
GUIDE TO OYSTER NURSERIES

UK & IRELAND

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BLUE MARINE
FOUNDATION



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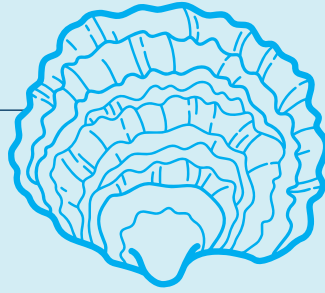
BRITISH
MARINE
LEADING THE INDUSTRY



MDL MARINAS



"The lessons learned by the Solent Oyster Restoration Project has led to a growing network of oyster nurseries around the UK, helping to restore local oyster populations and allow communities to take part in conservation on their doorstep".



INTRODUCTION

This introductory guide to setting up oyster nurseries in marina or pontoon environments has been written collaboratively between Blue Marine Foundation (BLUE), Marina Developments Limited (MDL), the University of Portsmouth, ZSL (Zoological Society London) and British Marine. The guide provides practical support and instructions for oyster restoration and contains essential information for setting up and maintaining oyster nurseries deployed from marina pontoons or similar floating structures in the marine environment.

The information provided comes from experience using oyster nurseries over several years on the south coast of England, as part of the Solent Oyster Restoration Project. The lessons learned by the Solent Oyster Restoration Project has led to a growing network of oyster nurseries around the UK, helping to restore local oyster populations and allow communities to take part in conservation on their doorstep. Funding from the Peoples Postcode Lottery Dream Fund has helped to further expand the reach

of oyster nurseries across the country through the Wild Oysters Project. It is hoped that this guide will equip other groups to consider the use of broodstock nurseries to help restore native oysters across Europe.

This practical guide can be used alongside *existing native oyster restoration and monitoring handbooks* that provide broader context. See further reading section at the end of this handbook.

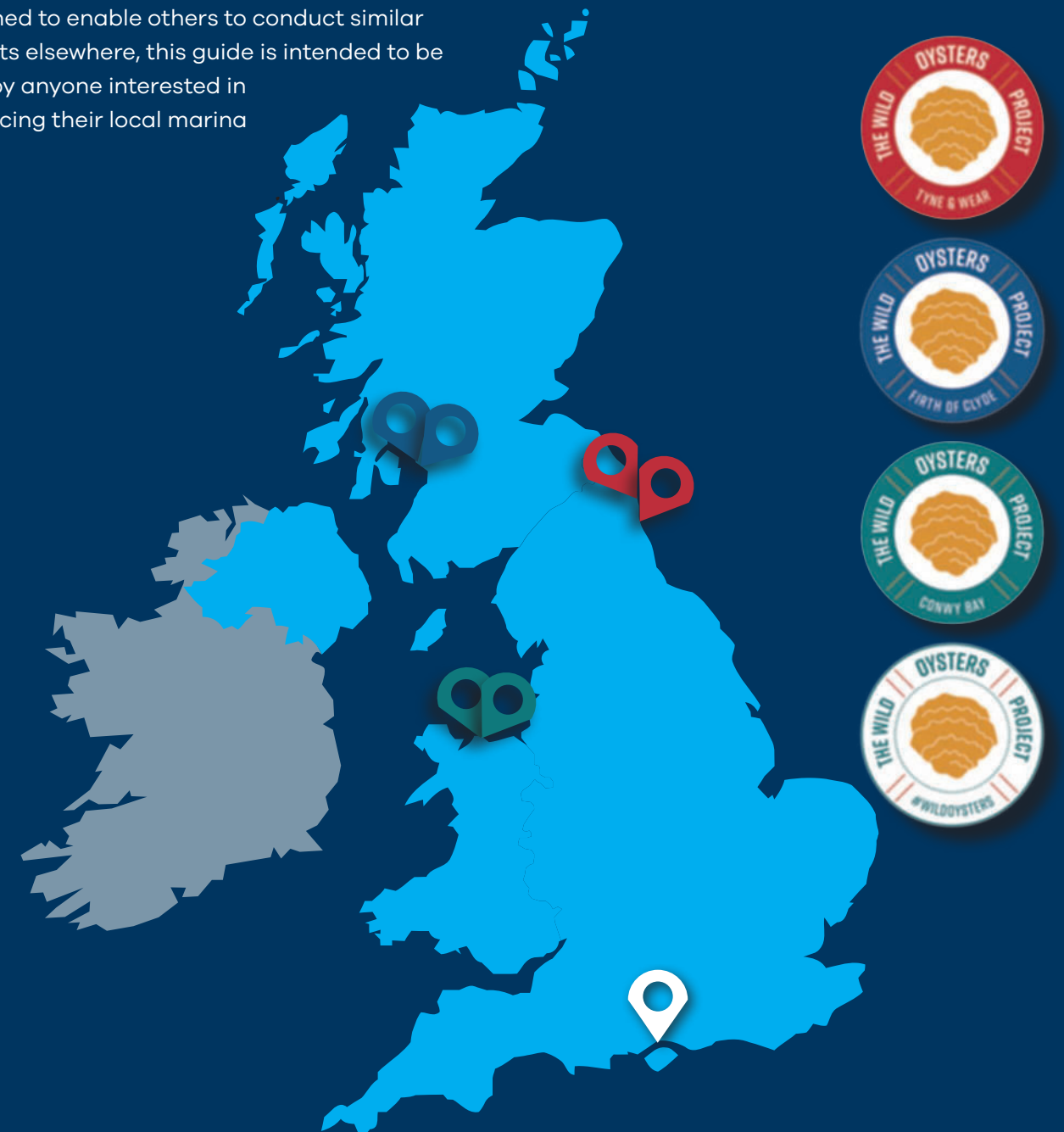


An oyster nursery can serve two functions, to grow juvenile native oysters to size (often called oyster gardening) or as broodstock sanctuaries for adult oysters to reproduce and act as “larval pumps”. The selection of either, or both, method, will depend on the situation in the local site and/or the long-term aim of a project. This, along with biosecurity considerations, will affect the decisions made on where to source oysters from and in what quantity. Each scenario is discussed under the ‘sourcing adult oysters’ and ‘growing oysters’ sections.

Designed to enable others to conduct similar projects elsewhere, this guide is intended to be used by anyone interested in enhancing their local marina

environment, through the practice of oyster restoration. It is not recommended that this handbook be used to produce oysters for consumption. It is also important that any work is conducted following the appropriate rules and regulations in your region.

By using this guide, we hope that local community groups, universities, local authorities, non-governmental organisations, marina companies and other parties can come together and enable new projects to flourish.



WHY RESTORATION

The seas around the UK have experienced devastating change over the last century. Overfishing, habitat loss, pollution all exacerbated by climate change have laid waste to marine life and habitats, altering coastlines beyond recognition.

(<https://www.decadeonrestoration.org/>) and 'Ocean Science for Sustainable Development' 2021-2030, there is growing recognition of humanity's dependence on healthy and robust marine ecosystems. The global population is rising to the challenge to protect and restore ecosystems at scale, rebuilding resilience and helping to tackle the climate emergency.

There are many examples of community-based restoration efforts from around the world, including large scale oyster gardening in the United States of America (US). These have provided a foundation for similar work to take place in the United Kingdom (UK) and Europe, allowing communities to engage and make a real-world difference. To find out more about native oyster restoration efforts taking place in the UK & Ireland, visit the Native Oyster Network-UK & Ireland website here:

<https://nativeoysternetwork.org/>

Oyster decline has been seen across the world. Globally, an estimated 85 per cent of oyster reefs have been lost, making them one of the world's most imperilled marine habitats. Active intervention and management is urgently needed to restore oyster populations. As we enter the UN decade on "Ecosystem Restoration"

85%

OF SALTMARSH HAS BEEN LOST IN ENGLAND

95%

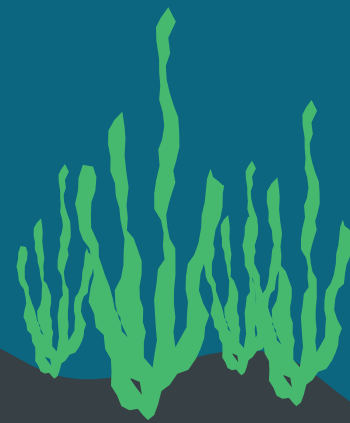
OF NATIVE OYSTERS HAVE BEEN LOST FROM ACROSS THE UK AND EUROPE

50%

OF UK STOCKS ARE OVERFISHED OR DATA DEFICIENT

49% OF UK SEAGRASS BEDS HAVE BEEN LOST IN THE LAST

35 yrs



BENEFITS OF OYSTER RESTORATION

As the important role marine and coastal habitats play in regulating our environment has become clearer, oysters have been recognised as more than just a food source. They form reefs that provide a home for other marine life, such as European eels, sea bass and sea horses, making them 'biodiversity hotspots'.

The ability of oysters to enhance the marine environment does not stop here, as the native oyster can play the role of the kidneys of the

ocean. As they feed, the surrounding water is filtered, removing tiny algae (phytoplankton), animals (zooplankton) and particles of suspended organic material.

It is estimated that an individual oyster can filter between 100 - 200 litres of water a day. The Solent was once Europe's largest oyster fishery with 15 million oysters landed in 1979 alone. That's the equivalent of 1.5 to 3 billion litres of water filtered each day lost.

By feeding on the algae, oysters also help to reduce the effects of algal blooms, including those caused by harmful species. These occur when excessive amounts of nutrients enter the marine environment, causing the phytoplankton population to grow out of control, often smothering other important habitats. Harmful species even release toxic compounds that have negative effects on humans, shellfish, fish and other important species. An example of this often occurs in Florida and is known as a "red tide".

This filtration ability of oysters also has the potential to improve surrounding water quality and conditions for other habitats, such as seagrass beds. Increased water clarity results in increased light penetration, thus photosynthesis and seagrass growth. Oysters can also stabilise the sediment allowing for saltmarsh habitat to recover, improving coastal protection.

The infographic below shows all the benefits the native oysters can bring.

ECOSYSTEM SERVICES PROVIDED BY

INCREASED WATER CLARITY

Can benefit recovery of seagrass and other coastal aquatic plants



INCREASED FISH PRODUCTION

Provides a suitable feeding and nursery grounds for fish



INCREASED OYSTER POPULATIONS

Provides a spill over effect to local oyster fisheries



CULTURAL VALUE

Have previously formed the heart of coastal communities



IMPROVED WATER QUALITY

Removes pollutants from the water column



BIODIVERSITY ENHANCEMENT

Form a complex structure that provides shelter and food for a diversity of species

NATIVE OYSTERS OSTREA EDULIS

CULTURAL VALUE

Have previously formed the heart of coastal communities



IMPROVED WATER QUALITY

Removes pollutants from the water column



DENITRIFICATION
Removes excess nutrients



STABILISATION OF SEDIMENTS
Reduces the resuspension of fine sediment, improving water clarity



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- Provisioning services
- Regulating services
- Cultural services

THE CONCEPT BEHIND THE OYSTER NURSERIES

The reproductive cycle of the native oyster is complex and relies on adults being at high densities in proximity to one another. In many areas, where the decline of oysters has been severe, their distribution is patchy, and they are often found in low densities. This makes it hard for oysters to breed successfully and for populations to recover. This is known as being recruitment limited.

The Solent, on England's south coast, was facing this exact issue when what was once Europe's largest self-sustaining oyster fishery, was closed in 2013 due to decades of decline. In 2015, with the aim of restoring the Solent's dwindling oyster population BLUE, the University of Portsmouth and Marina Development Ltd. (MDL) developed and refined a restoration tool designed to remedy

this decline and increase reproductive success of local oyster populations. Known as oyster nurseries, the system was designed to supercharge the breeding of mature oysters. By holding oysters in close proximity, they find it much easier to reproduce and can release millions of larvae into the surrounding waters, where they settle and grow on the seabed. By suspending them above the seabed, they also have more available food and are kept away from predators and potential smothering by sediment.

By holding oysters in close proximity, they find it much easier to reproduce and can release millions of larvae into the surrounding waters



WHY RESTORE OYSTERS IN A MARINA OR ON OTHER STRUCTURES?

A marina may not be the first place you think of when looking to restore oyster reefs. They are relatively harsh environments that can suffer from the effects of pollution. However, floating pontoons in marinas allow restoration projects, as well as boat users, direct access to the water.

Placing nurseries in marinas has a number of benefits that can help your project:

- Easy access to the water without the need for boats or scuba divers which can be costly.
- The marine setting and suspending oysters provide protection from predators, smothering and interference.
- Monitoring and husbandry can be done from the pontoons in a range of weather conditions.
- Community education and outreach is possible to a wide range of audiences.
- Relatively cost-effective method of restoration when compared to largescale seabed restoration.

RESULTS FROM NURSERY TRIALS:

2017

TRIALS CONDUCTED IN 2017
IN THE SOLENT, HAMPSHIRE

20%

OF OYSTER SPAWNED IN A
SINGLE YEAR

130

SPECIES FOUND LIVING
AROUND NURSERIES

1 billion

LARVAE RELEASED IN A SINGLE YEAR
(FROM 20,000 BROODSTOCK)



SUITABILITY OF A MARINA OR OTHER FLOATING STRUCTURE

There are a few key considerations before installing nurseries, which are outlined in this section.

ENVIRONMENTAL PARAMETERS

Ensuring that the environment around the chosen nursery site is suitable for the survival and reproduction of native oysters is essential for the success of the project and these need to be assessed before getting started.

WATER TEMPERATURE

Native oysters can tolerate a wide range of water temperatures, but it is important to make sure that the local area is suitable.

Sea surface temperature must ideally be between a range of 25 °C in the summer and 5°C in the winter. Information on water temperatures throughout the year can be gathered from environmental regulators responsible for measuring water quality, such as the Environment Agency, Scottish Environment Protection Agency or Natural Resources Wales.

SALINITY

Native oysters can be found in both fully marine and estuarine environments, where fresh and saltwater mix. However, if the water gets too fresh this can shock and even kill native oysters. Salinity is a very important factor that will dictate the suitability of a site.

It is recommended to ensure that the water around oyster nurseries stays within a salinity range of 25-40 parts per thousand (ppt) and ideally 30-35 ppt.

It is important to check if there are any freshwater outfalls, such as storm drain pipes,

or rivers close to the site or if the site is known to receive a lot of surface run-off, as this can cause short but dramatic changes in salinity that can harm the adult oysters and their larvae. Storm events that introduce large quantities of freshwater to a site are inevitable and unavoidable so selecting a site with the right salinity during much of the year provides a buffer against this.

DEPTH

It is important to check with the local marina or harbour authority and assess the depth of the basin is right for the size of nursery decided upon for the location. The very surface layer of the water can be dirty, from marine plastics to potential fuel spill from boats. It is therefore recommended that the top of any oyster nursery sits at least 30 cm below the surface of the water.

Therefore, ensuring that that the depth of water at low tide is sufficient for the bottom of any nursery to remain off the seabed.

OTHER FACTORS

There are other factors that can affect the success of oyster nurseries, including the flow rate of the water, food availability, shading, pollution and dissolved oxygen.

A shady site, away from long exposure to direct sunlight, with reasonable water flow is recommended. The flow rate can be visually assessed during the ebb or flow of the tide. If you are suspending nurseries directly below a pontoon or pier, this can help to provide shade. To help make your decision, check online to see if there is any freely available data on food availability and oxygen levels from the environmental regulators mentioned above.

LOGISTICAL CONSIDERATIONS

For a project to be successful, the practical aspect of any work must also be addressed to be sure that any planned work is possible in the chosen location. It goes without saying that if the marina or structure is not owned by project partners, then it is essential to determine if the owner or operator is willing to accommodate such a project and permission sought. Being aware of some of the logistical considerations is key to a constructive collaboration with the chosen site.

Some of the logistical challenges that may be faced include:

ACCESS

Accessing pontoons during busy periods in the summer and/or at weekend may be difficult as there is higher footfall at the marina. It is advised to try and avoid busier times when checking on nurseries, check with the local marina when might be the best time to visit.

DREDGING

Some marinas or channels need to be dredged regularly, this is to ensure that the basin maintains its depth and ensures vessels can pass or access berths safely. During this time, pontoons or structures may be moved by the operators and the increased sediment in the water can harm the oysters. If possible, the nurseries should be relocated while dredging takes place, it is best to check with the marina and local harbour authority to allow for plans to accommodate this.

CLEANING

Cleaning of nurseries also poses the risk of conflict with berth holders who do not want their vessels to be covered in mud or dirt. Finding suitable locations, or screening off areas, to allow any necessary cleaning to take place should be factored into the plan and discussed with all those involved throughout.

If consulted early in the project, berth holders and boat owners may be more willing to accommodate activities and even offer to lend a helping hand. Having information brochures or leaflets to hand, presenting at AGMs or arranging specific volunteer events can all be ways of engaging the boating community.

BIOSECURITY

It is advised that the *"European Guidelines on Biosecurity in Native Oyster Restoration"* document should be used for a comprehensive list of considerations and legal requirements that should be adhered to when conducting restoration work.

Both diseases and non-native species are significant threats to biodiversity globally. It is therefore essential that any project prevents the accidental spread of pathogens and or invasive non-native species (INNS). Biosecurity works best when it is built into day-to-day practices and constantly monitored.



The two key things be aware of are:

PATHOGENS

Microbial pathogens such as parasites and viruses are known to cause ill health and mortality in humans, but they can also harm shellfish. Being aware of the pathogens that affect shellfish health is essential and ensuring that any work with nurseries and oysters will not facilitate their spread. Of major concern for native oysters is a protozoan parasite called *Bonamia ostreae*, often shortened to "Bonamia",

but it should be noted there are several species around the world and in Europe. While causing large mortalities in oysters, the parasite is not harmful to humans.

INVASIVE SPECIES






The impact of Invasive Non-Native Species (INNS) is highlighted as one of the main causes for biodiversity loss. Many of these species will compete with the native species of oyster for food and space and may even predate on the species intended for restoration.

The transfer of INNS between production or source site (donor) and the restoration (recipient) site(s) where they are not already present at the recipient site(s) should be avoided at all costs, especially for those considered "high-impact". Even when a species is present at both sites care should be taken to minimise the introduction and avoid increasing the genetic diversity of these species.

The infographic below describes how to be vigilant while working with various bits of equipment.



AREAS TO BE VIGILANT WITH WHEN CLEANING AFTER CARRYING OUT FIELDWORK FOR OYSTER RESTORATION PROJECTS:

- 
Stop the spread The success and reputation of a restoration project can be negatively impacted by accidental introductions of invasive species and pathogens. Project equipment such as vans, boats and field kit can all be vectors for their transmission, which will ultimately damage the marine environment and wildlife.
- 
CHECK Check your equipment, clothing and boats after carrying out fieldwork for fouling material. Ensure that you remove anything that you find and dispose of it in the appropriate manner.
- 
CLEAN Clean all fieldwork items thoroughly with freshwater as soon as possible. Ensure that you pay attention to items such as fieldwork clothing, restoration equipment, trailer wheels and areas that are damp or hard to reach.
- 
DISINFECT Disinfect – Where the risks are higher, include disinfection as part of cleaning procedures.
- 
DRY Dry – Ensure that you drain water from any water remaining on fieldwork items, and equipment such as a trailer and boat. Try to dry all equipment for as long as possible before next usage.

CHECK - CLEAN - DISINFECT DRY



NOTIFYING THE RELEVANT AUTHORITIES

In compliance with national legislation, the Solent Oyster Restoration Project and the Wild Oysters Project have been required to register the nursery system as an aquaculture facility. Registering a restoration site will allow for the relevant regulatory authority to have oversight of activities and can often provide guidance for a project when making decisions. In many areas it will be a legal requirement to contact the relevant authority when handling live animals. It is therefore recommended that the legislation in the local area is adhered to before commencing any nursery installation and authorities responsible for nature conservation and aquaculture are informed of the project.

In the UK, under the Aquatic Animal Health Regulations (England and Wales), (Northern Ireland), (Scotland) 2009, you are required to notify the relevant authority of your intention to set up an Aquaculture Production Business (APB). Official guidance on how to do this can be found here:

England and Wales:

www.gov.uk/guidance/fish-shellfish-or-crustacean-farm-authorisation

Scotland:

www.gov.scot/publications/aquaculture-production-business-apb-forms-and-guidance/

Northern Ireland:

www.daera-ni.gov.uk/publications/application-authorise-aquaculture-production-business



SETTING UP AN OYSTER NURSERY

Once a suitable site to house oysters has been found, it is important to design a nursery system to fit the needs of the marina or structure. There is not one single way to hold oysters in nurseries, or suspend them beneath the water, each project may have its own specific needs that require bespoke installations. In this section, the key considerations are outlined that can help with the design phase.

DESIGNING A NURSERY

There are several key aspects to oyster nurseries that make them a useful tool for restoration. Below are the main functions that an oyster nursery needs to provide to make sure they are a successful addition to a project. It is also important to determine who will fabricate the nurseries so that realistic designs can be developed throughout the process and the design stages can be iterative. For example, the system developed by the Solent Oyster Restoration Project has been used as a blueprint by Lochnell Oysters and the Wild Oysters team. This has allowed the creation and adaption of a slightly different system that puts these principals into practice and works for the audiences that are expected for the Wild Oysters Project.

ACCESSIBILITY

First and foremost, it is imperative that the oyster nurseries are easily accessed for regular monitoring and maintenance, it is recommended that this takes place at least once a month. The setting of a floating marina pontoon or other structure means that nurseries can be seamlessly accessed from dry land. It is also essential that the system is designed in a way that means it is safe to reach your nurseries, remove them from the water and assess the oysters inside of them, when you are on the pontoon itself. This is particularly prudent when involving volunteers and school groups in activities as the nurseries can become quite heavy when other organisms settle on them.

ROBUSTNESS

The marine environment is very dynamic, tides, waves and currents all mean that marine engineering requires careful thought to make sure equipment doesn't perish or break, causing damage to the area intended for restoration. A marina offers a relatively more stable environment than an offshore site, yet it is still important to ensure your nurseries stand the test of time.

THERE ARE SEVERAL AREAS WHERE EXTRA CARE WILL BE NEEDED:

- A robust exterior housing is needed to ensure that the oysters within are protected from any collisions. This can be constructed from material used to construct fishing pots or other similar devices as they are designed for rough handling.
- Attachments to the pontoon need to be sturdy and designed so that they do not wear over time. Nurseries may move due to wave action or tidal movement. If this is the case, steps will need to be taken to ensure that the nurseries will not detach or collide with vessels under any conditions.

PROTECTION

A key aspect of nurseries is that the oysters within are protected from predators. This is achieved by suspending them away from the seabed. It is also important that your nurseries are protected from marina users from tampering with or even removing them – although this is unlikely. This can either be done using deterrents such as CCTV, by making nursery hatches lockable, or through engaging with local boat owners and marina users.

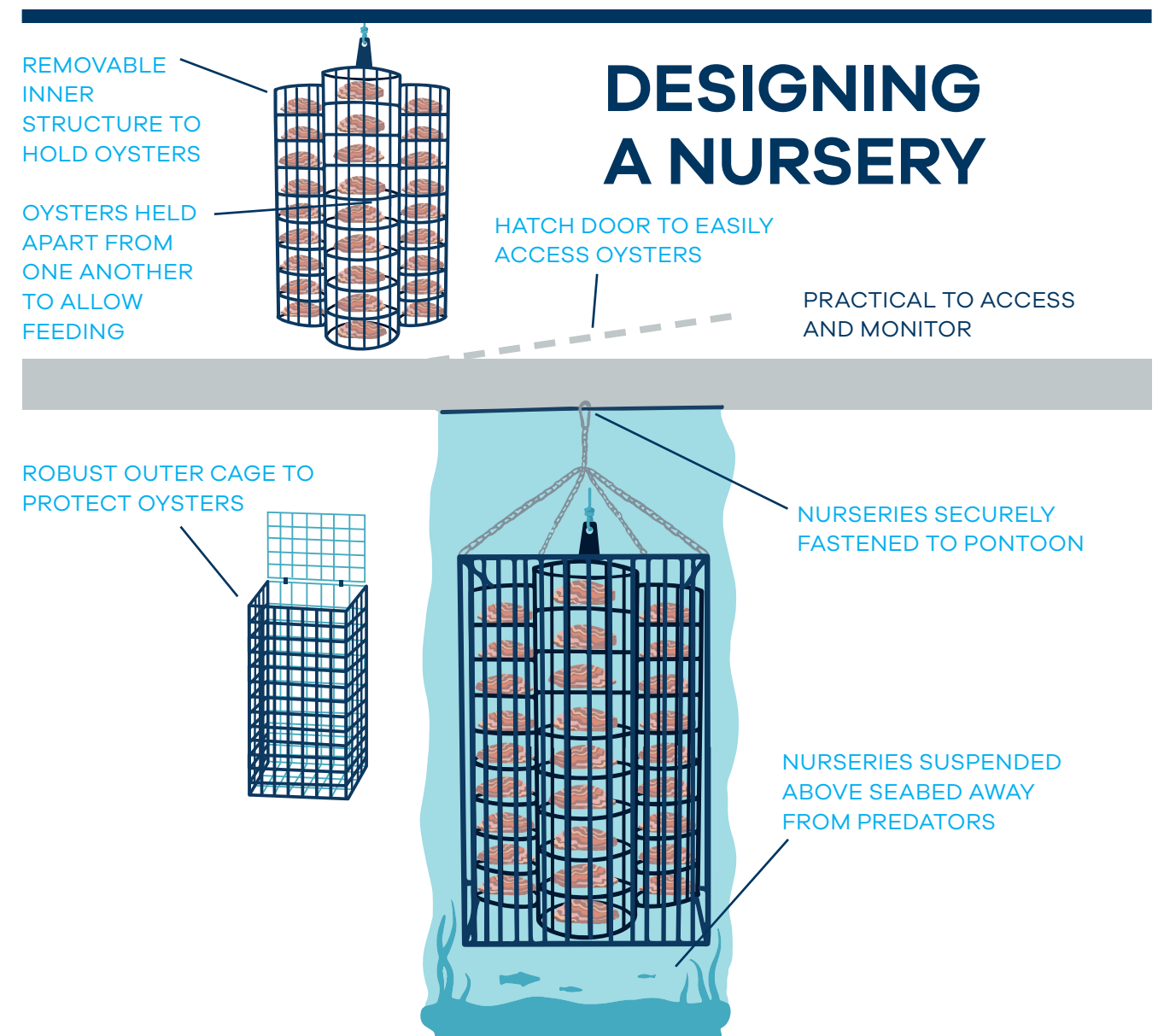
PRACTICALITY

Caring for nurseries and the oysters inside them is crucial to making sure they are successful. This requires regular handling of the nurseries, and it is important to ensure their design allows for this. Again, it is recommended that at least a visual inspection is carried out on a monthly basis. A balance must be struck between nurseries being large enough to hold a significant number of oysters and not being too large and un-wieldy that regular handling will be difficult or cause injury. A safer option is to have more, smaller nurseries rather than fewer larger ones.

SUITABLE FOR OYSTERS

Perhaps the most important aspect of an oyster nursery is that it is suitable for keeping oysters happy and healthy. Some key considerations are:

- Holding oysters at very high densities can facilitate more rapid spread of disease. The Solent Oyster Restoration keeps oysters at an approximate density of 39 oysters per meter cubed.
- Ensuring oysters are not exposed to a highly fluctuating environment, as previously mentioned, this can be achieved by placing them in a shaded area with minimal freshwater inputs.
- Oysters need to open and close their two valves to feed, make sure the oysters are not packed too tightly in a manner that prevents this, or presents opportunity for objects to get trapped, again preventing closure.





SOURCING YOUR OYSTERS

The most important part of any nursery will be the oysters inside of it. If implementing a restoration project, there are probably not very many oysters left in the local area. In-fact, native oysters may now be completely absent from the intended restoration site(s).

Sourcing oysters from as close to the project site(s) as possible will help to reduce some of the logistical challenges that transporting oysters creates. As stated above, any translocation of live shellfish should be discussed in advance with local regulators.

SOURCING ADULT OYSTERS

The key to a healthy oyster reef or bed is a large enough quantity of mature individuals for the population to be self-sustaining, where adults can successfully reproduce, and the juveniles then settle in the area and replenish the stocks. Broodstock nurseries will help to input the larvae needed, as the adult oysters reproduce.

Adult oysters are usually sourced from active fisheries where native oysters are harvested for human consumption. Oysters are still alive when they are fished so can be taken from the fishery and placed into nurseries.

It should be noted that the average expected lifespan on native oysters is variable and often dependant on several factors. A peak in mortality after spawning events is to be expected and the nurseries will require restocking periodically. Again, sourcing of oysters, regardless of species, should only be sourced from areas that fall within their natural biogeographical range and should follow strict biosecurity protocols.

GROWING OYSTERS TO PLANT ONTO REEFS

Due to declines in wild oyster populations, it may be difficult to find adult oysters to place

in nurseries. In this case it may be worth considering the use of nurseries to grow juvenile oysters to a larger size before deploying them onto a seabed reef. By doing so, the oysters can grow to a greater size under conditions that reduce the impact of predation at their most vulnerable stages.

Juvenile oysters can be sourced from shellfish farms or hatcheries that produce native oysters, rather than active fisheries as it may be illegal to land juvenile oysters.



MONITORING AND MAINTENANCE

Once oyster nurseries are in the water, it is a matter of ensuring they stay healthy and happy. This will be key to ensuring the oysters inside grow, survive and, most importantly for broodstock, breed! This section will outline what needs to be built into a monitoring and maintenance programme and how this can be achieved.

HUSBANDRY AND MAINTAINING EQUIPMENT

Oysters are known as "ecosystem engineers". This means that they positively influence the natural environment where they are present. An example of this is the sheer number of

other species that they provide a habitat for, currently known to be over 400 for the European flat oyster!

There is a balancing act to find a suitable middle ground between allowing other species to flourish and keeping the oysters themselves alive. With attachment of other species to the complex nursery structure, flow rate, thus food availability, is going to be reduced over time. Periodically removing some of this additional biodiversity by hand is necessary for maintaining the nurseries and oyster within.

MONITORING EQUIPMENT

ESSENTIAL EQUIPMENT

Lifejackets – safety first! It is strongly recommended (and may be a legal requirement) that it be mandatory for anyone working on the pontoons, structures or vessels to wear a lifejacket. It is important that they are certified and serviced regularly.

Food, water, sun cream, hat, sunglasses are all essential for those working on the pontoons/ structures, particularly in the summer.

Waterproof/warm clothing particularly in the colder months.

Clothing to get dirty, primarily in the summer months when waterproof clothing is not required.

Gloves for protection and warmth. Oysters and other species that grow on them, such as barnacles, are remarkably sharp. To reduce plastic waste, try to select pairs that can be washed and reused, these often provide more protection than the thinner single use ones as well.

Knee pads are a life saver and will be well worth the investment. It is recommended that those with no metal clips be used as these degrade quickly when in regular contact with seawater.

Calipers are used to measure oysters and their growth. Cheap plastic ones will work fine, no need for digital ones unless your budget allows.

Data collection sheet(s) and clipboard make the process much smoother and print outs make life easier in the field. Waterproof/windproof clipboards are also worth the investment.

Hatch key may be needed if the hatches or installations require an Allen/hex key but don't forget to take it with you each time.

Cleaning equipment it is very important to leave the pontoon in the manner in which it was found. If the pontoon has hose availability, then an adaptor and nozzle can be used to wash the area down, however, a wide broom and bucket filled with seawater will do the job.

RECOMMENDED MONITORING EQUIPMENT

ID books are extremely useful if monitoring the biodiversity associated with nurseries. Ensure they are appropriate for your geographic region.

Temperature loggers such as the HOBO Pendant® logger are relatively cheap and easy to use. *These should be used to monitor the conditions after initial surveys have determined that the location is suitable.

Salinometer can be purchased cheaply and are easy to use. *These should be used to monitor the conditions after initial surveys have determined that the location is suitable.

Pressure-washers may be needed if nurseries require thorough cleaning, but they will need to be compliant with the energy supply on the pontoon(s) and approved by the marina company/owners prior to use.

A portable balance can be useful if weight data is required, but most will need to be on solid ground not a pontoon to work.

Protective footwear for those working with the larger nurseries it is recommended that steel toe capped boots be worn, to prevent injury to your feet when removing nurseries.

Coins or tokens are useful when required to borrow marina trolleys.

Cable ties are useful if on-site repair work is needed on nurseries.



MINIMUM MONITORING REQUIREMENTS

Regardless of any requirements to register as an aquaculture facility, and the reporting responsibilities that come with that, it is important to regularly monitor the status of the oysters in the nurseries. Provided in this section is an example of a monthly monitoring plan.

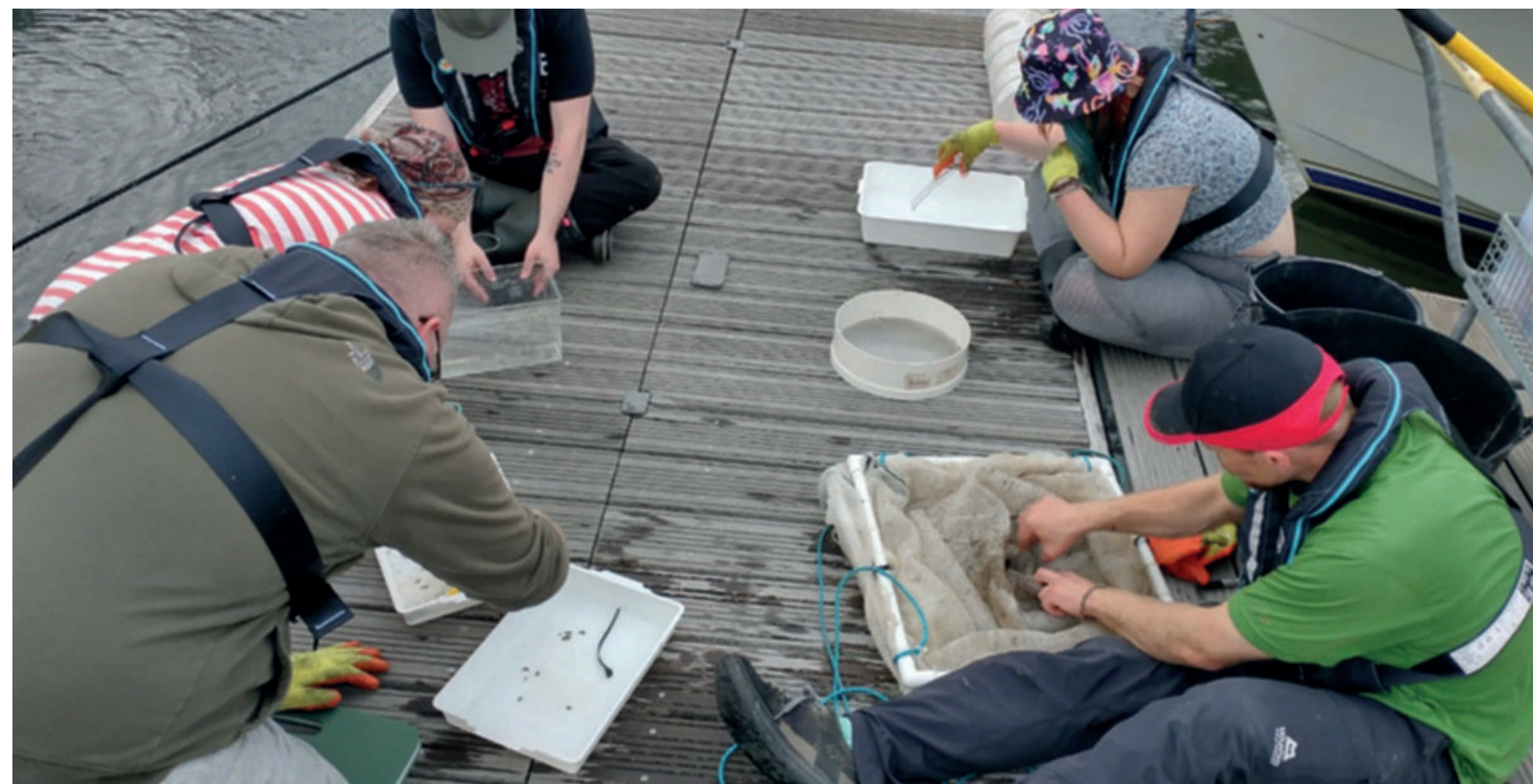
SURVIVAL

First and foremost is survival, ideally assessed on a monthly basis this will give an insight into how the oyster population at any site is coping and ultimately how suitable that location is for a project in the long term. When an oyster is alive it can control the opening and closing of its two valves with the adductor muscle, when it dies it can no longer do this and will often remain open. The most obvious sign that an oyster has unfortunately died is an open shell with no flesh present inside. If an oyster contains flesh but remains open after squeezing the two valves together a few times this lack of response is also a sign of a mortality.

Hint: it is often useful to press and slide the two halves of an oyster you think might be dead as they sometimes get filled with mud and remain shut. You can also use a long thin object (screwdriver or similar) to prize the valves apart easily if the oyster is dead. Alternatively tapping them gently with a solid object to see if they “sound hollow” is also a sign that they are dead.

Hint: Do not dispose of oyster shell in waste or over the side of a pontoon, it is an extremely precious resource and can be used to settle the next generation of oysters once cleaned off.

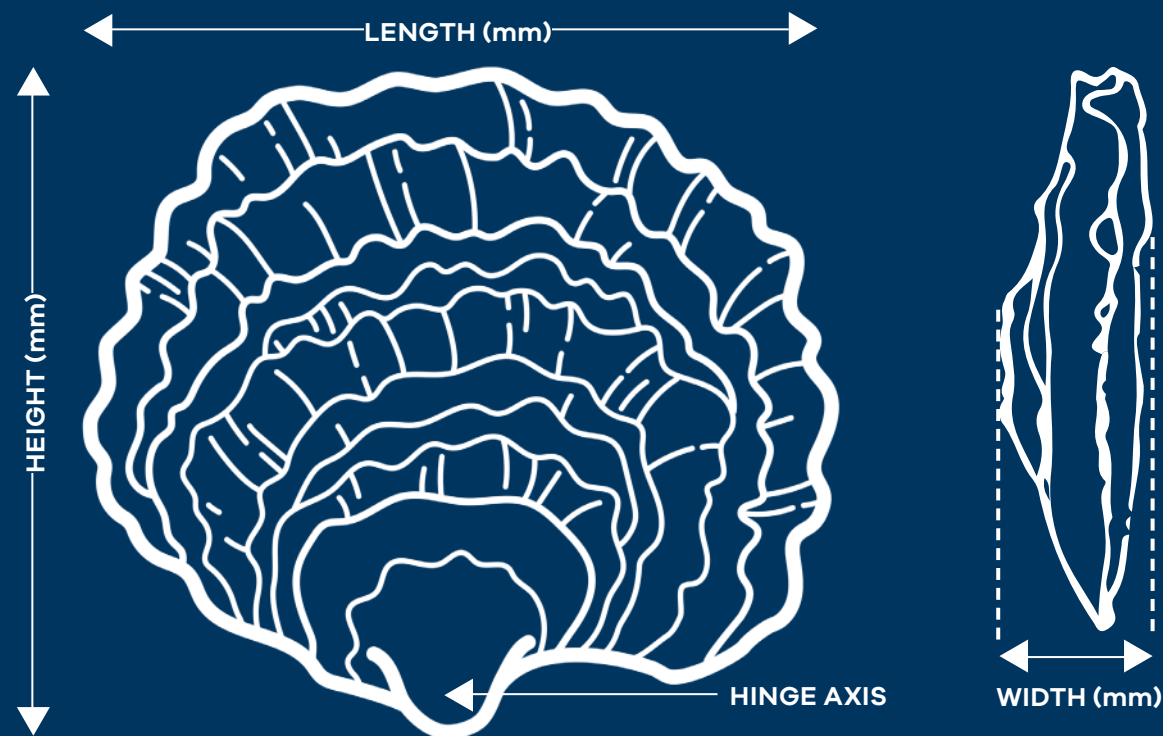
Cultch – A mix of shells and gravel that is used to restore the seabed for oysters. The coarse, hard structure cultch provides the ideal conditions for oyster settlement.



SIZE AND GROWTH

(MAINLY FOR ON-GROWING JUVENILES)

Oysters are typically measured using four parameters: shell height (mm), shell length (mm), shell width (mm) and whole wet weight (g). Again, this should be conducted as frequently as possible and on a sub-set of the population.



If using nurseries to grow juveniles, before deploying them onto seabed reefs, it is important to keep monitoring how fast they are growing. If nurseries in some areas of the site are seeing greater growth than others, then a rotation of nurseries may help to even this out. Alternatively, those with slower growth may require increased maintenance to remove other species, allowing for higher flow rates and greater food availability.

If using adult oysters to increase larval supply, there is a general positive correlation with adult size and larval output, therefore selecting larger oysters may improve larval outputs. Measuring size and growth across the seasons may also

allow for anecdotal identification of males and females, with males recovering quicker than females due to lower energy requirements and no brooding period, thus being able to feed more and having greater growing fringes after spawning.

Remembering to mark individuals is also important so you can quickly identify them and input data efficiently. If held in specific positions within a nursery then the position can be marked (making sure to put them back in the same place!), alternatively bee tags and adhesive putty can be used for both loose juveniles and adults if not measuring the total nursery population to gain an average.

ADDITIONAL MONITORING

BIODIVERSITY

With oysters being ecosystem engineers, it makes sense to monitor what impact they are having on the community in each area. This can be a powerful tool to persuade funders and policy makers to support further restoration activities and even scale up nursery settings. You never know, you may even find other critically endangered species or commercially important species inhabiting the systems. Custom built sampling nets can be used to collect any species that are within nurseries as they are brought to the surface. As there is such a wealth of diversity in coastal environments it may be worth teaming up with a local University or Institute to bring in their expertise and assistance for this section of a project.

REPRODUCTION

(WHEN USING ADULT OYSTERS)

Reproduction is more challenging to monitor and is likely to require the expertise provided by researchers at Universities or Marine Institutions. With any sampling during restoration projects, the aim should be to avoid killing any oysters where possible, so the opening (known as 'shucking') of oysters should be a last resort. For species that keep larvae within their shells before releasing them, such as the European native oyster, it is possible to open them using chemicals such as magnesium chloride ($MgCl_2$). This will anaesthetise individuals and avoid the need to sacrifice any precious oysters.

Natural settlement of larvae can also be tested as a proxy for reproductive activity when direct monitoring can't be carried out. Settlement plates can be used to monitor this and can be constructed from oyster shell (in a biosecure manner), roofing tiles, lime coated disks, known as "coupelles" or other surfaces with a rough texture. They should then be suspended near the broodstock nurseries or on the seabed in

suitable locations (this can be calculated to a relatively fine scale if hydrodynamic modelling is available) or on intended/existing seabed reef locations.

Hint: oyster larvae are gregarious (meaning they settle on other oysters) so don't forget to keep an eye out for little larvae/spat on the shells of adult oysters in nurseries in the months following the spawning season!



EXAMPLE MONTHLY MONITORING PLAN

GOAL	OBJECTIVES	INDICATOR	PROPOSED METRIC	METHOD OF DATA COLLECTION	FREQUENCY/ TIMING	MINIMUM MONITORING?
Create a source of larval of O. edulis through the use of nurseries	Demonstrate an increase in larval abundance beside oyster nurseries	oysters spawning in nurseries	% of oysters spawning in nurseries	Magnesium chloride sampling // Lab based sampling	Monthly during spawning season (May-Sept)	Yes
	Demonstrate survival of oysters in nurseries	Mortality rate	% Mortality	Monthly mortality surveys	Monthly	Yes
	Understand the biodiversity associated oyster nurseries at each site	Species richness of epibiota	Total species richness	Photographic samples	Monthly	Yes
		Species abundance of epibiota	Total species abundance	Photographic samples	Monthly	Yes
		Species richness of mobile fauna	Total species richness	Net sampling	Monthly	Yes
		Species abundance of mobile fauna	Total species abundance	Net sampling	Monthly	Yes
		Biomass of all mobile species	Total biomass of mobile species (g/ nursery)	Net sampling	Monthly	No
		Biomass of recreational / commercially important mobile species (g/nursery)	Total biomass of commercially or recreationally important species (g/ nursery)	Net sampling	Monthly	No

ENGAGING WITH YOUR COMMUNITY

Making sure the local community understands and is engaged with a project will be important to its success. The seas are a commons, and belong to all of us, so everyone has a stake in having a thriving and healthy marine environment. It is important to be clear with projects aims, ambitions and practices from an early stage and to make sure that nobody is excluded or left behind.

Oyster restoration is also a great way to engage with a local community and get people involved in marine conservation. The hands-on aspect of the project means that people of all ages and demographics can get involved.

Overfishing, invasive species, disease and climate change are all factors that affect issues that have led to the decline of native oysters globally. By getting local communities to understand the plight of oysters, projects can help locals to further understand the issues currently facing our coastal environments and the marine world in general.

Below is a list of stakeholders that may want to be considered for engagement with before, during and after a project to ensure its success. Note that this list is not exhaustive and there may be other people in the community to engage with.

BERTH HOLDERS
Many of the berth holders visit the marinas in their spare time to relax and enjoy being out on the water. Informing them of what the project is doing and how it intends to improve the local environment will help them understand habitat restoration and may even encourage them to become involved.

SCHOOLS
Working with school groups is a great way to engage with the next generation of conservationists, and give young people access to an immersive experience that they otherwise might not get.

COLLEGES
Colleges, like schools, can be full of budding and enthusiastic conservationists. Many of the students may be looking at ways to get involved in conservation.

UNIVERSITIES
A partnership or association with a university specialising in marine sciences can be an invaluable tool for expanding the scope of your project monitoring schemes.

MARINE CHARITIES OR NGOS
Non-governmental organisations (NGOs) and marine charities may also be keen to be involved with the restoration of native oysters at your site.

SOCIAL MEDIA
There are several social media platforms that can be used to target the messages of a project at different audiences and can be an extremely powerful tool to raise awareness of the work that is going on.



FURTHER READING

European Native Oyster Habitat Restoration Handbook UK & Ireland

https://nativeoysternetwork.org/wp-content/uploads/sites/27/2020/11/ZSL00150%20Oyster%20Handbook_WEB.pdf

European Guidelines on Biosecurity in Native Oyster Restoration

<https://nativeoysternetwork.org/wp-content/uploads/sites/27/2020/11/ZSL00161%20Biosecurity%20Handbook%20ONLINE.pdf>

More information on the Wild Oysters project can be found here

<https://wild-oysters.org/>





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