PRIFYSGOL BANGOR UNIVERSITY

Zoological Society of London

#NNF3 Connecting Conwy: Oyster Survival Trials in the Menai Strait SAC – Science Summary Report

2025-2026

Cronfa Treftadaeth Heritage Fund

Mewn Partneriaeth â Llywodraeth Cymru

In Partnership with Welsh Government

Author(s) name: Rhianna Parry[1], Maria Hayden-Hughes[1], Celine Gamble[2], Felix Wagner[1]
Author(s) affiliation: [1]School of Ocean Sciences, Bangor University, [2]Zoological Society of London (ZSL)

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Fossilised native oyster (Ostrea edulis) shell, Ynys Llanddwyn (west of the Menai Strait) © Rhianna Parry

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Crynodeb Gweithredol

Mae'r astudiaeth hon yn rhan o brosiect #NNF3 Cysylltu Conwy (Amcan 2: Treial Gallu Wystrys Brodorol i Oroesi) ac mae'n edrych ar hyfywedd adferiad yr *Ostrea edulis* brodorol mewn ardal a amlygwyd o Afon Menai, rhwng Medi 2025 a Mawrth 2026. Bu'r astudiaeth yn rhoi prawf ar dair rhagdybiaeth: rhagdybiaeth 1, yn ymwneud â goroesiad wystrys (H1), rhagdybiaeth 2, yn ymwneud â thwf y gragen (H2) a rhagdybiaeth 3 (H3), yn ymwneud â sefydliad rhywogaethau ar gewyll y feithrinfa.

Cafodd goroesiad wystrys aeddfed ei asesu mewn safle a amlygwyd (rafft Afon Menai) a safle cyfeirio cysgodol (Marina Conwy). Roedd y goroesiad cyfartalog yn 70% yn rafft Afon Menai a 98% ym Marina Conwy. Mae cyfraddau marw uwch yn ystod y cyfnod ar ôl y cyflwyno cychwynnol yn y safle a amlygwyd yn debygol o adlewyrchu straen cynefino sy'n gysylltiedig â throsglwyddo stoc o amodau acwariwm; yn dilyn y cyfnod hwn, roedd y cyfraddau goroesi'n parhau'n uchel yn y ddau safle (98–100%), sy'n cadarnhau Rhagdybiaeth 1 yn rhannol.

Roedd tyfiant cregyn yn gyfyngedig ac yn amrywiol iawn yn y ddau safle yn ystod cyfnod monitro Medi 2025 i Fawrth 2026, heb ddim gwahaniaethau arwyddocaol wedi'u canfod rhwng y safleoedd o ran dimensiynau'r cregyn (profion-t Welch, $p > 0.05$), sy'n rhoi cadarnhad rhannol yn unig i Ragdybiaeth 2. Roedd yr amodau amgylcheddol yn amrywio rhwng y safleoedd, gyda rafft Afon Menai yn cael ei nodweddu gan amodau halwynedd morol cymharol sefydlog a mwy o amlygiad hydrodynamig, gyda Marina Conwy yn dangos halwynedd a chrynodiadau cloroffyl-a is a mwy amrywiol.

Roedd cwmpas sefydliad rhywogaethau'n uwch yn rifft Afon Menai (cymedr 74%) nag ym Marina Conwy (cymedr 50%), gyda chasgliadau penodol a chynrychiolaeth uwch o dacsa dwygragennog wedi'u cofnodi yn safle Afon Menai. Ni welwyd dim effaith negyddol amlwg o sefydlogiad rhywogaethau ar oroesiad cewyll rhwng Medi 2025 a Mawrth 2026, sy'n cadarnhau Rhagdybiaeth 3 yn rhannol.

Mae'r canfyddiadau hyn yn dangos tystiolaeth ragarweiniol galonogol y gallai lleoliadau wedi'i hamlygu yn Afon Menai gynnal goroesiad wystrys brodorol aeddfed yn dilyn cynefino. Mae angen rhagor o waith i asesu perfformiad blynyddol llawn, gan gynnwys amodau gwely'r môr, a gwerthuso canlyniadau mewn ardaloedd a ganfuwyd drwy fodelu addasrwydd cynefinoedd a chrynhoi data.

Executive Summary

This study forms part of the #NNF3 Connecting Conwy project (Goal 2: Native Oyster Survival Trial) and explores the feasibility of native *Ostrea edulis* recovery within an exposed area of the Menai Strait between September 2025 and March 2026. The study tested three hypotheses: hypothesis 1, relating to oyster survival (H1), hypothesis 2, relating to shell growth (H2) and hypothesis 3, relating to species settlement on the nursery cages (H3).

Survival of adult oysters was assessed at an exposed site (Menai Strait raft) and a sheltered reference site (Conwy Marina). Overall survival averaged 70% at the Menai Strait raft and 98% at Conwy Marina. Elevated mortality during the initial post-deployment period at the exposed site likely reflects acclimation stress associated with stock transfer from aquarium conditions; following this period, survival remained high at both sites (98–100%), partially supporting H1.

Shell growth was limited and highly variable at both sites during the September 2025 to March 2026 monitoring period, with no significant differences detected between sites for any shell dimension (Welch's t-tests, $p > 0.05$), providing only partial support for H2. Environmental conditions differed between sites, with the Menai Strait raft characterised by relatively stable marine salinity conditions and greater hydrodynamic exposure, while Conwy Marina exhibited lower and more variable salinity and chlorophyll-a concentrations.

Species settlement cover was higher at the Menai Strait raft (mean 74%) than at Conwy Marina (mean 50%), with distinct assemblages and a greater representation of bivalve taxa recorded at the Menai Strait site. No clear negative effect of species settlement on cage survival between September 2025 and March 2026 was observed, partially supporting H3.

These findings provide encouraging preliminary evidence that exposed locations within the Menai Strait may support adult native oyster survival following acclimation. Further

work is required to assess full annual performance, including seabed deployment conditions, and evaluate outcomes within areas identified through habitat suitability modelling and ground truthing.

Introduction

Native oyster, or European flat oyster (*Ostrea edulis),* is a temperate bivalve species which settles on hard substrate such as rock or shell (Smyth *et al.,* 2018). When present in high densities, native oysters act as ecosystem engineers, forming complex three-dimensional biogenic reefs which provide habitat for a variety of marine species and deliver important ecosystem services including water filtration, nutrient cycling and habitat provision (Morris *et al.,* 2019; Peterson *et al.,* 2003; Thomas *et al.,* 2022; Albentosa *et al.,* 2023; Coen *et al.,* 2007). Historically widespread across the British Isles and Europe (Thurstan *et al.,* 2024), native oyster populations have declined substantially due to a combination of disease, poor water quality, habitat loss, historic overfishing and competition with invasive non-native species (Beck *et al.,* 2011; Zu Ermgassen *et al.,* 2024; Herbert *et al.,* 2016; Pouvreau *et al.,* 2023; Sas *et al.,* 2020). As a result, native oyster recovery has become an increasing focus of marine conservation and seascape recovery initiatives across the UK and Europe. Survival trials are commonly used within recovery planning to assess the suitability of different environmental conditions prior to any future recovery activity (Helmer, 2016; Helmer *et al.,* 2021; Uttley *et al.,* 2023).

Figure 1. Historical oyster cultivation in North Wales. (1) Building the oyster cultivation tanks at Conwy, 1921. (2) Workers wiring tiles to make bouquets for oyster cultivation, 1921. (3/4) Oyster cultivation at Tal y Foel, Menai Strait, 1960s (Conwy Archives, 2019).

North Wales has a long association with native oysters. Wales was once renowned for its thriving oyster fisheries, with records showing that Welsh boats landed up to 8,000 oysters daily in the mid-18th century and, in some areas, 15,000–20,000 oysters per day in the mid-1800s. Conwy Bay and areas near the River Conwy, including Puffin Island, Anglesey and the Menai Strait, historically supported productive native oyster beds during the 18th and 19th centuries (Hayden-Hughes *et al.,* 2023). Historical oyster cultivation and shellfish research activities also took place within the Menai Strait at Tal y Foel during the 1960s, including investigations into alternative oyster species and shellfish cultivation techniques (Morgan, 2012). Today, the Menai Strait remains an important shellfish fishing ground, particularly for farmed mussels and Pacific oysters, contributing to the local economy and coastal livelihoods.

This oyster survival trial forms part of the #NNF3 Connecting Conwy project: *A plan for seascape scale recovery of coastal habitats in Conwy Bay and the Menai Strait*, as part of Goal 2: Native Oyster Survivability Trial, building on previous native oyster recovery work in Conwy Bay and contributing to efforts to advance understanding of native oyster recovery and associated benefits. The work also supports the assessment of potential opportunities to undertake oyster recovery work within the Menai Strait and the wider Conwy Bay Special Area of Conservation (SAC).

To support this objective, oysters were deployed at two contrasting sites: the exposed Menai Strait and the sheltered Conwy Marina. The Menai Strait is characterised by strong tidal currents, shallow-water frictional effects and large tidal range of approximately 6.6m during spring tides, creating a highly dynamic hydrodynamic environment (Campbell *et al.,* 1998). Conwy Marina represents a site with established oyster survival (Hayden-Hughes *et al.,* 2025) and provides a reference for interpreting performance at the more exposed Menai Strait location.

Suspended cage units were used as a temporary method to retain oysters at each site, enabling repeated monitoring of survival and performance under contrasting environmental conditions.

The aim of this study was to assess whether adult native oysters, *Ostrea edulis,* can survive a six-month period between September 2025 and March 2026 at an exposed site in the Menai Strait, to inform future seascape recovery planning within the Menai Strait.

The following hypotheses were tested:

- **Hypothesis 1 (H1) (Survival):** Adult *Ostrea edulis* will maintain high survival between September 2025 and March 2026 at the Menai Strait raft, although survival may be lower than at the sheltered reference site at Conwy Marina.
- **H2 (Growth):** Shell growth will be limited during colder months but will be greater in the Menai Strait site than at Conwy Marina.
- **H3 (Settlement):** Settlement of species on the cages units over time will be associated with reduced oyster survival and growth.

Methods

Study Sites

Two sites within the Menai Strait and Conwy Bay SAC were selected to assess oyster survivability under contrasting environmental conditions.

The Menai Strait raft (MSR) is a floating research platform owned and maintained by Bangor University secured to a leased mooring located east of Ynys Gaint. This site represents an exposed, high-energy environment characterised by strong tidal flow, wind exposure, and storm influence.

Conwy Marina (CM) situated on the western band of the River Conwy operates a marina gate which closes for approximately 12 hours daily, restricting water exchange. The marina was used as a sheltered reference site due to previously observed high oyster survival under low-energy conditions. Nursery cages were cleaned and redeployed for this study in September 2025.

Deployment Locations

The locations of the two study sites are presented in Table 1.

Table 1. Location of oyster survival trial sites at Conwy Marina (CM) and the Menai Strait raft (MSR).

Site	Latitude	Longitude
Conwy Marina (CM)	53.29103 °N	3.838073 °W
Menai Strait raft (MSR)	53.230004 °N	4.153737 °W

Nursery Deployment

Native oyster nurseries comprise of a solid exterior rectangular frame and an inner plastic scallop tray comprising of interlocking chambers that each hold an individual mature oyster. The exterior frame is an Aquamesh® (PVC-coated welded wire mesh) housing. It is commonly used in aquaculture and is a solid material that does not break down or corrode in the marine environment (Figure 3). Four cleaned suspended nursery cages were deployed at each site in September 2025. Each nursery contained 27 adult oysters, giving a total of 108 oysters per site.

Oysters deployed at the Menai Strait raft included a mixture of oysters transferred directly from aquarium holding conditions and oysters previously maintained at Conwy Marina. Aquarium-conditioned oysters were intentionally grouped within two nursery cages (N30 and N32) to assess potential acclimation effects following deployment to the exposed site.

Within each nursery, nine oysters were individually labelled using embossed plastic identification tags attached to the shell using cyanoacrylate reef-safe adhesive, allowing repeated growth measurements of the same individuals (see figure 2). Tag retention was high, with no tag loss during the monitoring period.

Figure 2. Example of individually labelled oysters showing embossed identification tags attached to the shell (left) and tagging process during preparation (right).

Nurseries were suspended approximately 35–90 cm below the water surface and secured to horizontal support structures beneath the raft or pontoon (see figure 3).

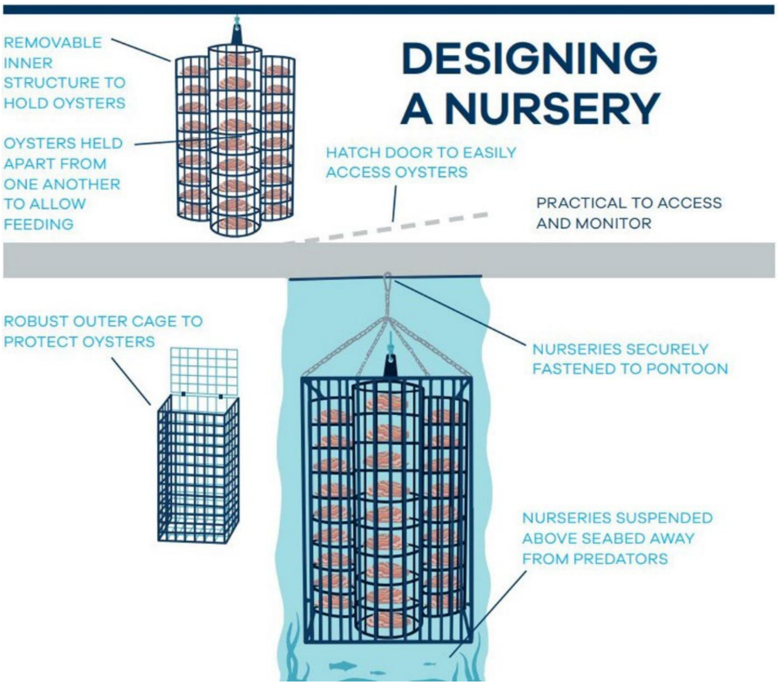

Figure 3. Schematic of the oyster nursery design, structure and installation under the marina pontoon and raft adapted from Helmer et al. (2021). © Blue Marine Foundation.

Suspended nurseries were used as a temporary monitoring method to retain oysters at each site and enable repeated observations under field conditions.

Monitoring Data Collection

Monitoring was conducted monthly between October 2025 and March 2026, following baseline measurements at deployment in September 2025.

Oyster Survival

Oyster survival was recorded during each monitoring visit as the number of live and dead individuals within each nursery. Dead oysters were removed and were not replaced.

Mortality (%) was calculated for each cage at each monitoring time point based on the proportion of dead oysters relative to the initial stocking density (n = 27 per cage). Mean monthly mortality values were calculated by averaging across cages within each site (n =

4), with variability expressed as ±1 standard deviation. These values were used to describe changes in mortality over the monitoring period.

Differences in final survival between sites were assessed by comparing survival percentages from individual nursery cages at each site (n = 4 per site) using Welch's two-sample t-test.

Shell Growth

Shell growth was assessed using the labelled sub-set of oysters within each nursery cage. Shell dimensions were recorded monthly between September 2025 and March 2026. Growth was assessed by comparing shell dimensions at deployment (September 2025) and at the end of the monitoring period (March 2026). Measurements included shell length (mm), shell width (mm), and depth (mm) (see figure 4). Length and width were measured using callipers. Only live oysters with complete measurements throughout the monitoring period were included in growth analyses.

Individual oyster growth was calculated as the difference between final and baseline measurements. Mean growth values were then calculated per cage and averaged across cages within each site (n = 4), with variability expressed as ±1 standard deviation. Differences between sites were assessed using Welch's two-sample t-tests (two-tailed).

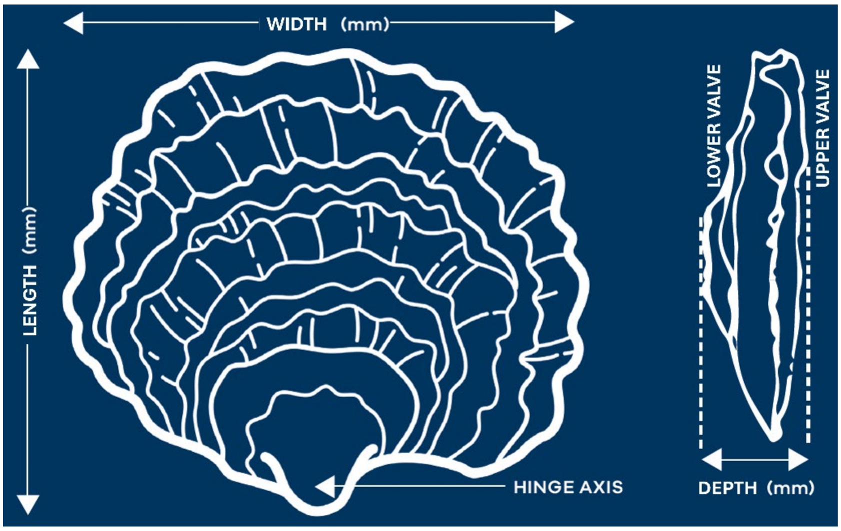

Figure 4. Diagram of oyster shell dimensions; shell length, width and depth, adapted from Helmer et al. (2021). © Blue Marine Foundation.

Environmental Conditions

Environmental data were collected alongside biological monitoring to provide context for survival and growth outcomes. Measurements included water temperature (°C), salinity (PSU), turbidity (NTU/FNU), chlorophyll-a (fluorescence proxy), and depth (m).

Data were recorded using CTD sensors deployed at each site, including a YSI CTD at the Menai Strait raft and an NKE CTD at Conwy Marina. Meteorological data from the raft-mounted weather station at the Menai Strait raft and a HOBO logger deployed at Conwy Marina were also used to support interpretation of site conditions.

Due to the high frequency of data collection (1-minute sampling interval), measurements were summarised as monthly averages to allow comparison of seasonal trends between sites. Raw data were screened to remove clear sensor anomalies (e.g. short-term spikes). Chlorophyll-a and turbidity values were derived from sensor proxies and are therefore presented as relative indicators of change rather than absolute concentrations.

Settlement Species

At the end of the monitoring period, when nursery cages were removed, photographs were used to estimate settlement cover. Each nursery was assessed visually and the percent cover quantified by the proportion of exterior nursery frame occupied by settlement species (top, bottom, and four sides). Values were averaged across all surfaces to obtain a mean fouling cover estimate per nursery, expressed as mean percentage cover.

A species inventory was also recorded to document organisms associated with the nursery cages and settled on the shells of the oysters. Taxa were identified *in situ* during cage retrieval; samples of organisms that could not be identified *in situ* were collected for later identification alongside photographic records. Both sessile and mobile species observed using the nursery structures as habitat were included in the inventory.

Results

Oyster Survival

Monthly mortality rates (±1 standard deviation) were plotted over time to assess September 2025 to March 2026 survival trends (Figure 5 and 6). Monitoring data were collected between October 2025 and March 2026.

Final survival was significantly lower at the Menai Strait raft (70.4% ± 11.4%, SD) than at Conwy Marina (98.2% ± 2.1%, SD) (Welch's t-test, $p = 0.016$), based on cage-level survival values (n=4 per site). This difference was driven primarily by elevated mortality shortly after deployment. Mortality at the Menai Strait raft peaked in October 2025 (20.37%) shortly after deployment, whereas mortality at Conwy Marina remained consistently low (<1%) throughout the study.

Following this initial adjustment period, mortality rates stabilised and remained minimal throughout the remainder of the monitoring period. When considering the overwinter period following acclimation (December 2025–March 2026), survival remained high at both sites, averaging 98% at the Menai Strait raft and 100% at Conwy Marina.

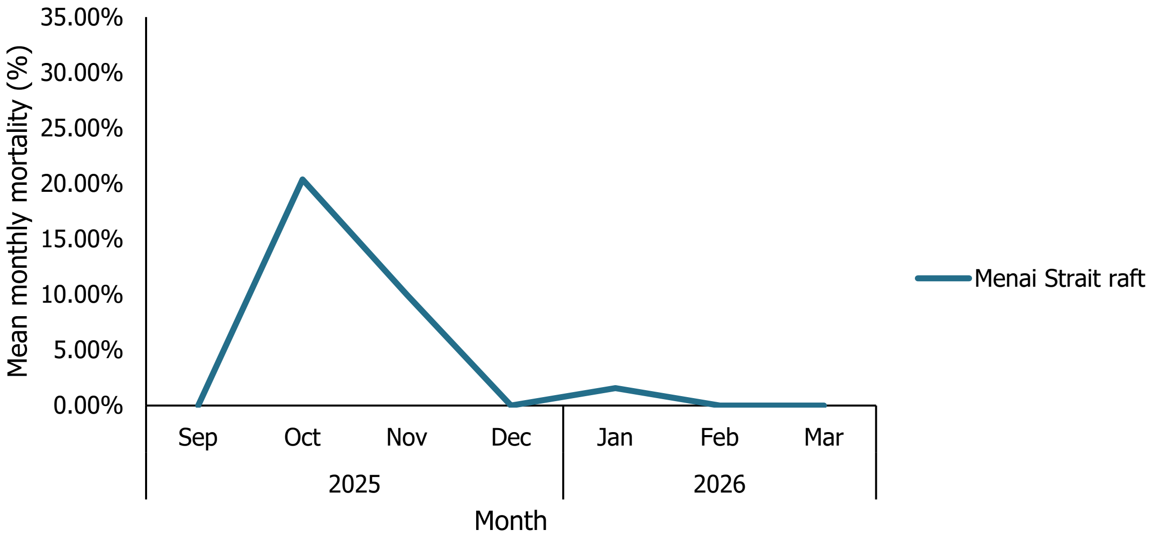

Figure 5. Mean monthly mortality (%) of Ostrea edulis deployed in suspended cages at the Menai Strait raft between September 2025 and March 2026.

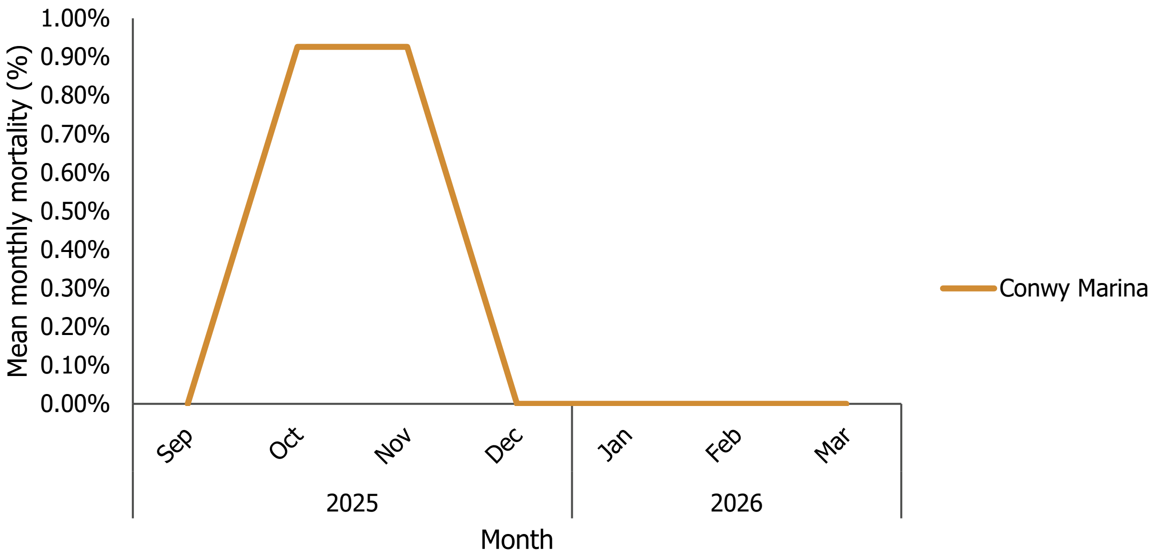

Figure 6. Mean monthly mortality (%) of Ostrea edulis deployed in suspended cages at Conwy Marina between September 2025 and March 2026. Mortality remained consistently low throughout the monitoring period (<1%).

Shell Growth

Shell growth varied among individuals at both sites, with both positive and negative changes observed across all shell dimensions (length, width, and depth). Mean shell growth by site and dimension is shown in figure 7.

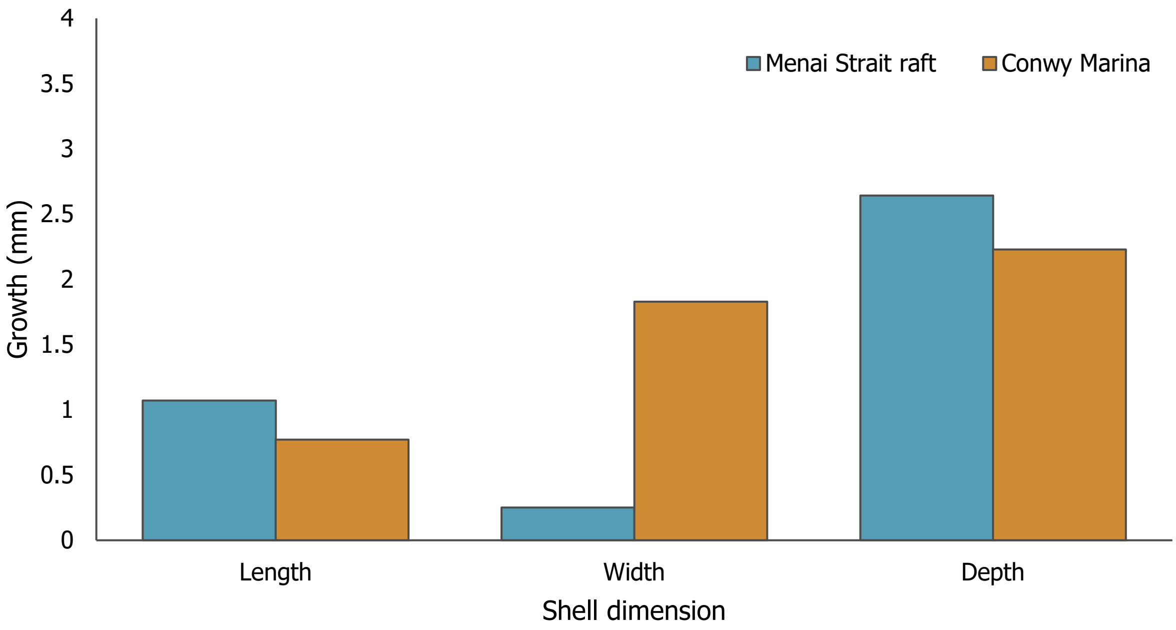

Figure 7. Mean shell growth (mm) of Ostrea edulis between September 2025 and March 2026 at the Menai Strait raft (blue) and Conwy Marina (orange), shown for shell length, width and depth. No significant differences were detected between sites for any shell dimension (Welch's t-tests, $p > 0.05$).

Mean growth in shell length was slightly higher at the Menai Strait raft (1.07 mm ± 4.81 SD) compared to Conwy Marina (0.77 mm ± 3.34 SD). Mean growth in shell width was higher at Conwy Marina (1.83 mm ± 4.48 SD) than at the Menai Strait raft (0.25 mm ± 9.99 SD), while mean shell depth growth was similar between sites (MSR: 2.64 mm ± 3.11 SD; CM: 2.23 mm ± 1.86 SD). No significant differences were detected between sites for shell length (Welch's t-test, $p = 0.78$), width ($p = 0.44$), or depth ($p = 0.54$). Growth variability was high at both sites, particularly for shell width at the Menai Strait raft, reflecting substantial variation among individuals.

Environmental Conditions

Environmental conditions at the Menai Strait raft (MSR) are presented in Figure 8.

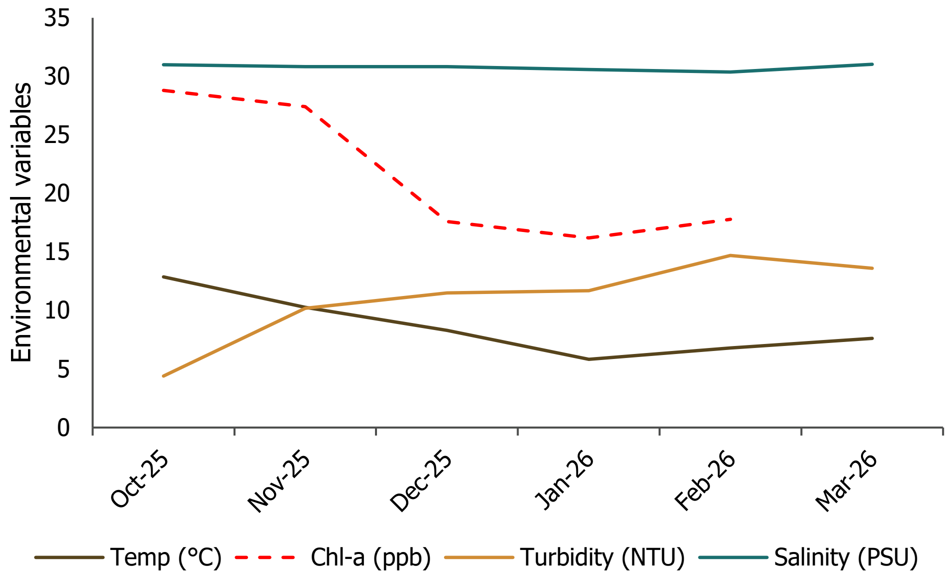

Figure 8. Monthly variation in temperature (°C), salinity (PSU), turbidity (NTU) and chlorophyll-a (ppb) at the Menai Strait raft between October 2025 and March 2026. Values represent monthly means.

Temperature declined from 12.9 °C in October to a minimum of 5.8 °C in January, before increasing slightly towards March (7.6 °C). Salinity remained relatively stable throughout the study period (30.3–31.0 PSU). Turbidity increased from autumn into winter, peaking in February (14.7 NTU), before declining slightly in March (13.6 NTU). Chlorophyll-a concentrations declined from autumn (28.8 ppb) to winter (16.2 ppb) and remained relatively stable thereafter; data were unavailable for March.

Environmental conditions at Conwy Marina (CM) are presented in Figure 9.

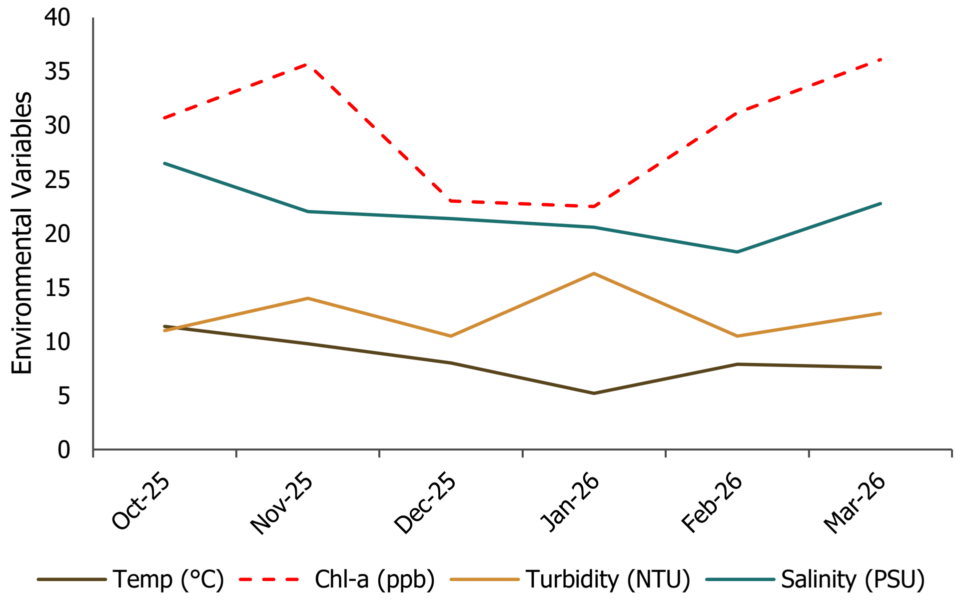

Figure 9. Monthly variation in temperature (°C), salinity (PSU), turbidity (NTU) and chlorophyll-a (ppb) at Conwy Marina between October 2025 and March 2026. Values represent monthly means.

Temperature followed a similar seasonal pattern, declining from 11.4 °C in October to a minimum of 5.2 °C in January, before increasing slightly towards March (7.6 °C). Salinity was more variable than at the Menai Strait raft, ranging from 18.3 to 26.5 PSU, with lower values recorded between November and February. Turbidity values remained elevated throughout the monitoring period, ranging from 10.5 to 16.3 NTU and peaking in January. Turbidity trends during winter months were broadly comparable to those observed at the Menai Strait raft. Chlorophyll-a concentrations were higher and more variable (22.5–36.1 ppb), with peaks observed in November and March.

Overall, environmental conditions at Conwy Marina were more variable than at the Menai Strait raft, particularly in salinity and chlorophyll-a concentrations.

Settlement Species

Species settlement on the surface of the nurseries varied between cages and between sites. At the Menai Strait raft, mean percent cover ranged from 66–78% (mean 74%), while percent cover at Conwy Marina ranged from 42–57% (mean 50%).

Species settling within the internal compartments of the nurseries was not quantified in the percent cover assessment; however, visual observations indicated greater settlement found within nurseries deployed at the Menai Strait raft (Figure 11). Fouling communities also appeared denser at the Menai Strait raft, whereas fouling observed at Conwy Marina was generally sparser, typically occurring as thinner coverage along the nursery frame.

The assemblage comprised predominantly of sessile taxa; several mobile species were also recorded as these were observed using the nursery structures as habitat and are included in full species inventory (Table 2).

A total of 28 taxa were recorded across both locations, including 19 taxa at Conwy Marina and 12 taxa at the Menai Strait raft. Several taxa were observed at both sites, including *Mytilus edulis*, *Conopeum reticulum* and Rhodophyta. The composition of taxa differed between locations, with distinct assemblages recorded at each site. Conwy Marina supported a more diverse assemblage including tunicates, bryozoans and sponges, whereas the Menai Strait raft was characterised by hydroids, amphipods and bivalves.

Figure 10. Dense settlement of saddle oyster (Anomia ephippium) observed across deployed Ostrea edulis within suspended nursery cages at the Menai Strait raft between February and March 2026.

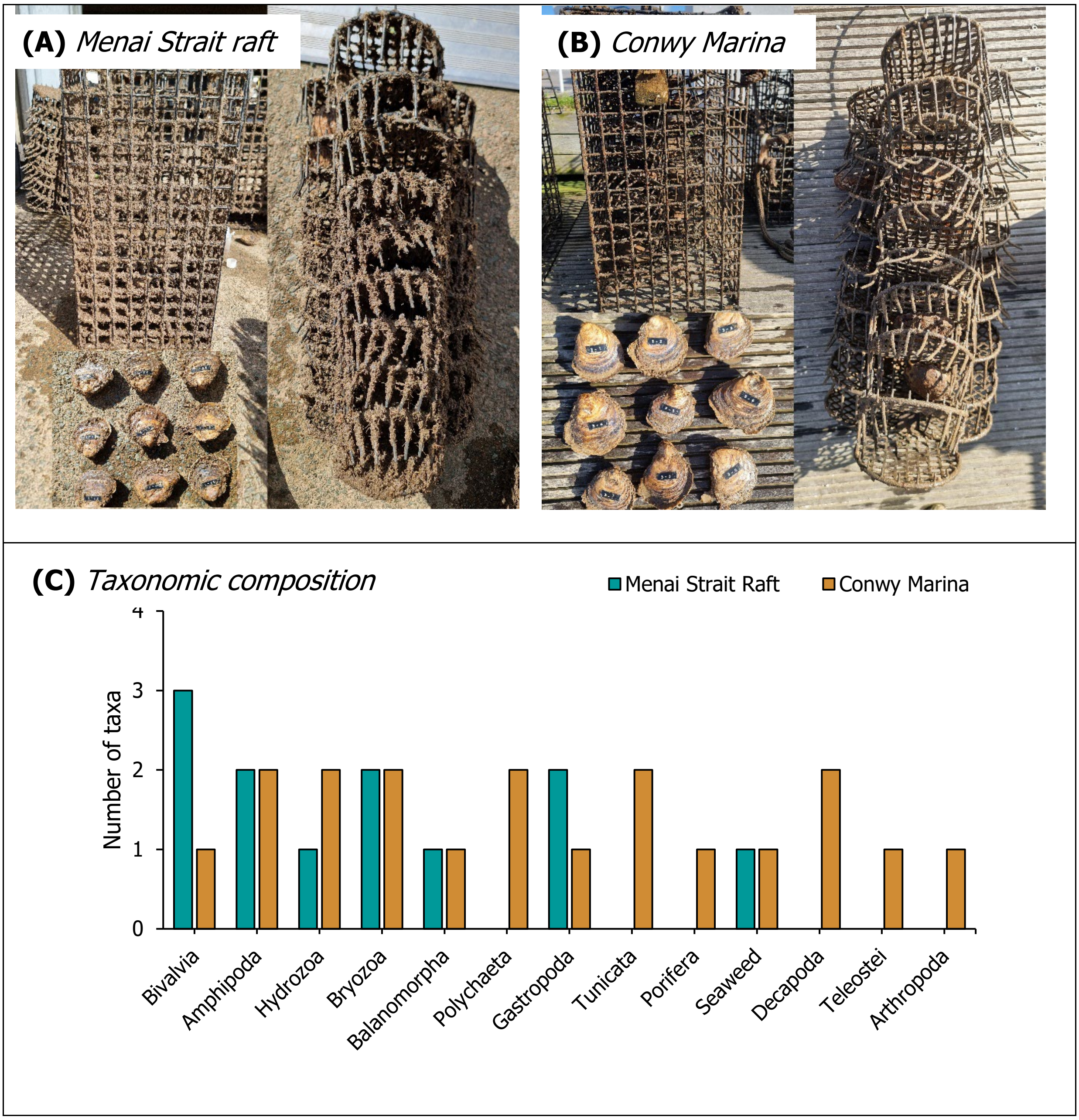

Figure 11. Taxonomic composition of organisms recorded on oyster nursery cages at the Menai Strait raft (blue) and Conwy Marina (orange) at the end of the monitoring period. (A) Nursery cage and sub-set oysters at the exposed Menai Strait raft site. (B) Nursery cage and sub-set oysters at the sheltered Conwy Marina site. (C) Taxonomic composition of organisms recorded at each site.

*Table 2. Species recorded on oyster nursery cages at the Menai Strait raft and Conwy Marina. * indicates a species reported as non-native within UK waters.*

Taxa	Common name	Group	Menai Strait raft	Conwy Marina
Mytilus edulis	Blue mussel	Bivalvia	✓	✓
Aequipecten opercularis	Queen scallop	Bivalvia	✓	–
Anomia ephippium	Saddle oyster	Bivalvia	✓	–
Gammarus spp.	–	Amphipoda	–	✓
Corophium spp.	–	Amphipoda	–	✓
Jassa falcata	Mottled tube-maker	Amphipoda	✓	–
Caprella linearis	Skeleton shrimp	Amphipoda	✓	–
Obelia spp.	Colonial hydroid	Hydrozoa	–	✓
Sertularella spp.	–	Hydrozoa	–	✓
Tubularia indivisa	Oaten pipes hydroid	Hydrozoa	✓	–
Conopeum reticulum	Encrusting bryozoan	Bryozoa	✓	✓
Cellepora pumicosa	Orange pumice bryozoan	Bryozoa	–	✓
Electra pilosa	Thorny sea mat	Bryozoa	✓	–
Balanus crenatus	Acorn barnacle	Balanomorpha	–	✓
*Solidobalanus fallax**	–	Balanomorpha	✓	–
Spirobranchus lamarcki	Lamarck's keelworm	Polychaeta	–	✓
Spirobranchus triqueter	Tubeworm	Polychaeta	–	✓
Doris pseudoargus	Sea lemon	Gastropoda	–	✓
Coryphella browni	Scarlet lady nudibranch	Gastropoda	✓	–
Polycera spp.	–	Gastropoda	✓	–
Ascidiella scabra	Sea squirt	Tunicata	–	✓
Ascidiella aspersa	Fluted sea squirt	Tunicata	–	✓
Halichondria panicea	Breadcrumb sponge	Porifera	–	✓
Rhodophyta	Red algae	Seaweed	✓	✓
Carcinus maenas	Common shore crab	Decapoda	–	✓
Cancer pagurus	Edible crab	Decapoda	–	✓
Pholis gunnellus	Butterfish	Teleostei	–	✓
Nymphon gracile	Sea spider	Arthropoda	–	✓

Discussion

This study demonstrates that adult *Ostrea edulis* can survive following deployment in September 2025 at an exposed site within the Menai Strait, indicating potential for adult oyster survival beyond sheltered marina environments during the September 2025 to March 2026 monitoring period.

Hypothesis 1 – Oyster Survival

While overall survival at the Menai Strait raft (70%) was lower than at Conwy Marina (98%), this difference was driven primarily by elevated mortality immediately following deployment. This early loss likely reflects acclimation stress associated with stock transfer from aquarium-controlled conditions to a high-energy exposed environment. Mortality was highest within nursery units N30 and N32, which contained oysters transferred directly from aquarium holding conditions, whereas lower mortality was recorded in nursery units containing oysters previously acclimated at Conwy Marina, suggesting prior environmental conditioning may have influenced initial survival following deployment. Similar initial mortality following deployment has been observed in oyster nursery systems and is commonly associated with handling, transfer, and environmental change (Helmer *et al.,* 2021; Uttley *et al.,* 2023). Oyster mortality is known to be influenced by environmental stress and physiological shock associated with rapid changes in conditions, including temperature and handling (Gilson *et al.,* 2021), supporting the interpretation that early losses at the Menai Strait raft reflect acclimation stress following transfer. Following this initial period, survival stabilised and remained consistently high (98–100%) at both sites between December 2025 and March 2026, partially supporting Hypothesis 1 and indicating that adult oysters are resilient to winter conditions in both exposed and sheltered settings. Native oyster populations also naturally occur across a broad geographic range, including within Norwegian coastal systems where populations extend close to the species' northern distributional limit at Møre & Romsdal County (Mortensen *et al.,* 2025). Although recruitment within these northern populations is considered strongly influenced by climatic conditions and summer temperature, stable populations have been reported from these colder environments, suggesting that adult *Ostrea edulis* can tolerate a broad range of winter environmental conditions.

Hypothesis 2 – Shell Growth

Shell growth was highly variable at both sites, with no significant differences detected between the Menai Strait raft and Conwy Marina for any shell dimension. High variability in shell growth is consistent with previous studies, where growth rates are influenced by environmental conditions and can vary substantially among individuals (Richardson *et al.,* 1993). Overall growth was limited during the September 2025 to March 2026 monitoring period, likely reflecting reduced metabolic activity associated with lower winter temperatures. Results therefore provided only partial support for Hypothesis 2. While shell growth remained limited during the monitoring period, no clear site-related differences in growth could be robustly identified. The presence of both positive and negative growth values likely reflects a combination of natural biological variability, shell damage, and measurement uncertainty, which highlights the challenges of detecting subtle growth differences over relatively short timeframes.

Interpretation of shell growth patterns is further limited by the relatively short monitoring period and seasonal timing of the study, as oyster growth is typically greater during spring and summer months.

Environmental Conditions and Site Context

The two study sites represented contrasting environmental settings within the Menai Strait and Conwy Bay SAC. The Menai Strait raft was characterised by relatively stable marine salinity conditions and greater hydrodynamic exposure, reflecting the strong tidal currents and well-mixed nature of the Menai Strait (Campbell *et al.,* 1998; Tweddle *et al.,* 2005). These hydrodynamic conditions are known to facilitate the transport of plankton-rich water through the Strait and may contribute to favourable feeding conditions for suspension-feeding bivalves (Tweddle *et al.,* 2005). Conwy Marina exhibited lower and more variable salinity conditions, likely reflecting restricted water exchange and freshwater influence within the marina basin and dredging activities.

Despite these environmental differences, survival remained high at both sites following the initial acclimation period. This suggests that adult *Ostrea edulis* can tolerate a wider range of environmental conditions than those typically associated with sheltered marina environments. However, the monitoring period did not include summer conditions, prolonged storm events, or marine heatwave periods, all of which may influence oyster performance and survival.

It is also important to note that this study utilised suspended nursery systems rather than seabed-based study approaches. As *Ostrea edulis* is a benthic species, oyster performance under seabed conditions may differ due to additional factors including predation, sedimentation, and benthic hydrodynamics. Previous restoration studies have demonstrated the use of a range of seabed and spat deployment approaches under differing environmental conditions. For example, Wolf *et al.* (2025) investigated the survival of oyster spat settled on different cultch structures, including individual shells, shell-filled mesh bags and more complex three-dimensional shell arrangements designed to reduce predation by shore crabs. Similarly, Pouvreau *et al.* (2025) developed elevated biodegradable collector systems that support larval settlement above the seabed before gradually transferring larger juveniles onto the seafloor as the support structures degrade. These approaches aim to improve early survival and settlement success while reducing pressures associated with predation, sedimentation and benthic disturbance. Consequently, while the high survival observed in suspended nursery systems is encouraging, further work is required to evaluate oyster performance under seabed deployment conditions and assess the suitability of alternative recovery methodologies within the Menai Strait.

Hypothesis 3 – Settlement Species

Settlement species increased over time at both sites, with higher mean cover recorded at the Menai Strait raft (74%) compared to Conwy Marina (50%), partially supporting Hypothesis 3. Despite this, no clear negative effect of species settlement between September 2025 to March 2026 survival was observed. Results therefore provided only partial support for Hypothesis 3. The associated species assemblages differed between sites, with the Menai Strait characterised by hydroids, amphipods, and a greater representation of bivalve taxa, including *Mytilus edulis*, *Aequipecten opercularis*, and *Anomia ephippium*. In contrast, Conwy Marina supported a more diverse assemblage including tunicates, bryozoans, and sponges.

These findings suggest that nursery structures provide habitat for a range of associated species, contributing to local biodiversity and habitat complexity. While the nursery units used in this study do not represent mature oyster reef habitat, the development of diverse settlement communities highlights the potential for native oyster recovery activities to provide ecological benefits beyond oyster conservation alone. More broadly, native oyster habitats are increasingly recognised as important components of connected coastal ecosystems, supporting biodiversity and contributing to wider seascape recovery objectives through their interactions with surrounding habitats and species (Preston *et al.,* 2025). Interpretation is limited by the relatively short monitoring period and seasonal timing of the study, as larval settlement and fouling development are typically greater during spring and summer months.

Conclusion

Overall, the findings provide encouraging preliminary evidence that adult *Ostrea edulis* may survive deployment at exposed locations within the Menai Strait following acclimation. However, the study was limited to September 2025 to March 2026 monitoring period and utilised suspended nursery systems rather than seabed-based recovery approaches. Further work is therefore required to assess full annual performance, including spring and summer conditions, alongside seabed deployment trials and habitat suitability assessments. Additional information gathered through site-specific surveys and local knowledge, as developed under the #NNF3 project, will help support evidence-based site selection where recovery is both feasible and likely to succeed.

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Contact information

The Zoological Society of London

https://www.zsl.org/what-we-do/projects/marine-habitat-restoration
Zoological Society of London
Regent's Park, London, NW1 4RY
Registered Charity no. 208728

Bangor University

https://www.bangor.ac.uk/the-wild-oysters-conwy-bay/nnf3-connecting-conwy
School of Ocean Sciences,
Menai Bridge,
Anglesey, LL59 5AB