



Citizen science as a tool for engaging communities in European flat oyster restoration projects - Restoration Forth

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Abstract

Globally, we have lost approximately 85% of our oyster reefs. The Firth of Forth, Scotland, was once home to one of the largest European flat oyster (*Ostrea edulis*) beds in Europe, but by the end of the 19th century, the beds had been fished to local extinction. Restoration Forth is a major marine restoration programme working with local communities to restore seagrass habitats and European flat oyster populations in the Firth of Forth.

Through community consultation, scientific input and citizen science expertise, the project designed and trialled a series of citizen science activities to engage local communities and contribute valuable data and understanding to identify suitable oyster deployment sites and determine the impact that oysters have on surrounding biodiversity and water quality. The activities spanned varying time commitments and training levels to allow for participation across the community. The programme launched a citizen science guide and associated resources in June 2024, later updated in December 2024. Staff engaged and trained local communities to identify shellfish species and conduct habitat and biodiversity surveys. Over 138 members of the local community joined an in-person or online citizen science training event. Between the launch (June) and reporting (September), 274 people conducted 114 surveys across the different activities.

Participants recorded 3,217 shells and recorded various substrate types around the Firth of Forth, which contributes valuable data to models which suggest suitable redeployment sites. Participants' thoughts and feelings were also captured and suggested that a high proportion of volunteers already engage in environmental activities, however some felt they had a lack of confidence when identifying shellfish species. The project concludes with recommendations for further development including improvement of data quality assurance procedures, alignment with other projects and further trialling and development of citizen science activities with local communities.

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1. Introduction

The Firth of Forth, Scotland, was once home to one of the largest European flat oyster beds in Europe, but by the end of the 19th century, the beds had been fished to local extinction. Globally, we have lost approximately 85% of our oyster reefs.

1.1 Restoration Forth

Restoration Forth is a major marine restoration programme working with local communities to restore seagrass habitats and European flat oyster populations in the Firth of Forth. Bringing together expertise from World Wildlife Fund (WWF), Royal Botanic Garden Edinburgh, Marine Conservation Society, Heriot-Watt University, Scottish Seabird Centre, The Ecology Centre, The Heart of Newhaven Community, Fife Coast and Countryside Trust and Edinburgh Shoreline, the 3-year project launched in 2022 and focuses on the restoration of marine species which historically thrived in the Firth of Forth.

The first phase of Restoration Forth (2022–24) was made possible by funding from Aviva, the Moondance Foundation, the ScottishPower Foundation and the Scottish Government's Nature Restoration Fund, facilitated by the Scottish Marine Environmental Enhancement Fund, and managed by NatureScot. A jointly funded study by the Marine Conservation Society and Heriot-Watt University conducted extensive scientific research and contributed to community engagement activities delivered by a Shellfish Engagement Officer.

By exploring innovative restoration techniques, conducting extensive habitat suitability mapping and taking inspiration from local communities, the project aimed to restore **30,000 European flat oysters and four hectares of seagrass to the estuary by 2024**. Restoration activities provide extensive benefits to recover natural habitats, enhance biodiversity, improve the overall health of the Firth of Forth and contribute to the long-term vision for maintaining the Firth of Forth as a thriving marine ecosystem for future generations. The project also aims to increase awareness of oyster restoration

work and inspire communities to support and adopt the delivery of marine restoration in the Firth of Forth and across Scotland.

In 2022, the Restoration Forth partners completed extensive habitat suitability assessments and conducted comprehensive stakeholder consultations to determine suitable restoration sites. Two subtidal and two intertidal sites were selected due to their suitability for oyster restoration efforts and, in the intertidal instances, public accessibility for engaging volunteers in monitoring activities. The intertidal sites are located in East Lothian.

1.2 European flat oysters

European flat oysters, otherwise referred to as 'native oysters', were once commonplace around the UK coastline. The Firth of Forth was once home to one of the largest European flat oyster reefs in the Northeast Atlantic, which during the 1800s, yielded up to 30 million oysters per year. Oysters from the Forth were transported across the UK and Europe, both for consumption and to re-stock beds elsewhere. However, ongoing pressures from fishing activity, alongside other human and environmental pressures, led to the complete collapse of the reefs, and by the beginning of the 1900s the oysters were deemed to be locally extinct.

Often referred to as 'ecosystem engineers', European flat oysters offer extensive benefits to our marine environments. They form complex reef structures, which provide habitats and safe nursery grounds for a diversity of species. Their ability to filter water and remove algae, organic matter and excess nutrients from the water column can significantly improve surrounding water quality, further benefiting the broader ecosystem.

As well as the benefits they provide to the marine environment, European flat oysters are also of significant cultural value. Oyster fishing and cultivation formed the heart of coastal communities all over the UK, providing livelihoods and significant food stocks for hundreds of years.

1.3 Citizen science

Citizen science, synonymous with the term 'community science' or 'participatory science', is where volunteers and scientists work together to conduct scientific research.

Citizen science offers a valuable opportunity to engage communities in environmental initiatives, like oyster restoration. By enlisting volunteers, local communities become not just spectators, but essential contributors to scientific research projects, with the added benefit of fostering a sense of stewardship and connection to their local environment.

This collaborative approach can expand the scale of restoration efforts whilst enhancing public awareness, education, and appreciation of valuable coastal and marine ecosystems. Offering opportunities to co-create aspects of restoration projects increases the likelihood that local communities will support restoration of their local areas, creating a more informed and resilient society and sustainable seas. There are additional societal benefits associated with citizen science activities including upskilling communities, social opportunities and health benefits.

The citizen science element of the project began in 2022, however additional expertise and resource was sought to further citizen science activity, which was developed in the third year of the project (2024). This report explores the citizen science approaches used, specifically with regards to oyster restoration activities. Further citizen science and engagement activity took place surrounding the seagrass restoration element of the project, which are detailed elsewhere. The report details the progress so far, lessons learnt and offers a series of recommendations for future iterations of the project and for other marine restoration projects looking to engage citizen scientists.

1.4 Other oyster restoration citizen science projects

Restoration Forth isn't the only project working with local communities to restore oysters to coastal environments around the UK and the world. A review of existing projects and where possible, their engagement and community activity, was conducted (Table 1). In some instances, the project team contacted these existing projects to seek learnings and suggestions from their experiences. The primary findings were that volunteer activity was focused around engaging and training volunteers

in practical biosecurity (cleaning oysters for deployment) or smaller scale oyster and biodiversity monitoring. There was limited available evidence of larger scale deployment and engagement of broader community effort to collect data on site suitability and biodiversity monitoring.

Project	Location	Community engagement activity
Solent Oyster Restoration Project	Solent, UK	- 'Oyster hoisters' – submerged cages on jetties to allow for volunteer engagement and monitoring of growth/survival rates. - Biosecurity volunteers – cleaning and preparing oysters for deployment.
Wild Oysters Project	Conwy, Clyde, Tyne & Wear, UK	- Underwater camera footage for online volunteer analysis. - Monitoring volunteers.
Seawilding	Argyll, Scotland, UK	- 'Oyster hoisters' – submerged cages on jetties to allow for volunteer engagement and monitoring of growth/survival rates. - Volunteers trained in site suitability surveys and coastal biodiversity surveys. - Hand deployment activities in intertidal sites.
Essex Native Oyster Restoration Initiative (ENORI)	Essex, England, UK	- Some oyster preparation activity.
Dornoch Environmental Enhancement project (DEEP)	Dornoch Firth, Scotland, UK	- Biosecurity volunteers – cleaning and preparing oysters for deployment. - Some volunteers assisted in deployment activity.
Operation Oyster	UK wide	- Divers and snorkelers monitoring oyster populations.
Native Oyster Restoration in Northern Ireland (NONI)	Northern Ireland	- 'Oyster hoisters' – submerged cages on jetties to allow for volunteer engagement and monitoring of growth/survival rates. - Biosecurity volunteers – cleaning and preparing oysters for deployment.
Humber Aquaculture Partnership (HAP)	Humber Estuary, England, UK	- Oyster monitoring and nursery maintenance. - Making oyster boxes.

		- Biosecurity volunteers – cleaning and preparing oysters for deployment.
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Table 1 - A summary of community engagement activity within existing UK wide restoration projects as of December 2024.

2. Key aims and objectives

The citizen science workstream begins to establish the infrastructure and processes required to enable communities to conduct activities to engage with, and valuably contribute to, oyster restoration projects such as this. It aimed to create or reinforce ways in which communities and researchers can collaboratively collect, access and use scientific data for further restoration activity and marine advocacy.

Where possible, the citizen science activities were designed to build on existing infrastructure and to enable data to be interoperable with other national recording systems. However, from desk studies and reviews of other oyster restoration projects, it may be noted that the Restoration Forth project is at the forefront of development in broader scale citizen science activities specifically surrounding oyster restoration projects.

A set of clearly defined objectives were outlined by the project team. The citizen science project aimed to:

1. Engage with local communities to co-develop a best practice approach for oyster, and wider biodiversity, citizen science monitoring that is replicable, scalable and sustainable.
2. Generate robust volunteer data collection that leads to scientific outputs and policy outcomes.
3. Ensure dissemination of results that celebrates and communicates community-led contributions.

2.1 Measuring success

To track progress towards these objectives, robust evaluation protocols and Key Performance Indicators (KPIs) were developed (Table 2). The outcome of these is detailed further in the project discussion and conclusion section below (section 9).

Objective	Measure of success	KPIs
1. Engage with local communities to co-develop a best practice approach for oyster, and wider biodiversity, citizen science monitoring that is both scalable and sustainable.	The community feels inspired to engage with the project and develop stewardship for the project, which will continue past the project end (Dec 2024).	1. The community feel that they are developing personal skills. 2. The community feel valued and have a strong sense of being part of a wider project team. 3. The community feel they have the skills required (and are motivated) to continue monitoring activities.
2. Generate robust volunteer data collection that leads to scientific outputs and policy outcomes.	Data is being used to contribute to wider scientific research and is available to support decision making.	1. A data need is identified with suitable data permissions and analysis and use pathways. 2. Data is readily available and used to contribute to wider research and decision making.
3. Ensure dissemination of results that celebrates and communicates community-led contributions.	Participants and wider audiences are able to see the importance of the data they are collecting.	1. The community understand the need of the data they are collecting. 2. The community understand the wider implications and importance of the data and research being gathered, as well as the environmental impacts .

Table 2 – Measure of success against objectives

3. Data

3.1 Identifying scientific needs

Before developing and designing opportunities to engage the public, it was important to ensure that the data collected would have real value for both the project and the ability to contribute to wider research, policy and decision making. This includes elements of quality control and ensuring the correct permissions (landowner or otherwise) and licenses are in place to openly share the data, increasing its robustness.

The community engagement team met with scientific specialists from Heriot-Watt University to make decisions on the data needs of the project. It was determined that there were three potential datasets of interest, these are listed below.

Site suitability

Finding the best places to restore oysters

Research and findings from other European flat oyster restoration projects and scientific research provide us with information on the most suitable conditions for the survival and growth of European flat oyster populations. For example, research suggests that oysters like to live in areas where the seabed is made of smaller pebbles or shell material. Conversely, muddy habitats aren't suitable as the oysters can become smothered and struggle to breathe or feed. Areas with calmer conditions and suitable temperatures may improve the chances of oyster reproduction and larvae settlement to establish oyster beds.

Collecting information at sites around the Firth of Forth which may show suitable characteristics can help to inform decisions on oyster deployment sites which may be suitable to sustain oyster populations. To make this accessible for local communities, the data types listed were specific to shoreline characteristics (e.g., washed-up oyster shells, water temperature and substrate).

This data need was also identified due to its potential to contribute to other research work within the project to conduct a complete habitat suitability assessment of the Firth of Forth. Collectively, this information also expands our knowledge of oyster restoration and the kinds of habitats they prefer, which could further inform other restoration projects around the world.

Monitoring

How are deployed oysters surviving?

Once the oysters have been returned to the Firth of Forth, it is important to monitor how they survive, grow and whether they start to reproduce. It is especially important to monitor changes over time to help identify longer-term trends or changes. Oyster restoration can be a very slow process, so revisiting monitoring sites can collect important data on their progress and help improve future oyster reintroductions.

We can collect information on the oyster shell sizes, survival rates, movement and also look for evidence of oyster spat, a sign of reproduction. These surveys are specific to the redeployment sites.

This data need was identified as important for furthering our knowledge on oyster restoration activities. This information could also provide evidence for policy changes in order to protect oyster habitats in future.

Biodiversity

Tracking the impact of returning oysters

Oysters are often referred to as ecosystem engineers. They form structures that influence the environment around them in ways that are beneficial to other species.

Collecting information on the presence of other species either living on or near oysters can tell us more about the impact of returning oysters to the Firth of Forth. Collecting this data before and after the oysters are returned can indicate changes in biodiversity and the impact that oysters are having.

By monitoring the impact returning oysters has on the local environment, we can provide evidence to inform government policies on the importance of oyster beds and how to protect them in future. This can also improve the way we manage oyster restoration activities to have wider benefits for nature.

3.2 Data use

During the project lifespan, scientific partners, Heriot-Watt University conducted in-depth modelling of the entire Firth of Forth. Using different parameters and overlaying available data sets like, seabed type, depth, and human activity, the team was able to develop site suitability maps, which indicate sites with the greatest potential to restore and sustain oysters.

Research suggests that areas of high oyster density or high shell material are associated with higher oyster spat survival. The habitat and historical shell data collected by the community can be used to improve the confidence of site suitability models with additional *in-situ* data. Additionally, intertidal data on substrates provides an opportunity to highlight suitable intertidal restoration sites.

Invasive non-native species, like Pacific oysters (*Crassostrea gigas*), could present issues with intertidal oyster restoration and associated species by competing for food and space. Data collected on the presence of multiple shell species could provide valuable indications of invasive

species, offering evidence for interventions or indicating areas which may be unsuitable for deployment due to increased risk of competition.

Information collected on the engagement of participants and the number of surveys conducted at specific locations can suggest areas of high impact for targeted community engagement activities. Additionally, this information could provide valuable insight to decisions around oyster deployment sites. A good example of this is Cramond – the most surveyed beach between June and September in part due to local population and in part to the number of training sessions run here. Conflicting arguments could be made for Cramond either as a suitable deployment site due to its evident volunteer population, or as an unsuitable site owing to the increased risk of oyster interference as a result of higher footfall.

4. Community consultation

4.1 Overview

The project aimed to take inspiration from the community as to their motivations, interests and survey ability, i.e. what would they like their engagement to look like? The long-term ambition is to support the community to develop a sense of stewardship for the oysters and develop the skills and confidence to continue monitoring and advocating for oyster restoration after the official project duration has elapsed.

4.2 Community science opportunities

After identifying the project's data needs and researching other existing projects, the project team discussed the importance of offering varying levels of engagement to provide accessible opportunities for anyone to interact with the project.

To maximise the opportunities for different audiences to engage in meaningful ways with the project, a citizen science matrix was developed, detailing a number of potential options to get involved and

contribute to the project's data needs. The suggested options have varying degrees of difficulty, time commitment and physical accessibility (Table 3) to allow for a broad audience to participate.

	Site suitability	Monitoring	Biodiversity
Easy (resources)	Oyster observation guide	Shell density (count)	Shore surveys (physical)
Medium	Habitat assessment	Growth and mortality	What's growing on oysters (pictures)
Specialist (training)	Water parameters	Spat Settlement	Associated species (identifying)

Table 3 – Citizen Science activity matrix

4.3 Volunteer motivations and interests

Before making any decisions on the citizen science opportunities to pursue, a number of community consultation workshops were held to collect thoughts and levels of interest from local people. The matrix was further expanded into 'activity stories' detailing the types of data which could be collected, what that data could be used for, and the levels of skill and time required for each (Annex 1).

Two workshops were held, and the locations were selected due to their proximity to identified suitable intertidal deployment sites. Details of the workshops were shared within existing volunteer networks, in community newsletters/forums and advertised online.

1. **Citizen Science Workshop Tynninghame in March (17 attendees)** – Here, there was an established group of interested volunteers who are already actively involved in Restoration Forth activity. This provided a good opportunity to engage and scope out the potential for a ready formed group to take stewardship of the project together.

2. **Citizen Science Workshop Musselburgh in February (19 attendees)** – Conversely to Tynninghame, there was less existing engagement at this site. This, alongside its proximity and potentially easy access from Edinburgh, makes this a good space to trial a broader approach which had the potential to reach a variety of interested individuals who could form a stewardship group.

The sessions included an introduction to the project, detailing the historic and cultural importance of oysters for the Firth of Forth, reasons and ambitions for restoration activity and the overall project goals, including community engagement and support. The workshops then shared the various opportunities and conducted a vote on which activities would be of the most interest to the community. The sessions also asked for input on preferred methods of engagement in any resulting citizen science activity (e.g., training resources, videos, in person sessions). Further feedback from these sessions is available in section 4.4 below.

4.4 Feedback from community consultation sessions

The workshops and activities were generally positively received with many attendees stating they were happy to be asked for their opinion and excited to be offered an open space for detailed discussion with project staff. After presenting the potential opportunities, the community consensus was that they would like to prioritise the activities by the data which could have the most impact on influencing policy. In this respect, participants stated they were happy to be steered by specialists to determine what data to collect.

Overall, very few people identified themselves as wanting to commit to a specific level of engagement or any kind of more involved stewardship role at this stage and the consensus was that they would prefer to be involved in more ad-hoc opportunities and attend organised events. The groups both confirmed that training guides and on-site, in person training would be well received and are most helpful to develop skills and engage in the project.

Other discussions revolved around interest in the science and data use, interest in historical and art elements of oysters, general safety issues, concern around the potential poaching at deployment sites and perceived impacts on local bird populations.

The community input is discussed further in section 9 and further evaluation of the engagement in the sessions is outlined in section 8.

5. Citizen science activities

Taking steer from community workshops and support from scientific staff on the most impactful data, a project workshop was held to decide on which activities to develop further. Four surveys were selected for trial and methods and resources were developed for each.

5.1 Activity 1 - Habitat survey

Various measures of 'habitat' condition were considered. It was determined that substrate type was a useful metric to survey and could contribute valuable information to site suitability mapping by indicating areas of shell or gravel material, which is known to be the preferred settling substrate for oysters.

This activity has broad engagement potential and accessibility as it can be conducted at any beach, anywhere around the Firth of Forth coastline. The survey methodology requires minimal previous knowledge or training and takes around 5-10 minutes to complete, acting as a short, simple introductory survey to begin engaging people in the science behind restoration activities.

The method (as described in the volunteer resource):

1. Randomly select and measure out a 1m x 1m square, marking each corner.
2. Look at your square and record the details about your beach on your survey form.
3. Submit your results on our website.

The recording form asked questions regarding the survey date, time and location, the location of the nearest river and an estimation of the beach substrate within the quadrat.

The results were submitted via an online form on the Marine Conservation Society website. A paper form (Figure 1) was also available and downloadable.

Habitat assessment recording form





About you and your location

First half of postcode:
 Your age:

Date of survey:
 Time of survey:

 Name of beach the survey took place at:

 Map co-ordinates of your location:

 Estimate the distance to the nearest river mouth (in meters):

About your seashore

How would you describe the beach type in your square?

☐ Shell matter
 ☐ Mostly pebbles (2-5cm)

☐ Mostly mud
 ☐ Mostly large rocks (5-20cm)

☐ Mostly sand
 ☐ Mostly boulders (>20cm)

☐ Mostly gravel (less than 2cm)

 Any other notes:

Figure 1 – Habitat assessment recording form

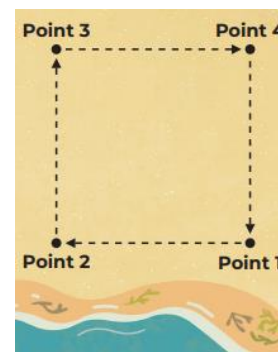
5.2 Activity 2 - Oyster Observer Guide

The Oyster Observer Guide (OOG) looks to identify historic sites where oysters once thrived. By identifying and counting washed-up shells on beaches around the Firth of Forth, we can estimate the locations of historic oyster reefs. This, in turn, may suggest areas which have suitable conditions to sustain oysters and could indicate potential future restoration sites.

This activity has broad engagement potential and accessibility as it can be conducted at any beach, anywhere around the Firth of Forth coastline. The survey methodology requires a small amount of training, primarily around species identification and takes around 15–30 minutes to complete.

The method as described in the volunteer resource:

1. Pick a random spot on the beach and mark it with an item (jumper/stick/ bucket etc.). This is point 1. Note the co-ordinates of this spot. You can do this on your phone by opening the Google Maps app and tapping on your location to drop a red pin. Click on the red pin to read your co-ordinates.
2. Starting at point 1, pace out a ten-by-ten metre square (ten adult paces each side) using items to mark each point.
3. Carefully explore your plot, taking note of all oyster and Horse mussel (*Modiolus modiolus*) shells on your survey form. You can collect your shells in a bucket, but remember to return them once you have completed the survey.
4. Tally up your totals for each shell species and upload your survey results using our online form.



Four species of shell were identified as useful data to collect. These include:

- **European flat oysters** – presence suggests previous historical beds nearby.
- **Pacific oysters** – presence could indicate a higher chance of outcompeting European flat oysters.
- **Saddle oysters** (*Anomia ephippium*) – presence could suggest nearby European flat oysters as they are an associated species.
- **Horse mussels** – presence could indicate nearby European flat oyster beds as they are known to prefer similar conditions.

Information and images on how to identify these species was included in the training materials (Figure 2).

Subsequently, it was identified that there was some confusion with Blue mussels (*Mytilus edulis*) being misidentified and included. To remedy this, information was added to direct volunteers to submit any sightings of these to Edinburgh Shoreline's existing 'Show us your Mussels' project.

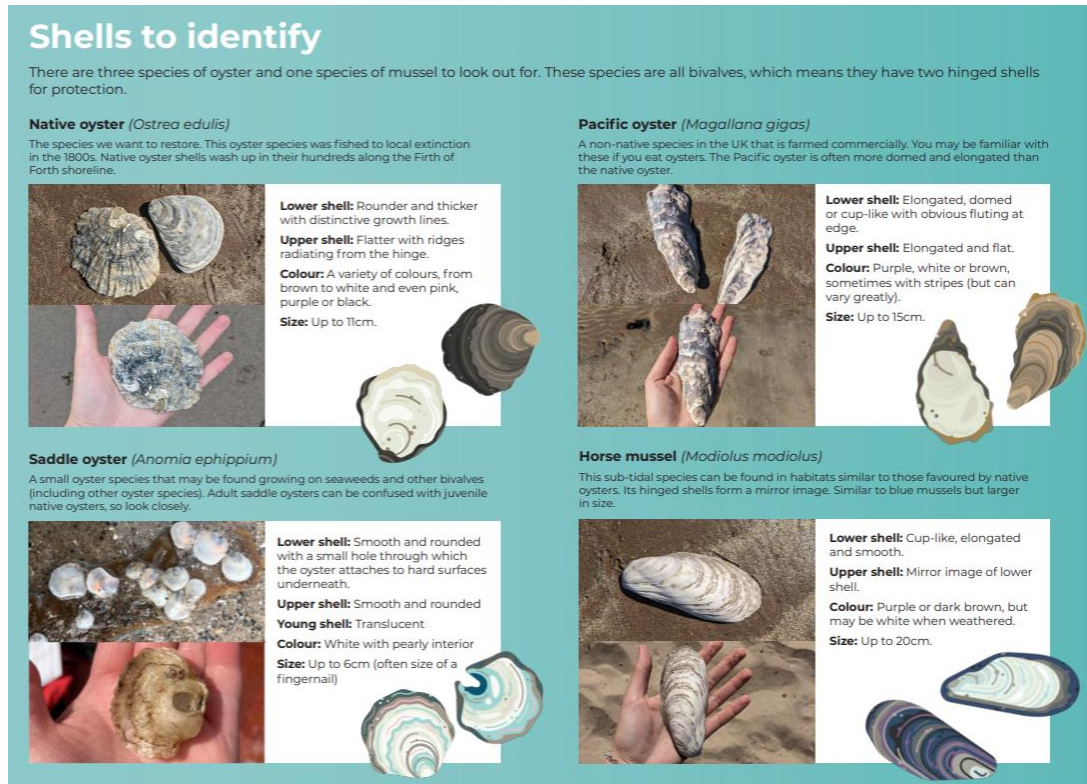


Figure 2 – Identification guide of shell species included in the Oyster Observer guide

The results were submitted via an online form on the Marine Conservation Society website. A paper form (Figure 3) was also available and downloadable.

Oyster observer recording form




About you and your seashore

First half of postcode:

Your age:

Date of survey:

Time of survey:

Name of beach the survey took place at:

Map co-ordinates of your location:

How would you describe the beach you were at?

☐ Mostly mud
 ☐ Mostly sand
 ☐ Mostly gravel
 ☐ Mostly pebble

Shell recording Tally up the species and record the total in the box

European flat oyster tally:	Total:
Pacific oyster tally:	Total:
Saddle oyster tally:	Total:
Horse mussel tally:	Total:

Figure 3 – Oyster Observer recording form

5.3 Activity 3 - Monitoring

Ongoing monitoring is important to determine the survival rates, movement, growth and potential reproduction of the deployed oysters. Monitoring of deployed oysters took place at the subtidal sites by members of the Heriot-Watt dive team. It was determined that there is significant engagement benefit to including volunteers in hands-on monitoring activities and the intertidal deployment sites offered opportunity, at low spring tides, to encourage participation in these.

Due to safety concerns, available tide windows, and for the protection of the oysters, it was decided that monitoring activities would be led by staff and be limited to a small group of volunteers. The sessions involved visiting the deployment sites and conducting surveys on individual survival, growth rates (measuring the oysters) and any movement from their deployment location.

Monitoring of mortality and growth is conducted by securing a 15m string of 30 oysters to the seabed. The string is pinned to the seabed using road pins to prevent the oysters from moving around by the waves and currents. Oysters are attached to the string using marine epoxy putty on capillary lines, with two oysters spaced evenly every meter. This setup enables the Heriot-Watt

University dive team and volunteers to record mortality rates over time and estimate average growth.

5.4 Activity 4 - Biodiversity survey

The biodiversity survey collects information on the presence or absence of associated marine species prior to and after oyster deployment. Any changes in species diversity or abundance could indicate the impact of returning oysters to the area.

There are a number of existing biodiversity surveys which collect information on marine species around the UK. An attempt was made to align with existing practice, however, due to differences in species lists and methodology, it was determined that these may not be suitable for the project's specific needs. As a result, the decision was taken to trial a new methodology for specific use with oyster restoration monitoring in mind. A PDF guide was developed and made available online so that it could be changed as needed after trialling the approach. A training video was also developed.

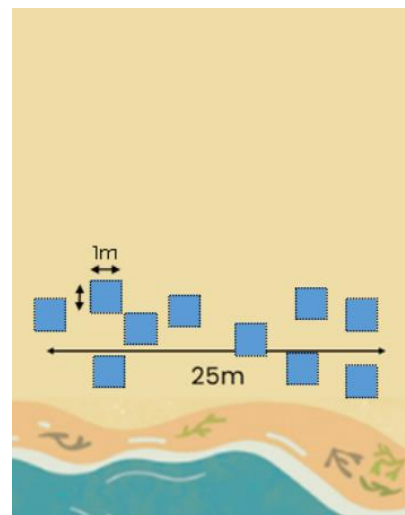
With support from scientific staff members, it was decided that the survey should take a standard survey approach recording species presence, absence and abundance along a 25m transect running parallel to the shoreline. The species list was determined by existing research into the impact oysters have on biodiversity and included shore-species, like hermit crabs and butterfish, and commensal species like keel worms and barnacles.

Two trial days were held with volunteers to test the biodiversity methodology at the existing intertidal deployment sites. Feedback was collected from participants on their feelings about the activity, the ease of taking part and their confidence in identifying species. Feedback surrounding the methodology was that conducting surveys in quadrats along a transect was more enjoyable as it offered an opportunity to survey in small groups. Participants felt confident in identifying species but did reflect that they would prefer further opportunities to survey with staff members before trying to survey alone.

After trialling the approach, the methodology was reviewed with the science team and adapted to reflect both scientific needs and community confidence.

The methodology (as described in the volunteer resource):

1. Select and mark a starting point close to the water line.
2. Walk 25m (roughly 25 adult paces) parallel to the sea and mark each end of your transect.
3. Along your 25m transect, randomly select and mark out ten 1m x 1m quadrats.
4. Carefully inspect each square and record the species you see from the ID guide below - take lots of pictures too!
5. Upload your results to our website.



A species identification guide was developed with pictures and descriptions of the species of interest to aid volunteers in their survey (Annex 2). An additional instructional video was developed and aligned with the guide to provide further training to participants.

6. Engaging volunteers

6.1 Recruiting participants

Participants were recruited through social media (figure 4), community networks, community groups and existing volunteer networks from project partners.

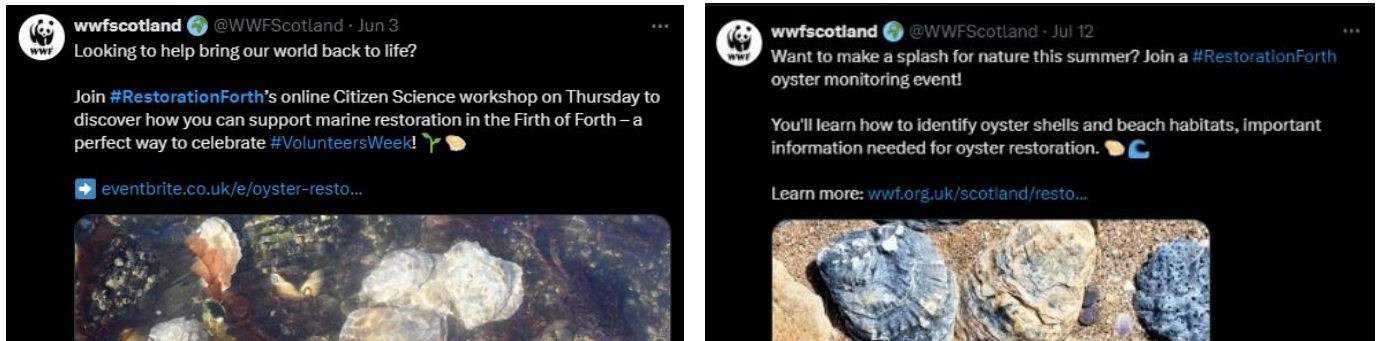


Figure 4 – Example social media posts to recruit participants

A [project webpage](#) (Figure 5) was also developed on the Marine Conservation Society website to form a central space to share project updates and survey resources. The use of accessible language was carefully considered and time was taken to identify and communicate mutual benefits to participants, for example, developing scientific skills, connecting with nature and social benefits of meeting like-minded people.



Figure 5 – Screenshot of the project webpage header

6.2 Safety

The safety of volunteers was carefully considered and ‘top safety tips’ were shared with participants in all survey resources and training sessions (Figure 6). Appropriate risk assessments were also in place.

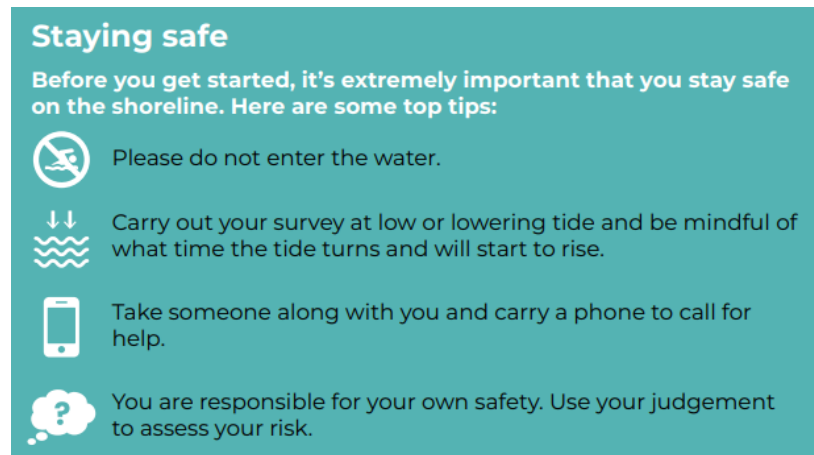


Figure 6 – Example of safety tips extracted from Restoration Forth Monitoring Guide

6.3 Developing resources

A Restoration Forth Monitoring Guide (Figure 7) was developed and designed to share the citizen science opportunities with local communities. The guide included introductions to the Restoration Forth project, and information about marine restoration and citizen science to highlight the importance of monitoring activities. The resource then detailed the four activities, including the importance of the data to be collected and instructions on how to conduct the surveys. A link was also provided to the website where further information, species identification guides and safety information could be found, and survey results could be submitted.

The guide was printed and distributed to six engagement hubs around the Firth of Forth. A PDF version was also made available for download from the Restoration FORTH page on the Marine Conservation Society website.

The activities were listed in order of increasing time commitment and the amount of training required to allow participants to progressively develop skills and confidence in survey techniques. This was specifically tailored to encourage interaction with the project at different levels, engaging participants to conduct longer activities with higher skill levels over time.

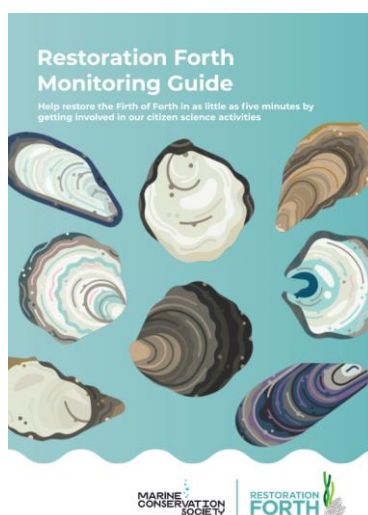


Figure 7 – Restoration FORTH Monitoring guide for volunteers

As the monitoring guide was developed later in the project (2023), a separate Oyster Observation Guide resource was already available and in use and so excluded from this resource. However, in December 2024, the OOG and the Restoration FORTH Monitoring Guide were combined and re-printed along with a double-sided recording sheet insert. The final full citizen science guide is included in Annex 3.

6.3.1 Sharing resources

After developing and trialling the various citizen science methodologies, and as an ambition of the project, the aim is to make the resources developed from this project publicly available for use by other community groups or restoration projects around the UK. The hope is that the learning from Restoration Forth can be used to further develop citizen science practices in marine restoration projects whilst avoiding 're-inventing the wheel'. In doing so, the resulting data will become interoperable across projects and build a more complete and valuable picture of UK oyster populations and the impact of restoration activities over time. As the printed resources were branded specifically for the Restoration Forth project, a separate downloadable PDF which includes the methodologies, but excludes any project context was developed. At the point of writing, this is still in development, but is intended to be made available on the Marine Conservation Society website when complete.

6.4 Training

As highlighted in the community consultation workshops, participants indicated the importance and desire for in-person training events. This allowed project staff the opportunity to detail the methods and species identification, and allowed participants to ask clarifying questions.

6.4.1 Online

Two online training sessions were held. These involved introductions to the project, detailing the historic and cultural value of oysters, the benefits to the environment and instructions for each of the four outlined activities.

Event	Month	Number of attendees
Oyster Citizen Science online launch	June	17
Oyster Citizen Science training	September	35 (including a school group)
	Total	52

6.4.2 In-person events

A number of in-person training sessions were delivered by the project community engagement team. These were conducted at various locations around the Firth of Forth. The sessions involved training participants in the survey methodologies, including practical demonstrations, training in scientific skills (e.g., pacing out quadrats) and information on identifying species. The events and number of attendees are listed below, with those actively trained highlighted in grey and those who engaged with the resource in white. There is a possibility that some of the participants attended more than one session.

Event (location)	Month	Number of attendees
Training Edinburgh Shoreline in oyster citizen science activities	June	6
Beach drop-ins (Cramond, Silver Sands)	June	47
Elie and Earlsferry Festival - beach clean and oyster citizen science	July	29
Oyster citizen science (Port Laing)	July	10
RBGE oyster citizen science session with ELREC	July	18
Oyster citizen science training (Wardie Bay)	August	8
Family friendly oyster citizen science training (Longniddry)	August	2
Biodiversity guide methodology trial (Musselburgh and Tynninghame)	August	9
Sparkling Dunbar Harbour Festival	August	87
Edinburgh Shoreline oyster citizen science sessions	August	21
VOCAL Oyster citizen science training	September	2
NKS Oyster citizen science training	September	10
	Total	249

6.5 Survey map

Evaluation surveys and ad-hoc conversations at in-person sessions raised a question about where it is best to survey. Multiple participants were interested in targeting their surveys to areas which had not yet been covered to maximise the coverage of the Firth of Forth coastline, increasing the potential to identify suitable sites.



Figure 8 – Map of survey sites (red indicates a higher number of surveys)

In response to this, a discussion was held around publicly sharing the locations at which surveys had been conducted and highlighting areas to survey. Concerns around safety and land access permissions were considered heavily in the resulting map. The developed map (Figure 8) only highlights areas of public beach (taken from a publicly available map layer) and was constrained to 100m above the low tide line so as to not encourage participants to access areas with potential hazards. At the time of writing, the map was still in development with plans to share on the project website. This would enable volunteers to identify sites which are yet to be surveyed and target their efforts.

7. Results

7.1 Consultation workshop participants

Figure 9 displays the age groups of participants who attended the two consultation workshops. Participants were primarily aged 55–64 with less representation from those under 34. Of those who

attended, 15 identified as women and 7 as male. All participants identified as 'White British' or 'White Scottish'.

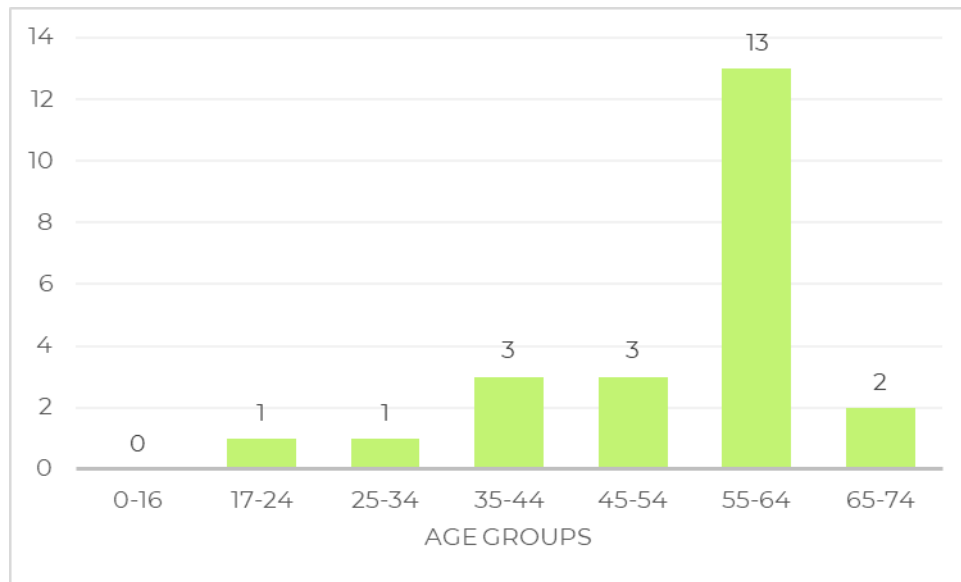


Figure 9 – Number of workshop participants by age group

7.2. Survey participants

The ages of participants were collected at survey submission (figure 10). Interestingly, the majority of surveys were submitted by participants in age group 0-16 (8 of these submissions were from a school visit), with 25-34 being the second category to submit the most surveys. This is contrary to the 'usual' demographics demonstrated in the majority of citizen science projects whereby volunteers tend to be primarily of retirement age (65-74).

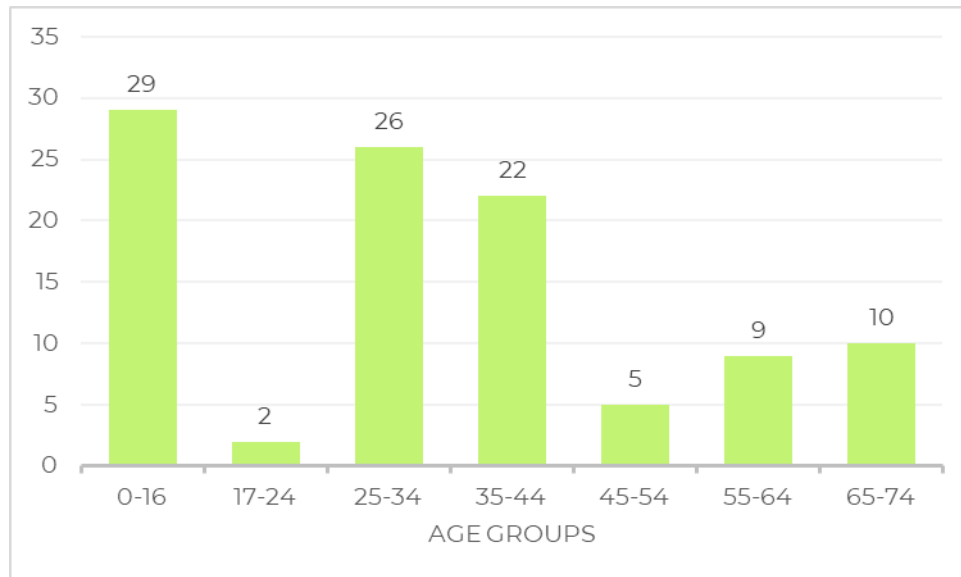


Figure 10 – Number of survey submissions by age group

7.3 Survey locations and habitat types

Almost 129 members of the local community joined an in-person or online citizen science training event for the oyster observer guide and habitat assessment. Between the launch (June) and reporting (September), 274 people conducted 114 surveys across the different activities.

Surveys were conducted on north and south Firth of Forth coastlines. The south side of the Forth had the most conducted surveys, with Cramond Beach being the most surveyed beach. This could be due to the number of engagement and training events held at this location alongside its proximity to Edinburgh. In total, 32 surveys were conducted in Fife, 33 in East Lothian and 36 in the Edinburgh area. The top survey locations are detailed in figure 11.

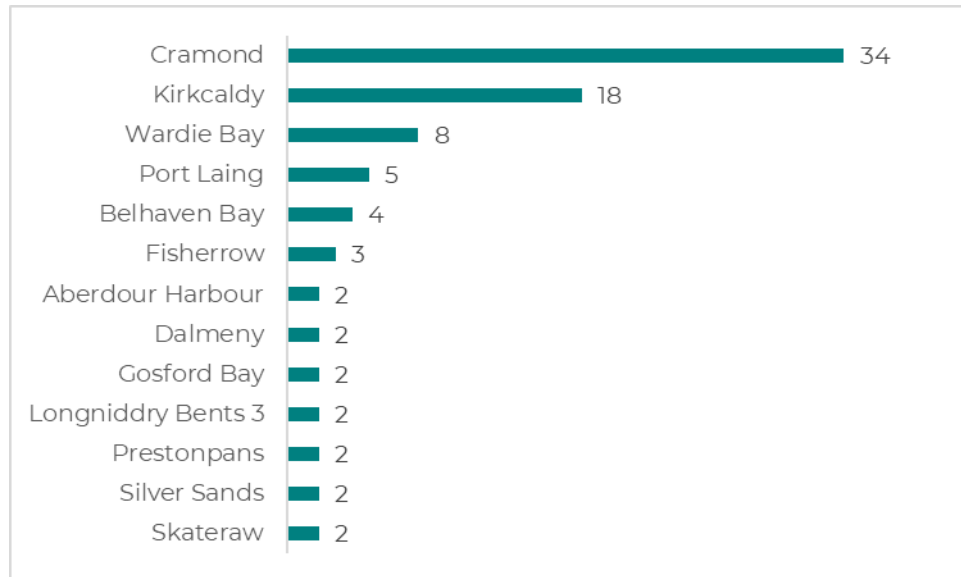


Figure 11 – Top survey locations

Figure 12 displays the location and number of surveys at each site (circle size) and the results of the habitat surveys conducted there (circle colour). From the surveys submitted, it appears that the western end of the Firth of Forth has more sandy beaches with some gravel substrates identified further out of the estuary. Increasing the number of surveys around the Forth coastline will improve the accuracy of the data.



Figure 12 – Survey locations and results from habitat surveys, substrate type

7.4 Oyster Observer Guide

A total of 3217 shells were counted as part of the search for historical oyster beds, figure 13 shows the number of each species identified. 73% (2349) of those were identified as European flat oysters. The number of Horse mussels identified (20%) is higher than expected for the survey locations indicating some mis-identification. The science team believe this may be due to Blue mussels being present. The number of Pacific oysters recorded is also higher than expected, which could indicate some confusion with shell identification by volunteers. This is discussed further in section 9.1.

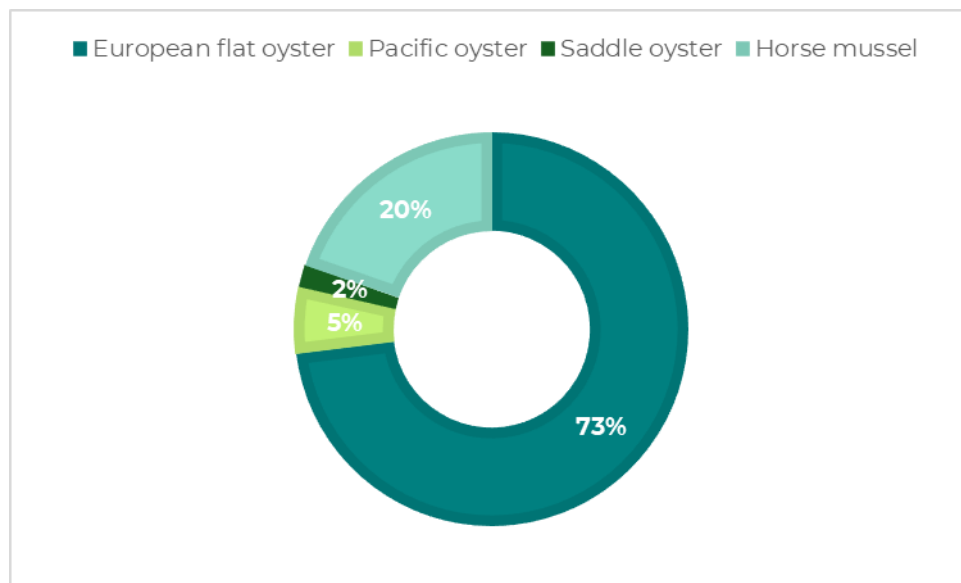


Figure 13 – Percentage of shells counted per species

7.5 Communicating results

To share the findings of the surveys and thank volunteers and wider communities for their contributions, a simple 2-page results report was developed. The report used plain English language

and detailed the survey findings from June to September 2024. It was shared via social media channels and in email updates to the project mailing list.

8. Evaluation

Evaluation was considered early in the project to allow the project team to collect and understand the impact and community response to engaging in the project. It was decided that a pre and post survey would be conducted, and questions were designed to allow for direct comparison of responses. The survey questions were also aligned where possible with existing project evaluation around more general community engagement and other health and wellbeing surveys. The full pre- and post-survey forms are detailed in Annex 5.

8.1 Pre-evaluation

Feedback was collected from attendees of community consultation sessions and provided the 'pre' evaluation responses. Of the 23 responses, only 9 participants had previously engaged in the project. The responses are considered here.

Participants were asked about their interaction and connection to the marine environment, specifically their local area around the Firth of Forth (figure 14). Participants generally had a positive attitude towards the marine environment and enjoyed spending time by the sea. There was a spread within the participants as to their previous experiences and engagement with conservation or scientific events, with some stating they do not regularly attend events.

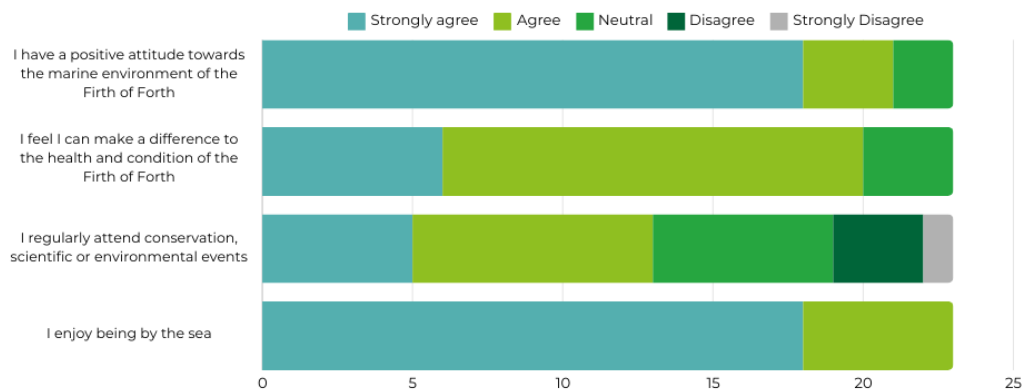


Figure 14: Participants' connection with the marine environment around the Firth of Forth

Participants were also asked about their understanding of the project goals and their confidence and desires to engage with oyster restoration (figure 15). Although most participants agreed with the statements around their motivations and general project understanding, it was evident that confidence levels in their own skills and abilities to contribute were lower.

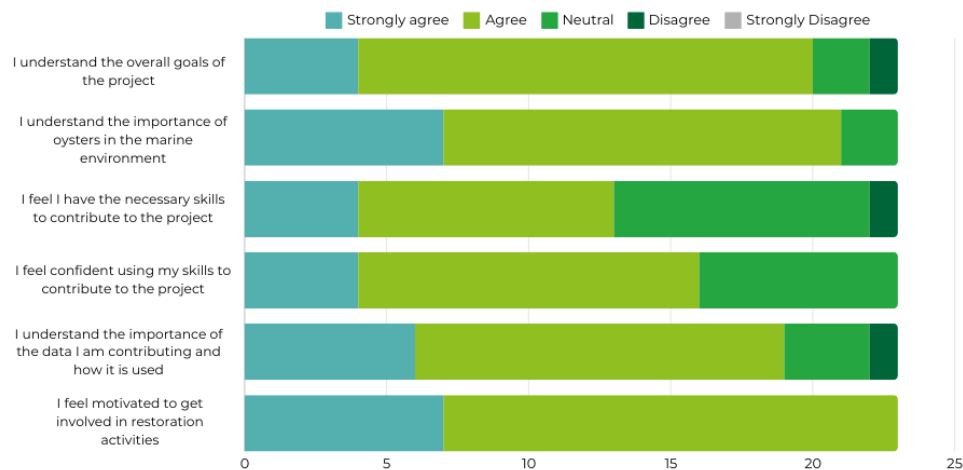


Figure 15: Participants' interaction with the Restoration Forth project

8.2 Post-evaluation

An online post evaluation survey was made available after all training events via a link and QR code. Unfortunately, the response rate was small, with only 3 responses received. This may be due to the outdoor nature of the events and lack of access to internet connections, taking paper forms may yield further return. These responses do indicate a potential increase in participants' understanding of the project and confidence in their skills and ability to contribute but are unable to offer conclusive information on participant development. There was also an open question where participants could detail any new skills, they felt they had gained from attending the training events. The responses were 'Oyster ID skills' and 'I can now recognise a badly eroded native oyster!' which also suggests some improvement in confidence, skill levels and understanding. There may be evaluation data collected elsewhere in the project which could provide further insight.

8.3 Online training events

Participants at online training sessions were asked about their confidence and motivation to take part after hearing about the various ways to get involved (figure 16). Of 22 responses, 15 people stated they were likely or highly likely to take part in ongoing citizen science activities with the remaining 7 either unsure or not submitting a response. Confidence levels of participants were marginally higher after the training sessions than those surveyed in community consultation workshops prior to training. Overall, 20 people were either highly confident after training, versus 16 people highly confident or confident before training.

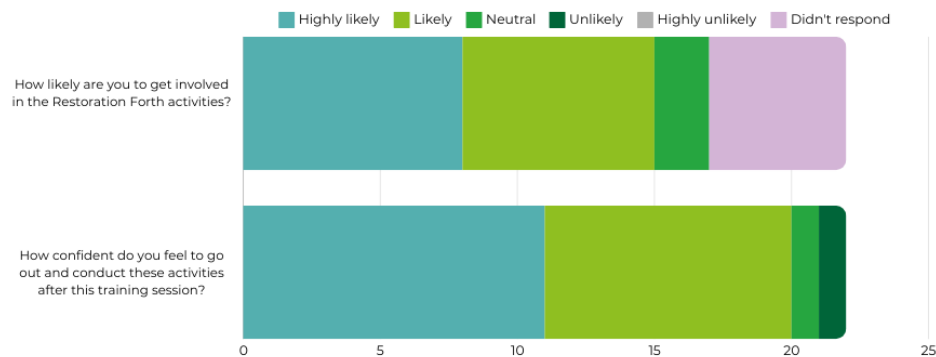


Figure 16: Participant confidence and motivations post training

9. Project conclusions

9.1 Progress towards objectives

1. Engage with local communities to co-develop a best practice approach for oyster, and wider biodiversity, citizen science monitoring that is both scalable and sustainable

Marine citizen science can be difficult to conduct due to the nature of the environment. Most of the marine environment is inaccessible in a safe way to the public, which limits the possibilities for surveying and monitoring. Therefore, participation is generally restricted to those who live, visit or can otherwise access the coast. The project set out to demonstrate that there are various opportunities to engage local communities in citizen science activities which contribute important data to better understand the restoration of European flat oysters.

The project proved the concept that local communities are able and keen to engage in oyster monitoring. General feedback from consultation events was positive and volunteers were pleased to have the opportunity to share their thoughts and knowledge of their local area and collaborate on the development of interactive activities. The general feedback from these sessions suggested that communities were not yet comfortable with taking ownership of monitoring activities, with some also

stating they didn't feel able to commit to long-term contributions. It was also noted that volunteers would prefer to engage in led or simple activities in the first instance which formed the basis of the developed activities.

There was some evidence of participants developing personal skills through engagement in the project and using these to conduct surveys, however further evaluation is required to evidence any volunteer feelings around improvements in confidence and ability. Further information on volunteers' motivations to continue monitoring activities in the long term would also be beneficial.

The activities developed were designed to be easily replicable, scalable and available for use in other projects around the country. The project team agreed on the importance of sharing any learnings from this pilot phase, allowing others to pick up and use the methodologies and resources. Building an element of project sustainability was also considered important and website infrastructure and resources were developed to stand the test of time allowing data to continue to be submitted even after the project lifespan. There is further opportunity to use the developed resources and survey infrastructure for other projects. This open approach encourages data to be collected in the same way across the UK, increasing its value at a national scale.

2. Generate robust volunteer data collection that leads to scientific outputs and policy outcomes

The types of data which would have the greatest value to both the project and wider understanding of oyster monitoring activities was considered early in the project. Heriot-Watt University identified different types of data which could contribute to our understanding of site suitability, the impact of restoring oysters and the health of the oysters themselves. With this in mind, existing approaches were explored to determine if there were methods available to gather the required data without 'reinventing the wheel'. In the case of site suitability, no methods were identified. Subsequently, the Oyster Observer Guide and habitat assessment surveys were developed to allow for this data collection. For the biodiversity survey, a few methods were identified and explored, including the Wildlife Trust Shoresearch and another oyster restoration project, Seawilding, both of whom conduct coastal biodiversity surveys. After further review and consultation with the organisers of these programmes, it was determined that the species they record was of a broader scale than the

biodiversity data requirements specific to oyster restoration. The team were interested in collecting presence and abundance information on species which are known to be indicative or relate to oysters being present.

Once analysed, the results from the OOG surveys suggested some signs of species identification confusion by volunteers, with higher numbers of Horse mussels and Pacific oysters than expected. Further ad-hoc feedback from attendees at training sessions suggested that Blue mussels, which are commonplace on the Forth shoreline, could be causing confusion. To rectify this, Blue mussels were specifically mentioned in the second iteration of the training booklet, inviting participants to submit sightings of these to Edinburgh Shoreline's 'Show us your Mussels' citizen science project. Due to the nature of searching for old shells, most of which are heavily weathered, mis-identification of oyster species is to be expected.

Adding additional volunteer training materials and verification steps could improve data quality. Unfortunately, the survey submission forms on the webpage currently lack the ability to upload photographs, although this is due to be resolved in the near future. This function would allow for specialists to verify surveys and improve overall confidence in the results. The images would also help to identify species of confusion and allow further development and improvement of training resources to support volunteers to better identify species. A quiz-type test and video training sessions would also improve confidence in the results.

3. Ensure dissemination of results that celebrates and communicates community-led contributions

The importance of sharing survey results, data and findings with participants is well documented as beneficial, both for individual motivations and accomplishment, and for the project. In this case, the results from surveys were submitted through online platforms and subsequently downloaded and analysed by project staff. The results were shared in a two-page infographic report using 'plain English' language and detailed the value of the data and where it would be used. The report was well received by volunteers via the existing mailing list and made available online. At the time of writing, the report had been made publicly available on the Restoration Forth project website, but had not yet been shared in external communications and social media.

Further evaluation of participants responses to these kind of feedback reports and the addition of community celebration would bring further understanding to the best approach to sharing complex data.

10. Recommendations

This report aimed to detail the learning from this project. What follows are a list of recommendations for the future and detailed suggestions for the ongoing development of citizen science participation within oyster restoration projects, such as this.

1. **Continue to engage and work closely with other marine restoration projects** – Share and learn from each other, standardise approaches where possible to maximise data use.

The resources and learnings from Restoration Forth, detailed in this report, aim to be openly available and replicable to allow future projects to learn from, further develop and align methodologies and increase the overall combined impact of local scale data across the country. Ensure data has the correct permissions to be publicly available where possible.

2. **Quality assurance protocols** – Ensure data robustness, develop data validation procedures.

Further work and development around data validation processes would improve data robustness and confidence levels for wider data use. Using experts to verify photographs, or increased volunteer training activities could begin to increase data confidence.

3. **Longer term support to build volunteer confidence in monitoring activities** – Continue to foster a sense of community interest and stewardship and share results openly where possible.

Continued support and engagement of volunteers over time will help to improve confidence levels and increase the chances of identifying community champions who may take a

training and support role for others. Further development and review of training resources and species identification information could also contribute to participant confidence levels.

4. More focus on community benefits – Continue to share and evaluate more social community benefits.

It is important to ensure volunteers feel valued and can see the benefits of contributing to projects such as this, of which there are many. Providing opportunities to develop skills, meet like-minded people and feel part of a scientific research team can increase the likelihood that participants will return a survey. The social and wellbeing benefits of engaging with restoration activities could be further evaluated.

5. Trial other citizen science approaches with a focus on increasing accessibility and inclusion of activities

This report details a year's worth of activity development, but there are further unexplored opportunities to engage communities in citizen science activities. Table 3 details some of the other identified potential projects. Focusing development of activities for under-represented groups could also prove beneficial, for example, remote activities, like online image repository tagging or satellite mapping offer opportunities to contribute to projects for those who are unable to access coastal areas to conduct surveys.

Expansion to other types of engagement outside of citizen science activities like data analysis volunteers, design or communication volunteers could also provide opportunities to interact with science projects whilst utilising or developing other skills.

6. Engage with policy makers to ensure the data collected is of the highest value – Identify specific data which would be useful to evidence decision making.

Exploring further data pathways and data use chains alongside policy makers could increase the value of the collected data and highlight a clear path for volunteers to understand the importance of citizen science data in marine decision making.

11. Annexes

11.1 Annex 1 – Citizen science matrix narratives used for community consultation workshops

Site suitability

Current oyster restoration projects and existing research provides us with information on the most suitable conditions for survival and growth of oyster populations (e.g. substrate, temperature, wave exposure, shell coverage). The research team have broadly assessed the Firth of Forth, but as there are currently no oyster populations located here, we need to test different areas to see which sites have the best conditions to sustain oysters.

What types of data will be collected?

By collecting information on washed up oyster shells, water quality and the ocean floor, we can work out where could be a good site to return oysters. The Restoration Forth Dive team have already been conducting surveys collecting information on substrate, depth, shell coverage and biodiversity across subtidal sites as well as looking at the locations of historic oyster fisheries.

What will the data tell us?

Initially, this data will be valuable to help our restoration team decide where best to return oysters so that they have the highest chance of survivability. Already, the team have identified five sites which are suitable for oyster restoration and have begun working on how to manage the return of oysters in four of them.

This information also contributes to expand what we know about oyster restoration, which could go on to help other restoration projects around the world.

Oyster Observer Guide (OOG)

How long does it take?

0-1 hour

How much experience is required?

Habitat Assessment

How long does it take?

0-1 hour

How much experience is required?

No experience is needed

Water parameters

How long does it take?

0-1 hour

How much experience is required?

No experience is needed

No experience is needed, we have a handy guide to help identify the different shells you may find. What skills could be gained? • Marine species identification • Scientific practices What training may be required? • Species identification Is any specialist equipment needed? No Submitting data Online form – MCS Accessibility? –Participants can complete paper or online forms –Participants need to be able to access a section of the beach	What skills could be gained? • Scientific practices • Scientific equipment What training may be required? • Guides or training session around surveying substrates and surrounding habitat Is any specialist equipment needed? No Accessibility? –Participants need to be able to access and reach the shore	What skills could be gained? • Scientific practices • Sampling techniques • Scientific equipment What training may be required? • Guides or training session around equipment use Is any specialist equipment needed? Yes Accessibility? –Participants need to be able to access and reach the water
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Aligning with other existing projects

Existing water parameters methodology – <https://noraeurope.eu/wp-content/uploads/other-publications/European-Native-Oyster-Habitat-Restoration-Monitoring-Handbook.pdf>

Monitoring

Once the oysters have been returned to the Firth of Forth, we need to monitor how they progress. This includes their growth, survival and whether they start to reproduce. This is especially important to monitor over a longer period of time to help identify any trends or changes. Oyster restoration can be a very slow process, so revisiting monitoring sites can collect important data on their

progress. This can also help validate the site selection process and contribute to the wider understanding of this species.

What types of data will be collected?

Information on the number of shells in an area, changes in oyster shell size, beached oyster shells and identifying oyster spat (baby oysters).

What will the data tell us?

The data will be invaluable in tracking how the oysters are surviving in their new habitat and help to work out what we may need to change to make the restoration efforts even more successful. Over a longer time, and combined with the site suitability data, this information will go on to inform other restoration efforts in the Firth of Forth and other projects.

<u>Shell density (count)</u>	<u>Growth and Mortality</u>	<u>Spat settlement</u>
How long does it take? 0-1 hour How much experience is required? No experience is needed, we have a handy guide to help identify the correct shells What skills could be gained? • Marine species identification • Scientific practices What training may be required? • Species identification • Tallys Is any specialist equipment needed? No Accessibility? -Participants can complete paper or online forms	How long does it take? 1-2 hours How much experience is required? No experience is needed What skills could be gained? • Marine species identification • Scientific practices What training may be required? • Species identification • Growth monitoring and measuring • Retrieving and returning growth strings Is any specialist equipment needed? Yes Accessibility? • Participants need to be confident to access a section of beach	How long does it take? 1-2 hours How much experience is required? No experience is needed What skills could be gained? • Marine species identification • Scientific practices What training may be required? • Spat identification • Spat locations • Avoiding identification bias Is any specialist equipment needed? No Accessibility?

-Participants may need good eyesight and be comfortable bending down

Aligning with other existing projects

Existing shell density/growth methodology - <https://noraeurope.eu/wp-content/uploads/other-publications/European-Native-Oyster-Habitat-Restoration-Monitoring-Handbook.pdf>

Biodiversity

Oysters are known as ‘ecosystem engineers’ because of the benefits they can provide to their local ecosystem and to other species. They are filter feeders and can change water quality and clarity over time and create complex reef structures which provide habitats for other marine species. Once the oysters are returned to the Firth of Forth, we need to monitor what benefits they are providing, like the biodiversity improvement which is expected to occur in their local environment.

What types of data will be collected?

Information on changes in other species either living or visiting the area, information on things beginning to grow on the oyster shells themselves.

What will the data tell us?

The data can tell us more about the impacts of returning oysters into the Forth. This information can be used to change how we manage oyster restoration activities in future and inform government policies on the importance of oyster beds and how to protect them.

Shore surveys How long does it take? 0-1 hour How much experience is required? No experience is needed What skills could be gained? • Marine species identification • Scientific practices • Survey techniques What training may be required? • Species identification • Survey protocols Is any specialist equipment needed? Yes Accessibility? -Participants can complete paper or online forms - Participants need to access a section of the shore	Photo collection How long does it take? 0-1 hour How much experience is required? No experience is needed What skills could be gained? • Marine species identification • Scientific practices • Photo and technology skills What training may be required? • Scientific photography • Handling oysters Is any specialist equipment needed? No - Cameras Accessibility? - Participants need to access a section of the shore	Associated species How long does it take? 1-3 hours How much experience is required? Some experience required What skills could be gained? • Marine species identification • Scientific practices What training may be required? • Species identification Is any specialist equipment needed? No Accessibility? -Participants can take part from anywhere (if looking at images)
Aligning with other existing projects Shoresearch (Wildlife Trust) – Shoreline species survey Big Seaweed Search (MCS/Natural History Museum) – Seaweed species survey		

11.2 Annex 2 – Biodiversity monitoring guide

Biodiversity monitoring guide



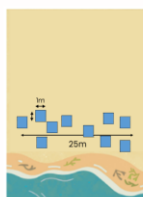
Tracking the impact of returning oysters

We need to monitor the impact the oysters are having on their local environment. Collecting information on the presence of other species either living or visiting the area, or growing on the oyster shells can tell us more about the benefits of returning oysters to the Firth of Forth. We can collect this before and after the oysters have been returned so we can see any changes.

This information can be used as evidence to change how we manage oyster restoration activities in future and inform government policies on the importance of oyster beds and how to protect them.

What to do

- Select and mark a starting point close to the water line
- Walk 25m (roughly 25 adult paces) parallel to the sea and mark each end of your transect.
- Along your 25m transect, randomly select and mark out ten 1m x 1m squares (called quadrats)
- Carefully inspect each square, record and tally the species you see from the ID guide below - take lots of pictures too!
- Upload your results to our website



Staying safe

- Please do not enter the water
- Carry out the survey at low tide
- Take someone with you and take a phone so you can call for help if you need to

Red filamentous seaweed

Size: 2-30cm
When: January-December

A group of small red seaweeds. They usually have long thin strands which are sometimes branched. Often found close to the shore growing on rocks and shells.



Brown wracks (*Fucaceae* sp.)

Size: 15cm - 2.5m
When: January-December

Wracks are brown seaweed and often have branched fronds. They are usually brown to olive green in colour. Some have air-filled sacs which help the seaweed to float and photosynthesise.



Encrusting Seaweeds (*Corallina* sp.)

Size: 2-30cm
When: January-December

Encrusting seaweeds are usually pink, red or white in colour and are often found on harder rocks and can be seen lining rockpools. You might spot ridges where neighbouring crusts meet.



Nearby

Have a look in the wider area and record any birds or any other marine life you spot near to your survey site or close to the waters edge.

Oyster catchers (*Haematopus ostralegus*)

Size: 40-50cm tall
When: January - December

Oyster catchers have a distinctive white underside and red beak. They also have a distinctive, loud call. They specialise in eating shellfish.



What to look for..

Oysters are brilliant ecosystem engineers. They create complex reef structures which provide habitats for other marine species, are proven to increase biodiversity and even store carbon.

We're looking for different species which often live near oysters. Look closely and carefully in your search area and record what you find there.

On the shore

Look closely within your quadrat and record what you find. If you move any rocks, be sure to return them!

Animals

Hermit crabs (*Paguroidea*)

Size: Usually around 2-4cm
When: January - December

Hermit crabs are found on lower shores. They live inside empty seashell shells, usually orange-brown in colour. As they grow, they move into bigger shells.



Butterfish (*Pholis gunnellus*)

Size: Up to 25cm
When: January - December

Butterfish are small, eel like fish. They like to hide under rocks and amongst seaweeds. Yellow-brown in colour with dark bands and white-ringed black spots.



Common starfish (*Asterias rubens*)

Size: 10-30cm
When: January-December

Five arms and usually orange in colour with small spines. Found close to the shore and are active predators, using their arms to open and eat shellfish, like mussels or clams.



Brittle star (*Ophiothrix fragilis*)

Size: 2-20cm
When: January-December

Brittle stars vary in colour from yellow, and purple to almost black. They have a round body with 5 thin, long, brittle arms which they can sometimes shed if disturbed.



Saddle Oysters (*Anomia ephippium*)

Size: Up to 5cm
When: January-December

Saddle oysters are usually white in colour, with a pearly inside. They are smooth and rounded with a small hole through which the oyster attaches to hard surfaces underneath.



Periwinkle (*Littorina littorea*)

Size: 1-5cm
When: January-December

A small marine snail, often with a dark brown or grey banded shell. Often spotted clumped together in crevices or under rocks.

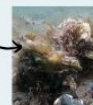


Seaweeds

Oyster thief (*Colpomenia peregrina*)

Size: Up to 10cm
When: January-December

Oyster thief is a non-native seaweed which attaches to rocks or oyster shells. Olive-brown with small brown dots. It has a gas-filled bladders which inflate and can float oysters away.



11.3 Annex 3 – Restoration Forth Monitoring Guide

Getting involved

The Restoration Forth science team at Heriot-Watt University has identified three key types of information that are valuable for assessing potential restoration sites, the survival of oysters and their wider impact on the Firth of Forth.

Finding the best places to restore oysters

By collecting information on washed-up oyster shells and seabed type around the Firth of Forth, we can determine which sites are most suitable for potential restoration and will give the oysters the best chance of survival once restored. This expands our knowledge of oyster restoration and the kinds of habitats they prefer.

Activity 1. Habitat assessment

Looking for the best habitats

 5-15 minutes

 Anywhere on Firth of Forth shoreline when the tide is going out

Oysters like to live on the low shore and in shallow waters in areas where the seabed is made of small pebbles, gravel or shell material, with fewer big rocks where predators could hide. Areas with more shell material and calmer conditions may improve the chances of oyster larvae settling and establishing oyster beds.

1. Randomly select and measure out a 1m x 1m square (one adult pace each side), marking each corner
2. Look at your square and record the details about your beach on your survey form
3. Submit your results on our website

Activity 2. Oyster observer guide

Looking for oyster and horse mussel shells

 15-30 minutes

 Anywhere on Firth of Forth shoreline when the tide is going out

Oyster shells continue to wash ashore around the Firth of Forth, possibly indicating where historical oyster beds thrived. This could suggest good areas to restore them to. Tell us how many shells you find on your local beach.

1. Randomly select and measure out a 10m x 10m square (10 adult paces each side), marking each corner
2. Carefully explore your square and make a note of the oyster and horse mussel shells you find on your survey form. Use the ID guide opposite to help you
3. Tally up your totals for each shell species
4. Submit your results on our website

European flat oyster (*Ostrea edulis*)



Lower shell: Round and thick with distinctive growth lines

Upper shell: Flatter with shallow grooves

Colour: A variety of colours, from brown to white and even pink, purple or black

Size: Up to 11cm

Saddle oyster (*Anomia ephippium*)



Lower shell: Smooth and rounded with a small hole

Upper shell: Smooth and rounded

Young shell: Translucent

Colour: White with pearly interior

Size: Up to 6cm (often size of a fingernail)

Pacific oyster (*Magallana gigas*)



Lower shell: Elongated, domed or cup-like with obvious fluting at edge

Upper shell: Elongated and flat

Colour: Purple, white or brown, sometimes with stripes (but can vary greatly)

Size: Up to 15cm

Horse mussel (*Modiolus modiolus*)



Lower shell: Cup-like, elongated and smooth - these are easily confused with blue mussels which are smaller and have a narrower 'point' to the shell

Upper shell: Mirror image of lower shell

Colour: Purple or dark brown, but may be white when weathered

Size: Between 8 - 20cm.

Tracking the impact of returning oysters

We need to monitor the impact the oysters are having on their local environment. By collecting information on the presence of other species either living in the area, visiting it, or growing on the oysters themselves, we can learn more about the benefits of returning oysters to the Firth of Forth.

Activity 3. Biodiversity monitoring Looking for other species

 1-2 hours  Anywhere on the low Firth of Forth shoreline when the tide is going out

This survey looks at the impacts returning oysters might have on other species. We're interested in seaweeds, birds and the species which start to grow on oyster shells. Visit the website link below for more information on how to conduct this survey.

How are the oysters getting on?

Once the oysters have been returned to the Firth of Forth, we need to monitor how they survive, grow and whether they start to reproduce. We can look at the oyster shell sizes, survival rates and look for oyster spat (baby oysters). Oyster restoration can be a very slow process, so revisiting sites to monitor the oysters can collect important data on their progress and help improve future oyster reintroduction.

Activity 4. Monitoring oysters Checking in on the oysters

 1-5 hours  Organised events at oyster restoration sites

Once they are in the sea, we'll be conducting regular checks to see how the oysters are surviving and growing. This may require a bit more time and training, but is a great chance to get hands-on experience and develop your science skills.

Visit our website link below for the latest news and information on upcoming events.

The data you collect is used by the science team from Heriot-Watt University, helping to inform their research on oyster restoration in Scotland.



Ready to get started?

Scan the QR code or head to mcsuk.org/restoration-forth to download the survey and ID guides, recording forms, and to submit your data

Other ways to get involved

Looking for more ways to help out? Here are other opportunities to get involved with Restoration Forth or other marine projects through citizen science activities.



Show Us Your Mussels - 1-2 hours, once a month

Our partners at Edinburgh Shoreline are on the lookout for blue mussels (*Mytilus edulis*). You can report your sightings at edinburghshoreline.org.uk/show-us-your-mussels-project



Big Seaweed Search - 1-2 hours, once a month

The Marine Conservation Society and Natural History Museum team up with people across the country to take a closer look at UK seaweeds. Head to mcsuk.org/big-seaweed-search to find out how you can get involved.



Wildlife Sightings - 5-10 minutes

Reporting jellyfish and turtle sightings provides vital information about our ocean's inhabitants and contributes to scientific research which finds solutions to protect our seas. Check out the ID guides and report your sightings at mcsuk.org/wildlife-sightings.



Beach cleans - 1-3 hours

Join or organise a beach clean at mcsuk.org/beachwatch to help clean up our coastline and collect important data which enables the Marine Conservation Society to campaign for change.



Seagrass restoration

You can get involved in seagrass restoration activities too! Find out more information on seagrass restoration work at projectseagrass.org/restoration-forth

11.4 Annex 4 – Pre and post evaluation forms

CITIZEN SCIENCE SURVEY



Please choose a unique identifier

This can be a memorable word or series of numbers (please don't use anything which makes you personally identifiable). Using this memorable phrase each time you provide project feedback allows us to match peoples responses whilst keeping feedback anonymous.

.....

Have you previously attended any other Restoration Forth events?

☐ Yes ☐ No

Interaction with the marine environment and the Firth of Forth

How do you feel about the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I have a positive attitude towards the marine environment of the Firth of Forth	☐	☐	☐	☐	☐
I feel I can make a difference to the health and condition of the Firth of Forth	☐	☐	☐	☐	☐
I regularly attend conservation, scientific or environmental events and activities	☐	☐	☐	☐	☐
I enjoy being by the sea	☐	☐	☐	☐	☐

Additional comments or suggestions



Interaction with the Restoration Forth project

How do you feel about the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I understand the overall project goals of the Restoration Forth project	☐	☐	☐	☐	☐
I understand the importance of oysters in the marine environment	☐	☐	☐	☐	☐
I feel I have the necessary skills to contribute to the project	☐	☐	☐	☐	☐
I feel confident using my skills to contribute to the project	☐	☐	☐	☐	☐
I understand the importance of the data I am contributing and how it is used	☐	☐	☐	☐	☐
I feel motivated to get involved in restoration activities around the Firth of Forth	☐	☐	☐	☐	☐

Is there anything else you would like to tell us about your skills, knowledge or experience?



Optional demographic questions

We want to know more about the people who collaborate on the project with us. These questions are entirely optional.

What is your postcode?

.....

What best describes your gender identity?

☐ Man ☐ Non-binary ☐ Woman ☐ Prefer not to say

☐ Prefer to self describe

Please indicate your age range

☐ 16-25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 56-65 ☐ 66-75 ☐ 76+

How would you describe your ethnicity or ethnic background?

.....

Do you consider yourself to be a person with a disability?

☐ Yes ☐ No ☐ Prefer not to say

Thank you for your time!