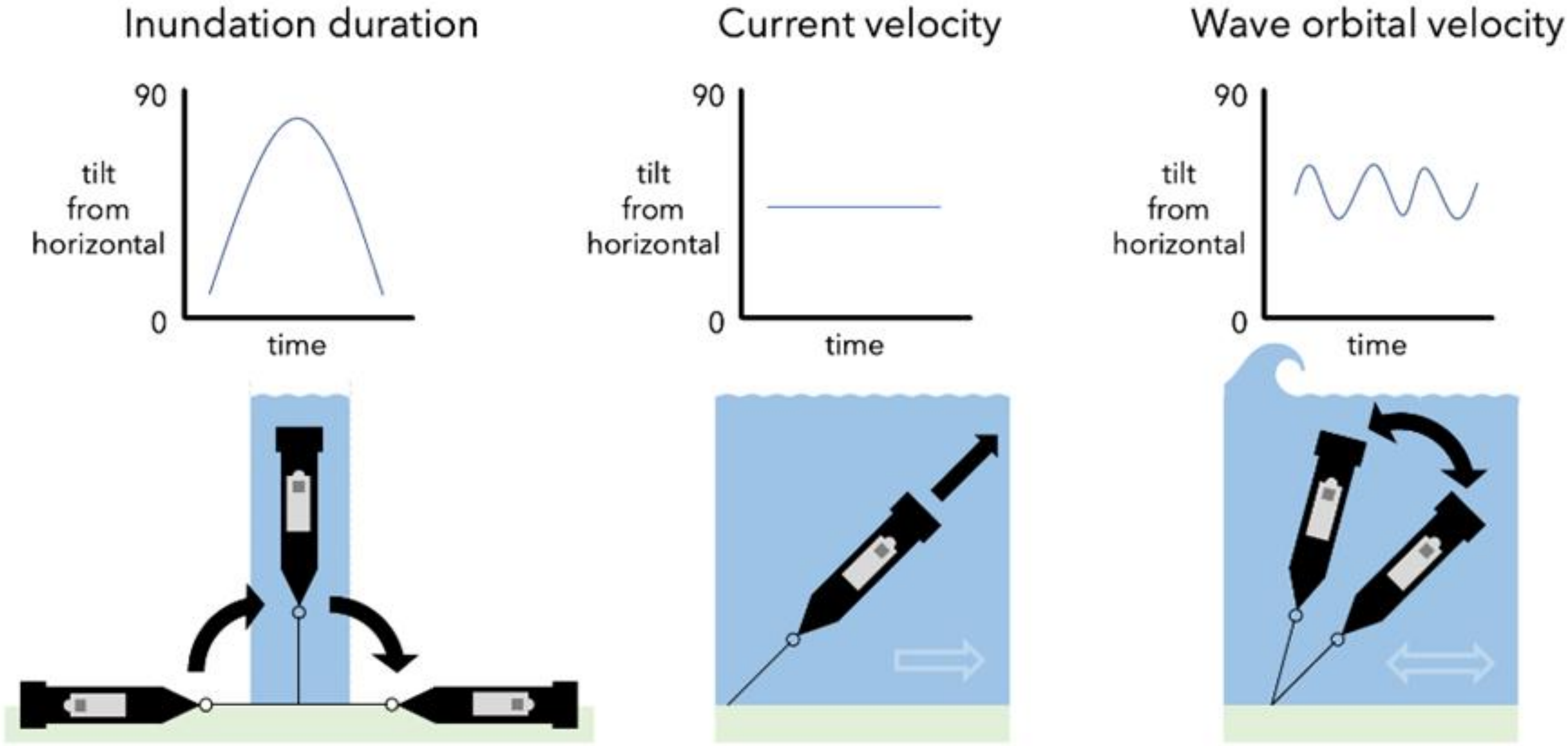
CLEAR coasts · Solway Firth Partnership · Swansea University Prifysgol Abertawe · Cumbria Wildlife Trust

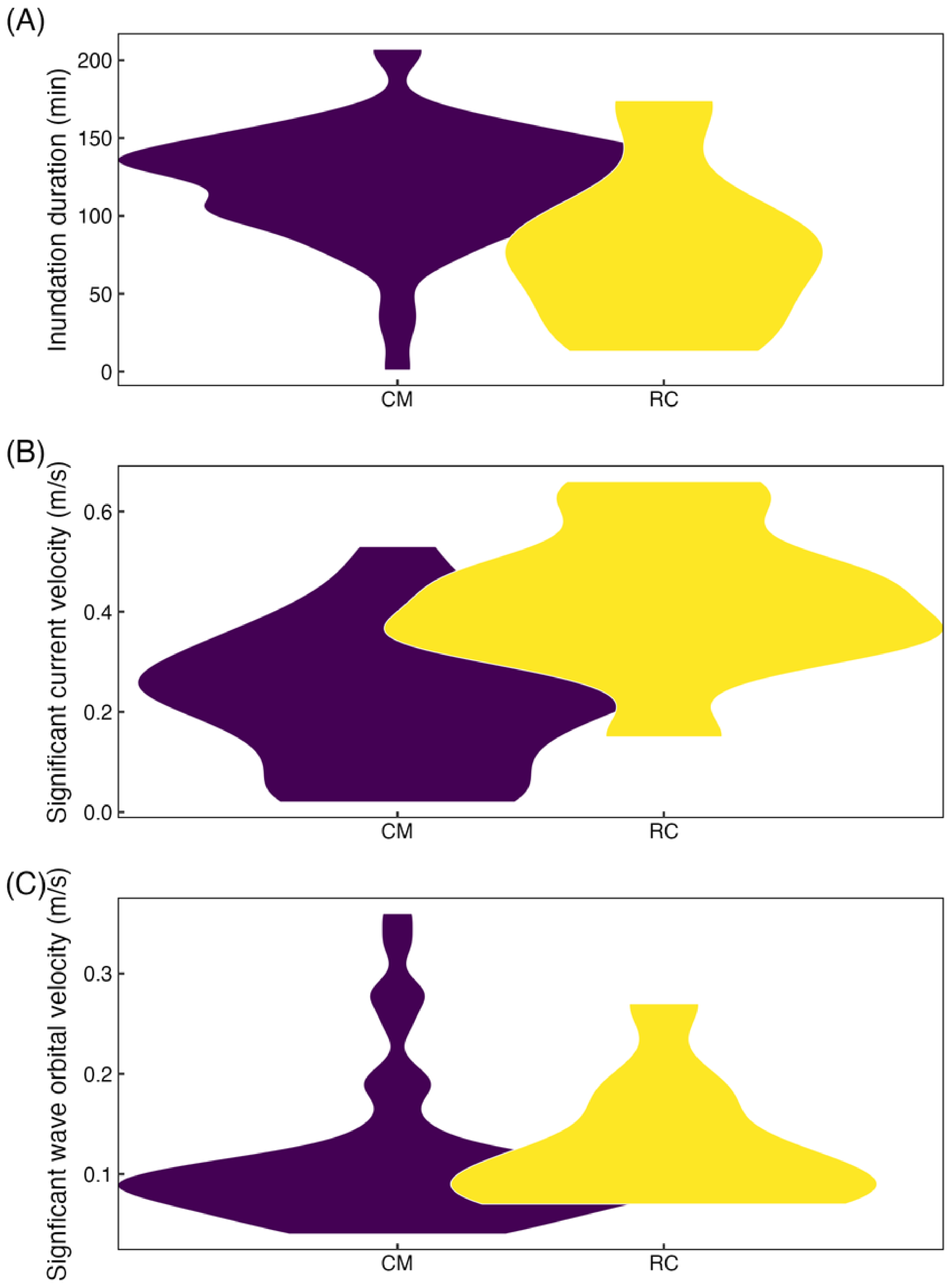
The Mini Buoy





CLEAR Coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust

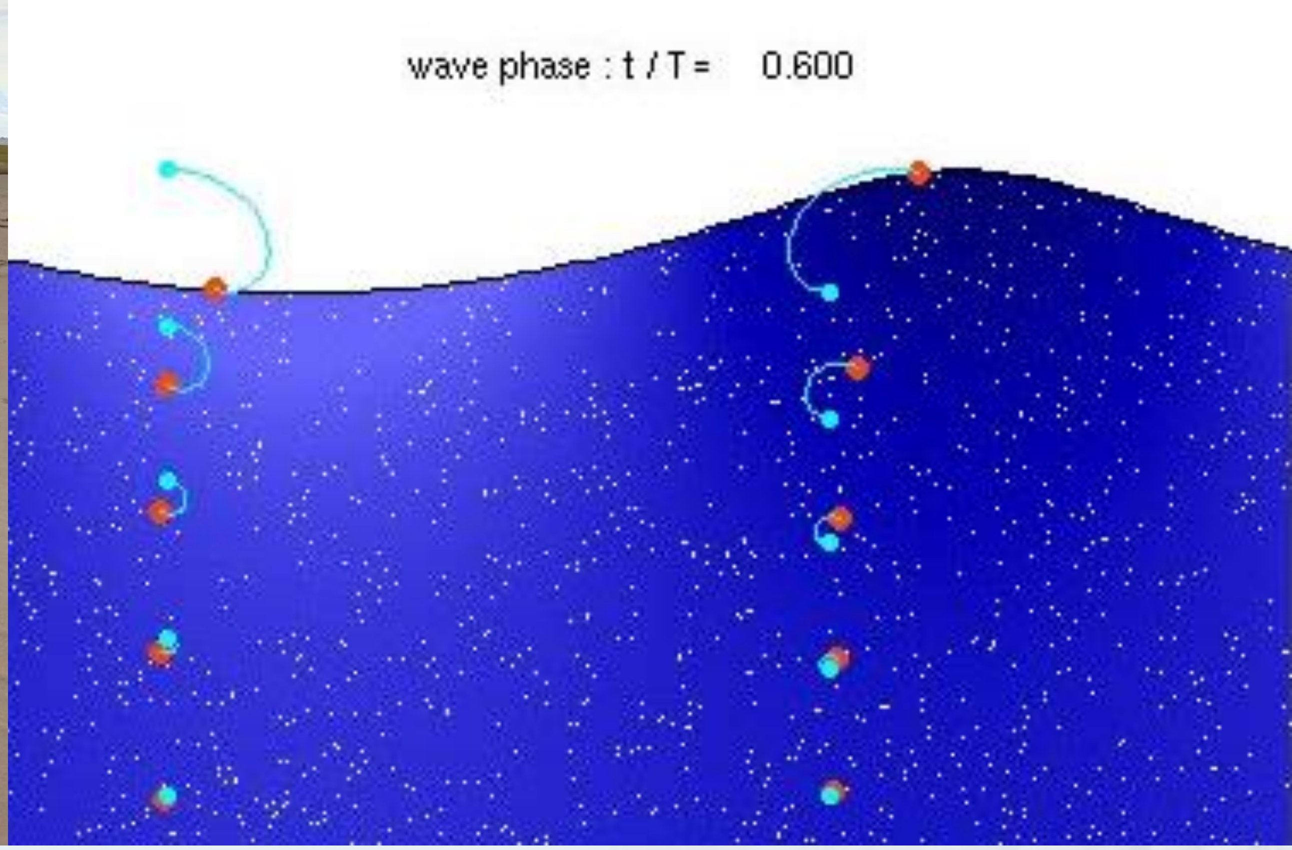

Inundation duration
Current velocity
Wave orbital velocity
90
tilt
from
horizontal
0
time
90
tilt
from
horizontal
0
time
90
tilt
from
horizontal
0
time


(A)
Inundation duration (min)
200
150
100
50
0
CM
RC
(B)
Significant current velocity (m/s)
0.6
0.4
0.2
0.0
CM
RC
(C)
Signficant wave orbital velocity (m/s)
0.3
0.2
0.1
CM
RC


CM


CM


R


wave phase : t / T = 0.600

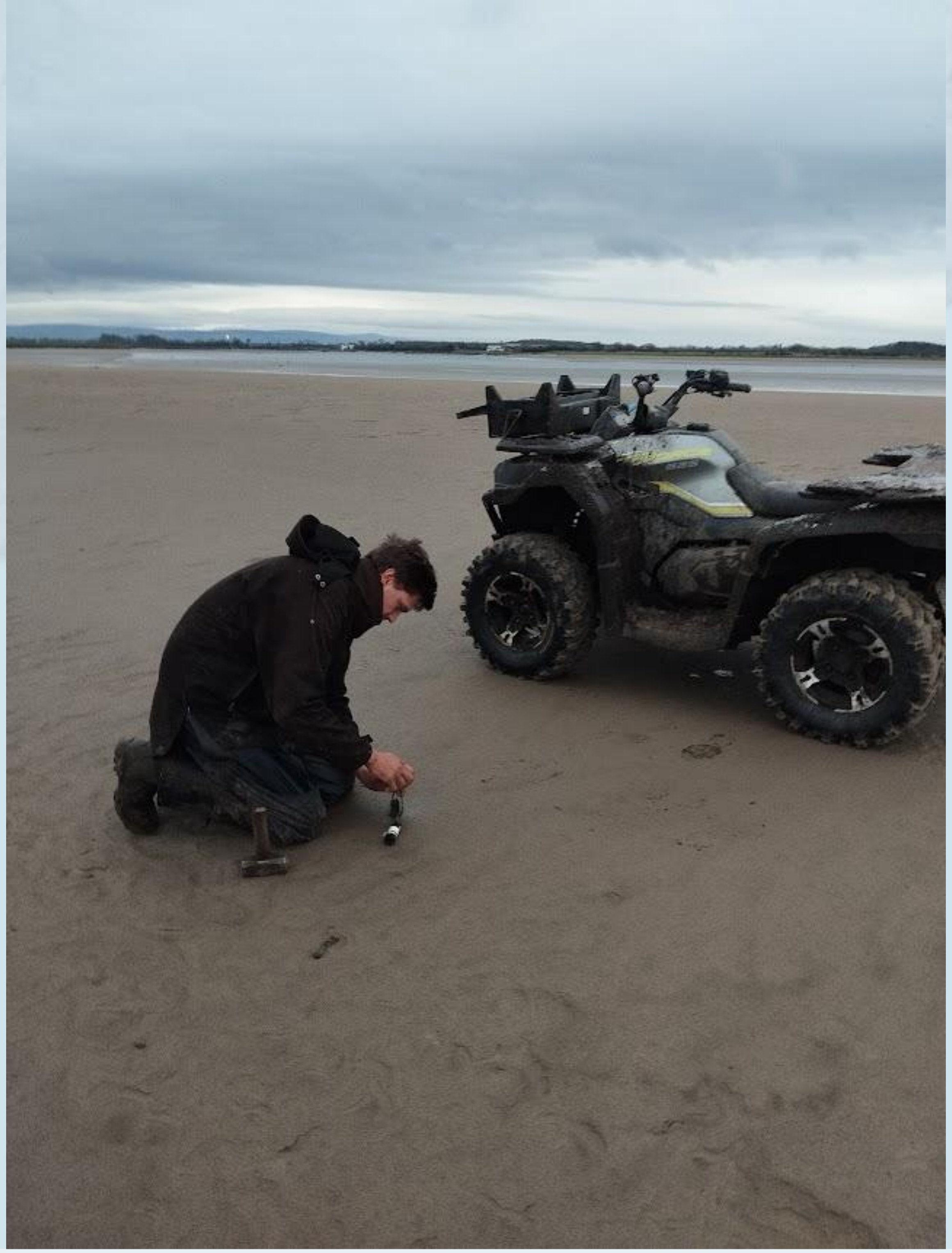
CLEAR coasts

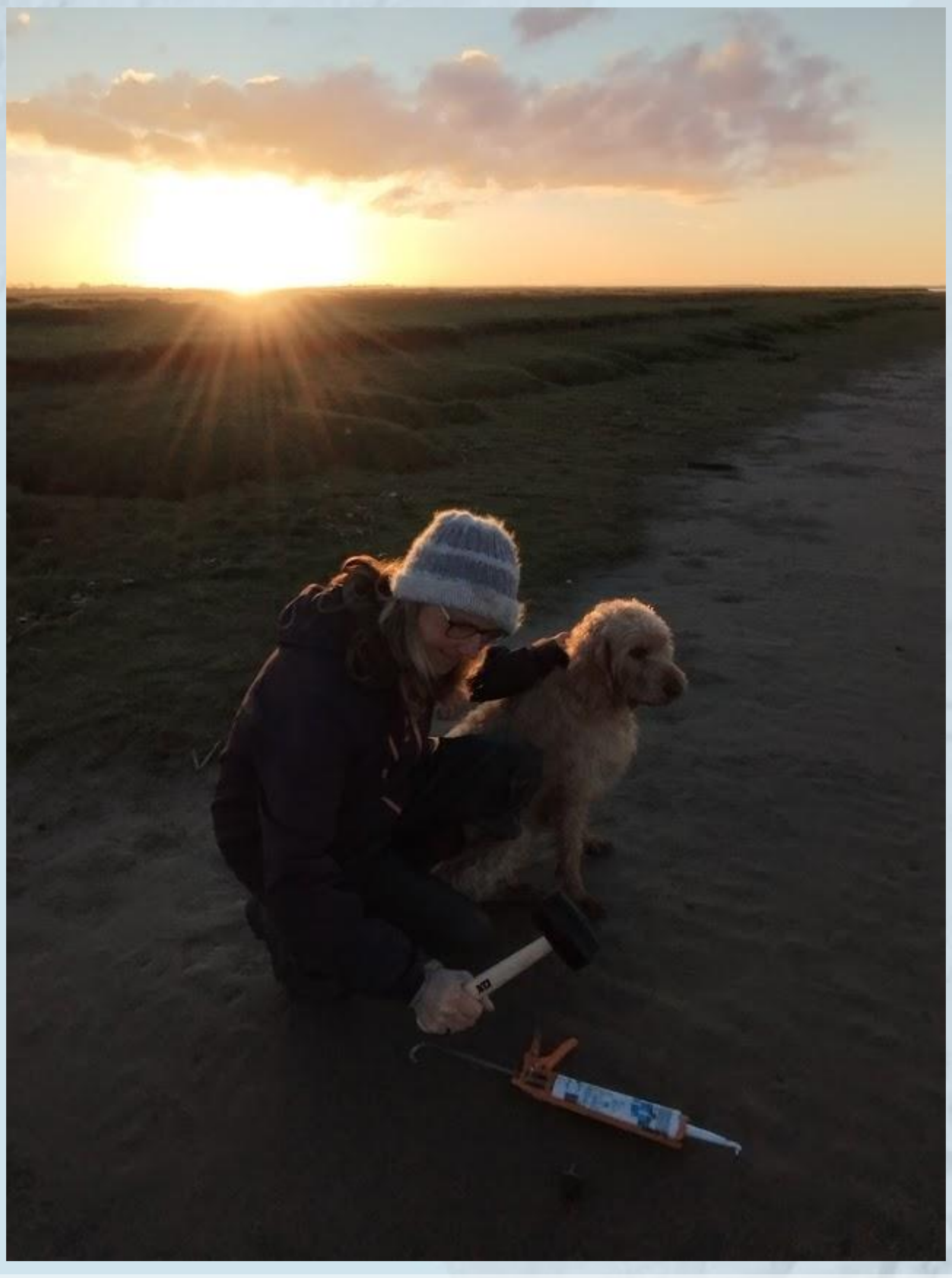
Solway Firth Partnership

Swansea University Prifysgol Abertawe

Cumbria Wildlife Trust

Couldn’t be done without help!





CLEAR coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust

CLEARcoast Champions

- Train citizen scientists to use Mini Buoys and identify suitable areas for habitat conservation
- Combine surveys with local knowledge and interests to narrow down potential sites for restoration
- Lead coastal habitat monitoring and advocate for conservation along the Cumbrian Solway Firth

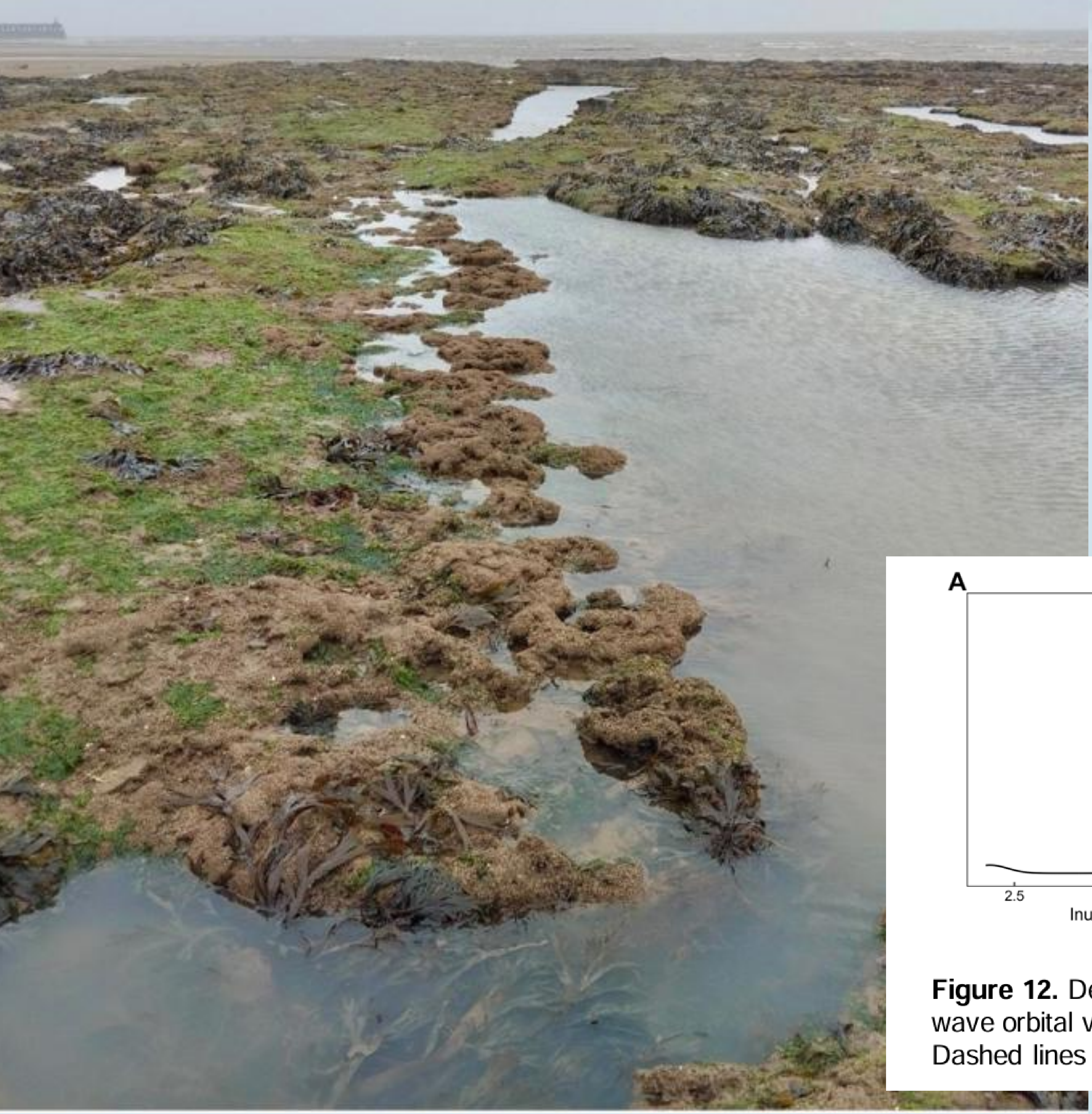
2 Workshops:

24/02/2024 Lake District Coast Aquarium

02/03/2024 RSPB Campfield Marsh

CLEAR coasts | Solway Firth Partnership | Swansea University Prifysgol Abertawe | Cumbria Wildlife Trust

The **first time** the assessment of hydrological suitability for honeycomb worm reef establishment has been attempted.



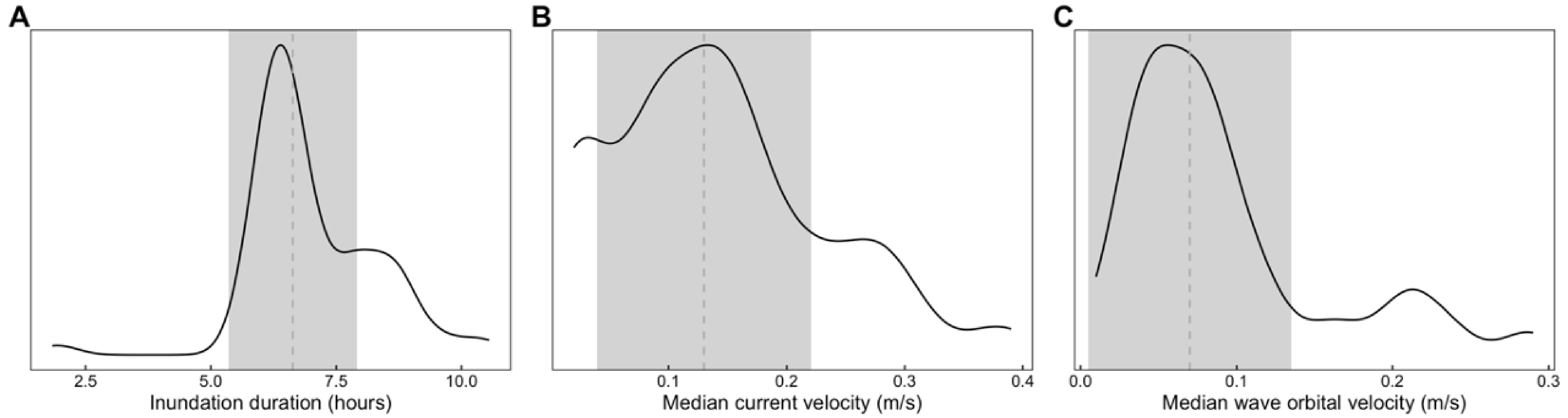


Figure 12. Density plots showing the frequency of **A** inundation duration **B** median current velocity, and **C** median wave orbital velocity values per inundation event across the honeycomb worm reef habitat at Maryport (black line). Dashed lines represent median values, and light grey shading represents standard deviation about the mean.

CLEAR coasts | Solway Firth Partnership | Swansea University Prifysgol Abertawe | Cumbria Wildlife Trust

Parameter	Unit	Anthorn	Cardurnock	Campfield	Glasson	Burgh (middle)	Burgh (inner)	Rockcliffe
Rate of lateral change	[m/yr]	-0.14 ± 0.30	-0.40 ± 0.00	0.01 ± 0.05	1.09 ± 1.34	-0.92 ± 0.95	-0.21 ± 0.37	0.17 ± 2.70
Replicates	[n]	1	2	2	1	2	2	2
Survey period	[days]	49.02	49.02	24.51	49.02	49.02	49.02	24.55
Inundation frequency	[n/day]	1.53	0.59	1.31	1.20	1.31	0.41	0.45
Inundation duration	[%]	17.91	3.86 ± 0.42	10.43 ± 0.31	10.92	12.29 ± 0.04	2.35 ± 0.39	2.10 ± 0.72
Longest emersion period	[days]	4.7	9.8	8.8	7.7	7.7	13.4	10.6
Median current velocity	[m/s]	0.27	0.08 ± 0.08	0.09 ± 0.09	0.24	0.10 ± 0.11	0.06 ± 0.06	0.11 ± 0.12
Upper current velocity	[m/s]	0.58	0.42 ± 0.05	0.38 ± 0.05	0.49	0.22 ± 0.07	0.31 ± 0.01	0.45 ± 0.11
Median wave orbital velocity	[m/s]	0.08	0.06 ± 0.01	0.05 ± 0.01	0.04	0.03 ± 0.01	0.05 ± 0.01	0.07 ± 0.02
Upper wave orbital velocity	[m/s]	0.17	0.17 ± 0.01	0.23 ± 0.04	0.12	0.09 ± 0.00	0.13 ± 0.01	0.19 ± 0.07

	Campfield	Anthorn	Cardurnock
Condition	**Expanding saltmarsh with some erosion along the marsh edge.**	**Eroding saltmarsh with high current velocities.**	**Eroding marsh, similar to Anthorn.**
Hydrodynamics	**Moderate tidal inundation and current velocities below the erosion threshold.**	**Frequent and prolonged tidal inundation, with strong currents (0.27 m/s) exceeding the erosion threshold.**	**Lower tidal inundation than Anthorn but still subject to erosion forces (-0.40 m/yr lateral change).**
Restoration Potential	**High – Well-suited for saltmarsh expansion and habitat restoration**	**Challenging – High erosion risk; stabilisation measures needed before restoration.**	**Moderate – Restoration possible but may require sediment stabilisation or other interventions.**

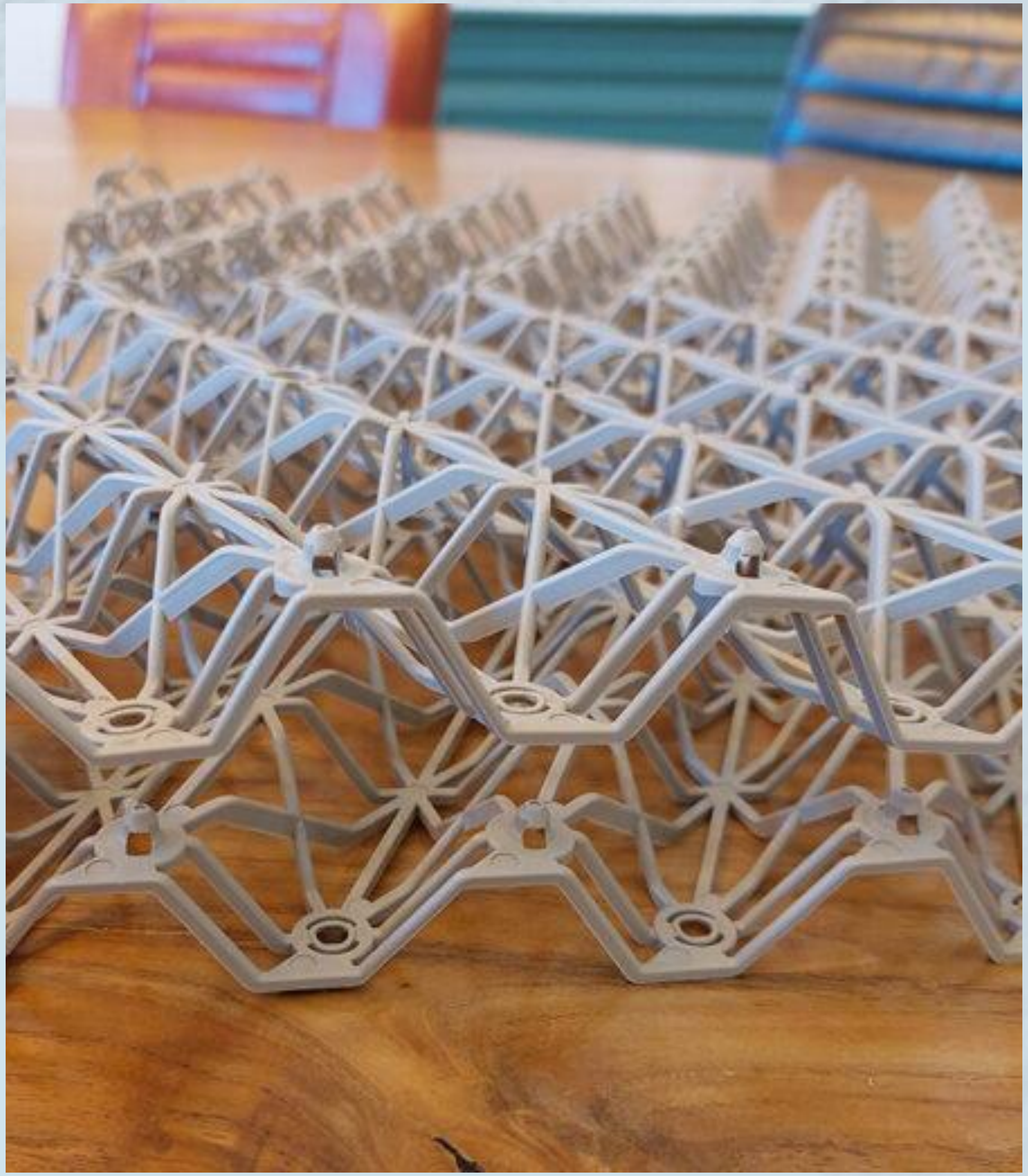
CLEAR coasts · Solway Firth Partnership · Swansea University Prifysgol Abertawe · Cumbria Wildlife Trust

Phase 3

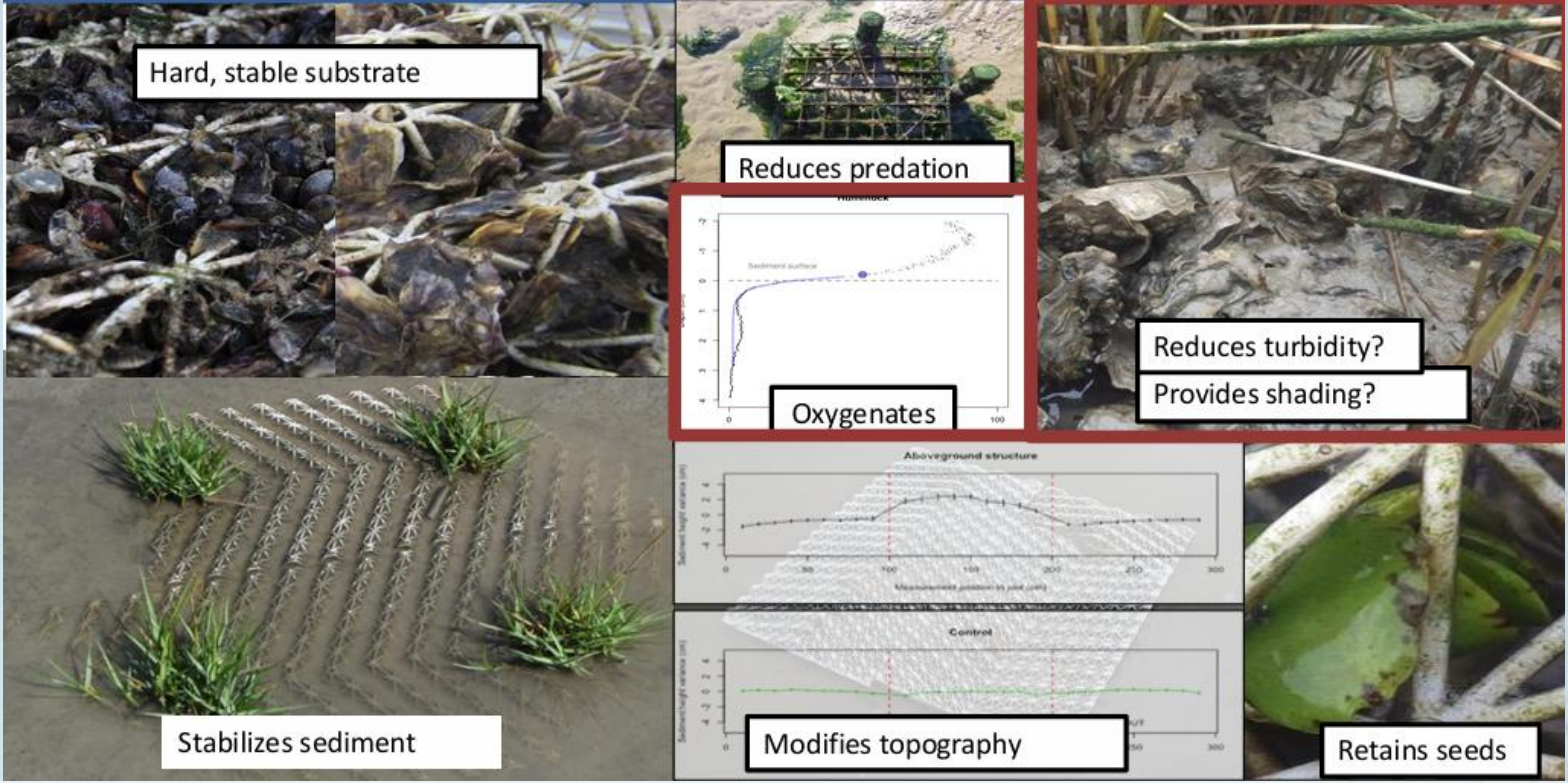
- Establish a citizen scientist led long-term restoration experiment (to determine the value of local involvement in achieving long-term restoration goals)
- Evaluate the impact of coastal restoration on both habitat evolution and community wellbeing.
- Test and refine intervention methods to enhance habitat growth conditions.

CLEAR COASTS | Solway Firth Partnership | Swansea University Prifysgol Abertawe | Cumbria Wildlife Trust

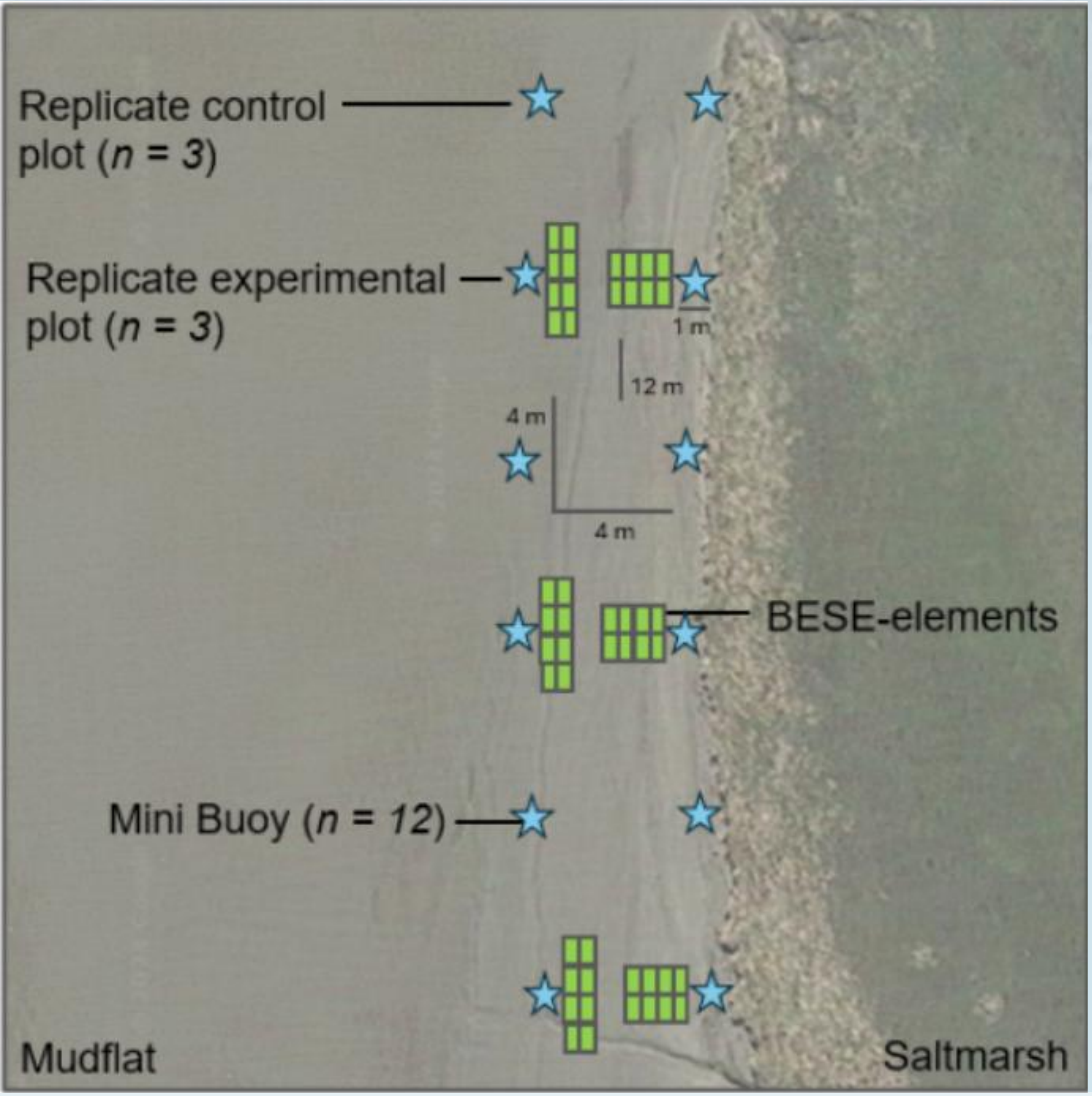
- **BESE-elements® are made from a starch biopolymer derived from potato waste and are designed to reduce local currents and waves, provide stability, and create shelter for organisms.**
- **This pilot study will assess their effectiveness in supporting saltmarsh restoration in the Solway region.**

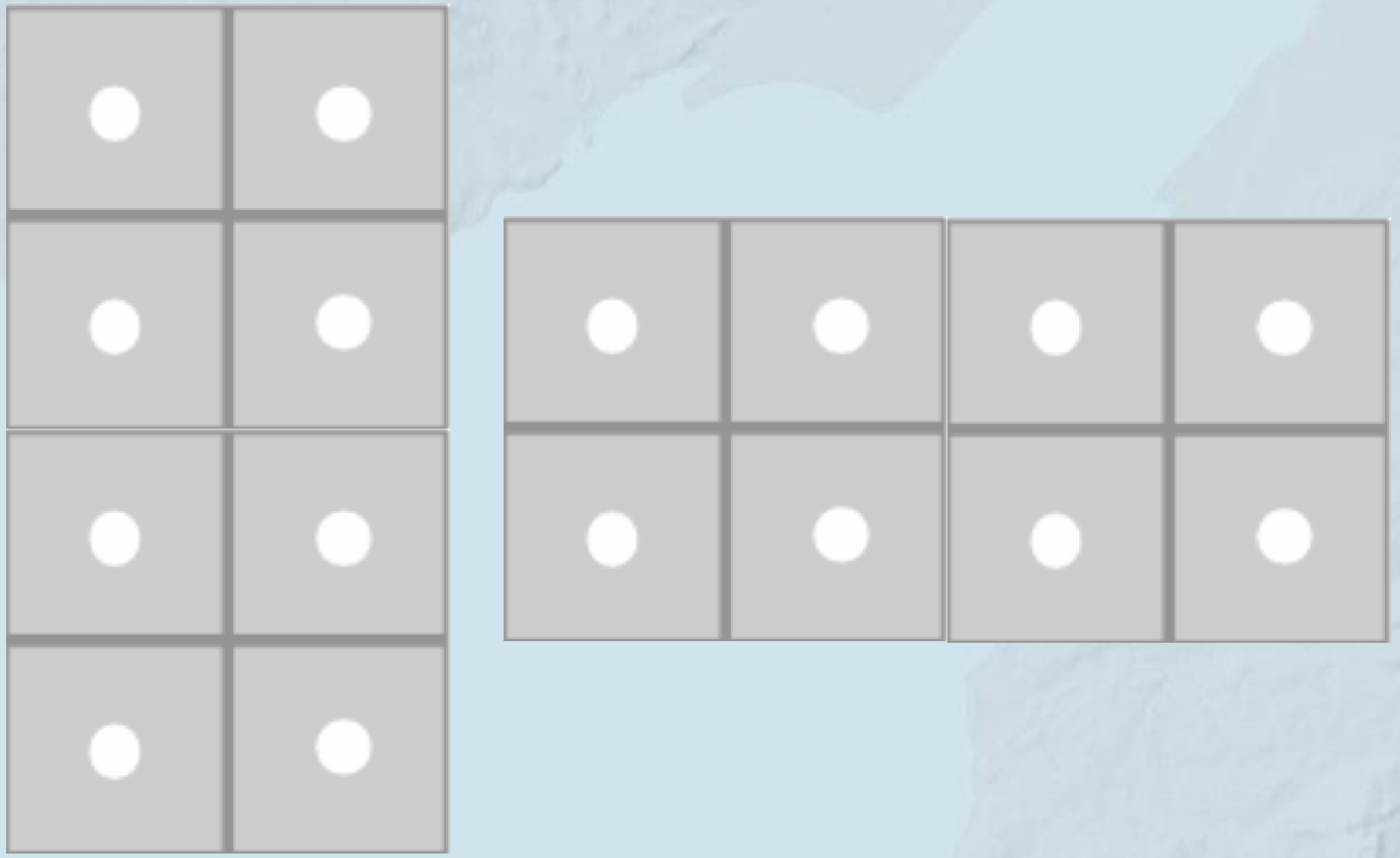


CLEAR coasts | Solway Firth Partnership | Swansea University Prifysgol Abertawe | Cumbria Wildlife Trust



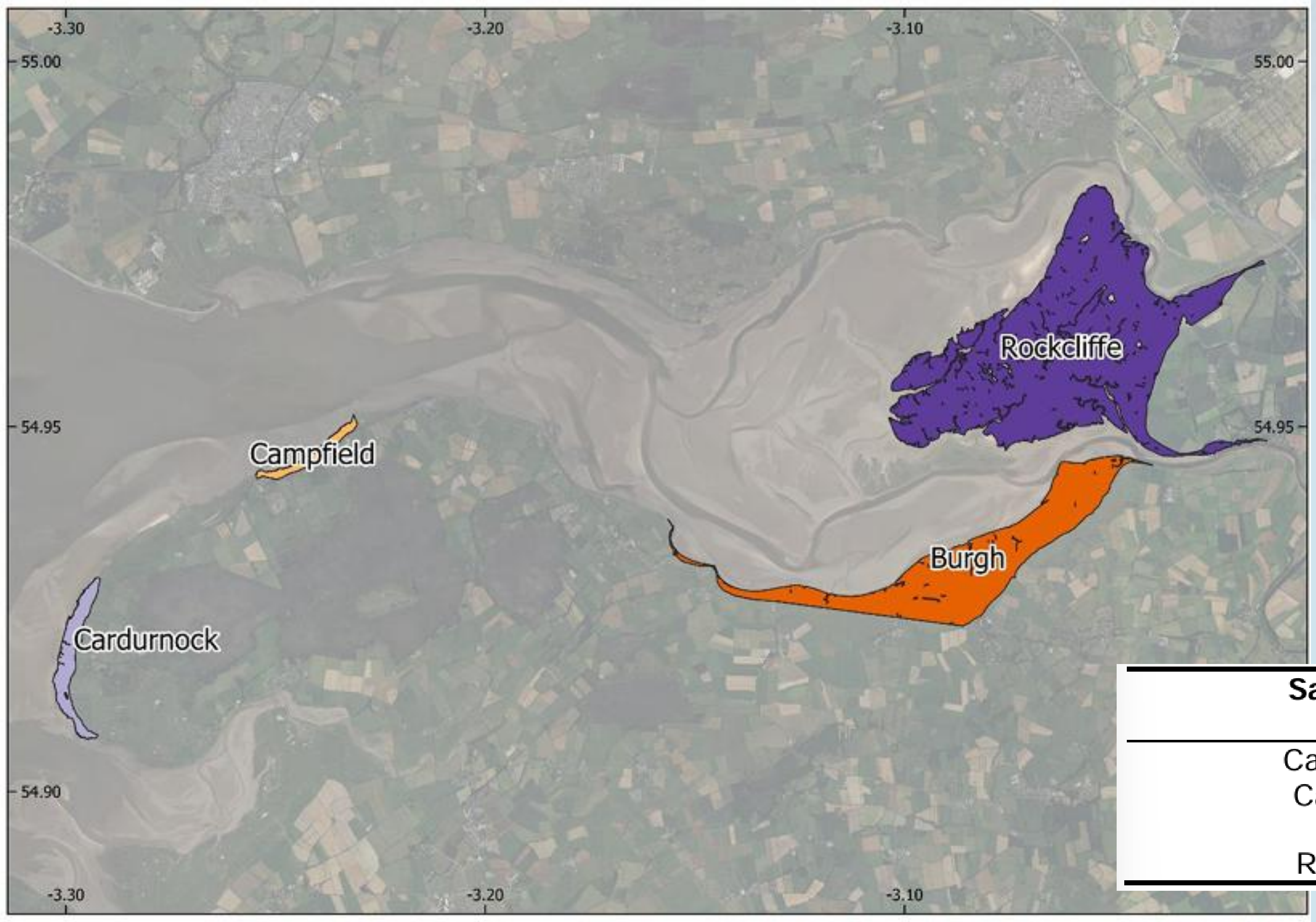
Fivash et al. 2021

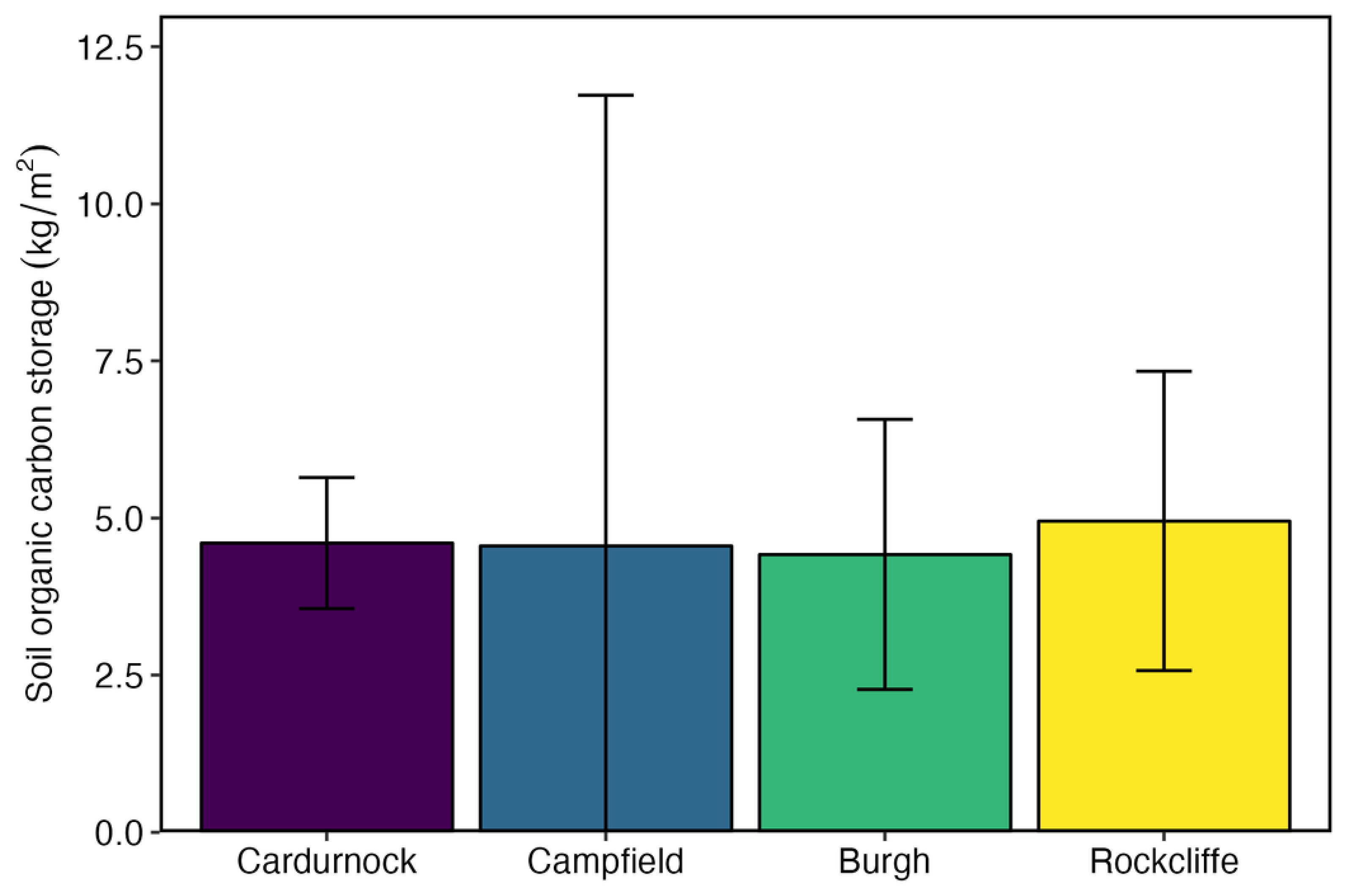




CLEAR Coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust

Solway Carbon Stocks



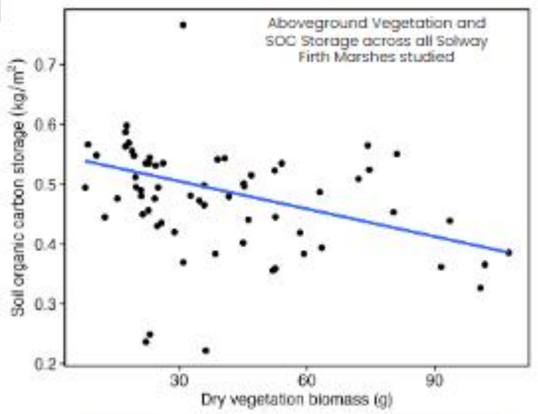


Saltmarsh	Area (km^2)	Soil organic carbon stock (tonnes)
Cardurnock	0.54	2,507 ± 171
Campfield	0.22	1,016 ± 480
Burgh	3.74	16,525 ± 2,410
Rockcliffe	9.37	46,410 ± 6,695

CLEAR coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust

CAMPFIELD

Soil Organic Carbon (SOC) distribution across **Campfield** saltmarsh



Why is mapping carbon important?

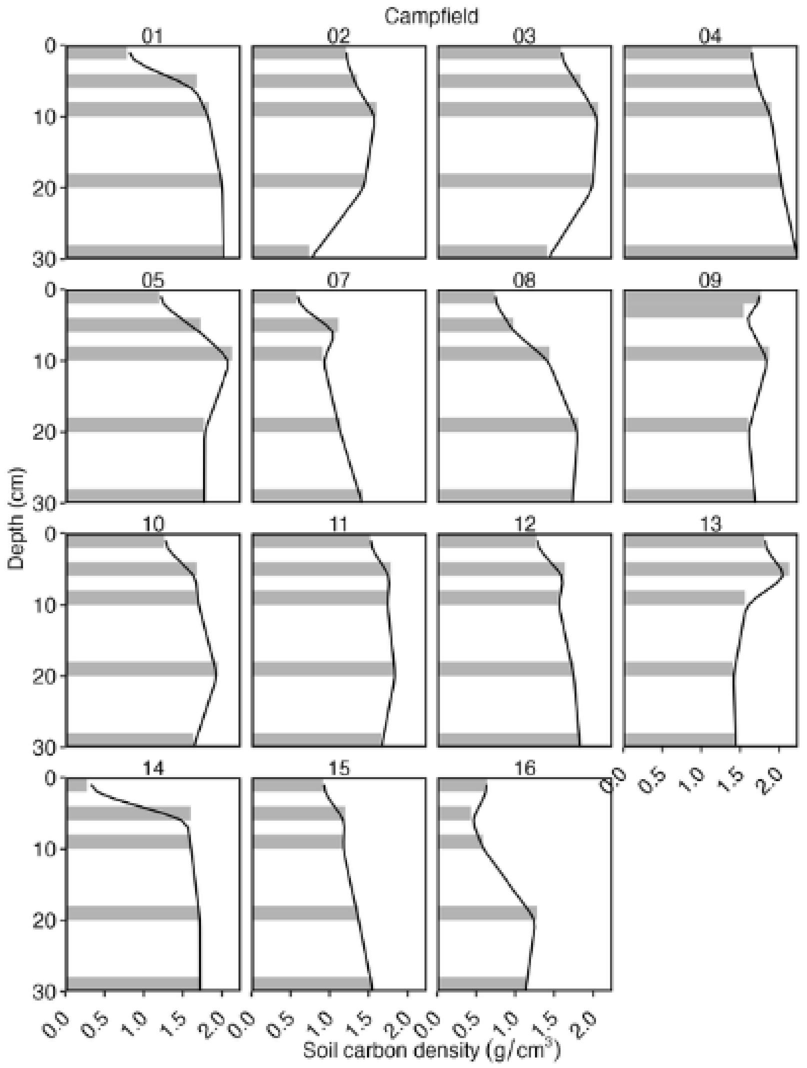
- Establishes a baseline against which to monitor changing carbon stocks over time.
- Offers insight into how tidal flow, vegetation, soil type etc. influences carbon accumulation.
- Areas with high carbon stocks would suit conservation priorities, whilst areas with lower or more variable carbon stocks might benefit from restoration efforts.

"Grams per cubic centimetre"
A measure of **soil carbon density**, showing how much carbon is stored in a given soil volume e.g. 50 g/cm³ means each cubic centimeter of soil contains 50 grams of carbon.

Interpreting patterns:

- Carbon stocks were generally highest in the low marsh zone.
- Carbon stocks tended to be highest when plant biomass was low (see figure above).
- Both patterns are in reverse to what we expect. It **may be** that the sandy substrate and therefore low-nutrient environment of the Solway Firth means marsh plants decrease carbon storage by mining the soil of nutrients (Terrer et al. 2021).

Soil Carbon Density with Depth



Vertical axis: This shows how deep the soil sample was taken, from the surface (0 cm) to 30 cm below. **The deeper you go, the older the soil tends to be.**

Horizontal axis: This tells us how much carbon is in each layer of soil. **Higher numbers mean more carbon in that layer**.

The **grey bands** indicate subsets of soil cores taken at specific depth intervals.
The **black line** represents how the carbon density changes as you go deeper into the soil. **If the line slopes right, the layer has more carbon; if it slopes left or flattens, it has less.**

Key Observations:

- **Relatively uniform soil carbon density with depth:** Most cores show consistent carbon density; some exhibit a minor increase with depth, aligning with the carbon-plant link observed across Solway Firth marshes.
- **SOC preservation in mid-layers:** SOC decomposition is non-linear (Bai et al. 2016); mid-layers **may** retain more carbon as organic input continues while decomposition slows, with finer sediments storing more SOC (Kelleway et al. 2016) before transitioning to coarser, lower-carbon material (Smeaton et al. 2022).
- **Sudden peaks: Likely** due to roots or buried organic-rich layers, **possibly** from past accretion events (e.g. storm surges, high tidal influx) where carbon-rich material was deposited and preserved over time. Instead of a steady decline, these events trap organic material at different depths.

CLEAR Coasts · Solway Firth Partnership · Swansea University Prifysgol Abertawe · Cumbria Wildlife Trust

Further Questions

CLEAR coasts
Solway Firth Partnership
Swansea University Prifysgol Abertawe
Cumbria Wildlife Trust