



Photograph © Francisco Martinez-Baena.

ROCK OYSTER GARDENING GUIDE

A practical guide to community-based oyster gardening

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The Nature Conservancy

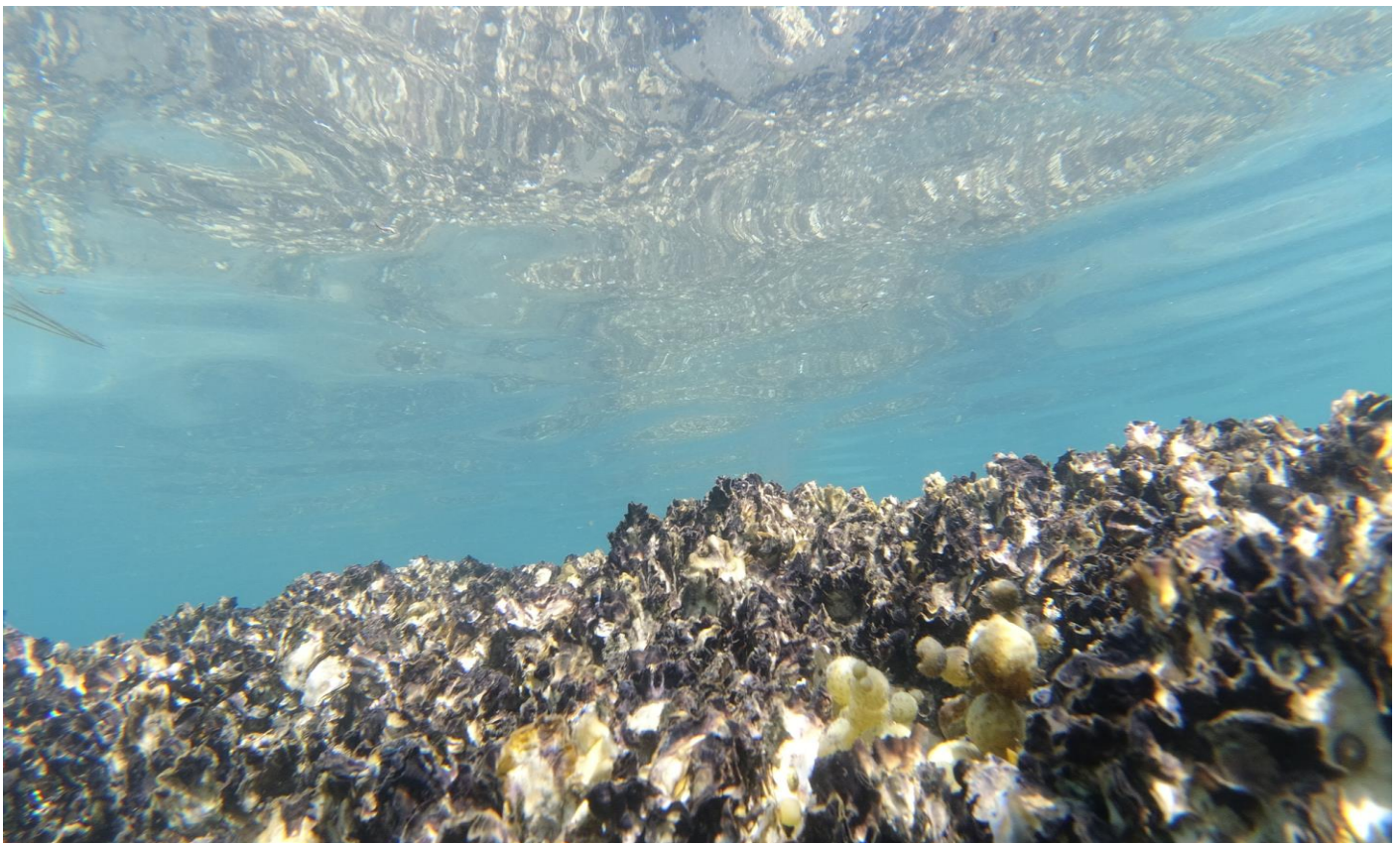
The Nature Conservancy is a global environmental non-profit organisation working to create a world where people and nature can thrive. In the last 70 years, The Nature Conservancy has grown to become one of the most effective and wide-reaching environmental organisations in the world, with over 400 scientists.

Rebuilding Australia's lost shellfish reefs

Shellfish reefs are one of Australia's most critically endangered marine ecosystems. These reefs, made from billions of oysters and mussels, once thrived in over 200 locations in Australia's bays and estuaries from Noosa in Queensland right around Australia's southern coastline to Perth in Western Australia. Now less than 10% remain.

This project is part of The Nature Conservancy's Reef Builder initiative to restore 30% of Australia's lost shellfish ecosystems, which if achieved, would make Australia the first nation to recover a critically endangered marine ecosystem.

To learn more about our work to restore shellfish ecosystems across Australia, visit natureaustralia.org.au/shellfishreefs



Rock Oyster Ecosystem Photograph © Francisco Martinez-Baena.

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Section 1. Overview

What is oyster gardening?

Oyster gardening is a community driven project whereby volunteers support a local oyster ecosystem restoration project by becoming *Oyster Gardeners*.

Oyster Gardeners support restoration efforts by growing oysters in baskets and then released onto the project restoration site.

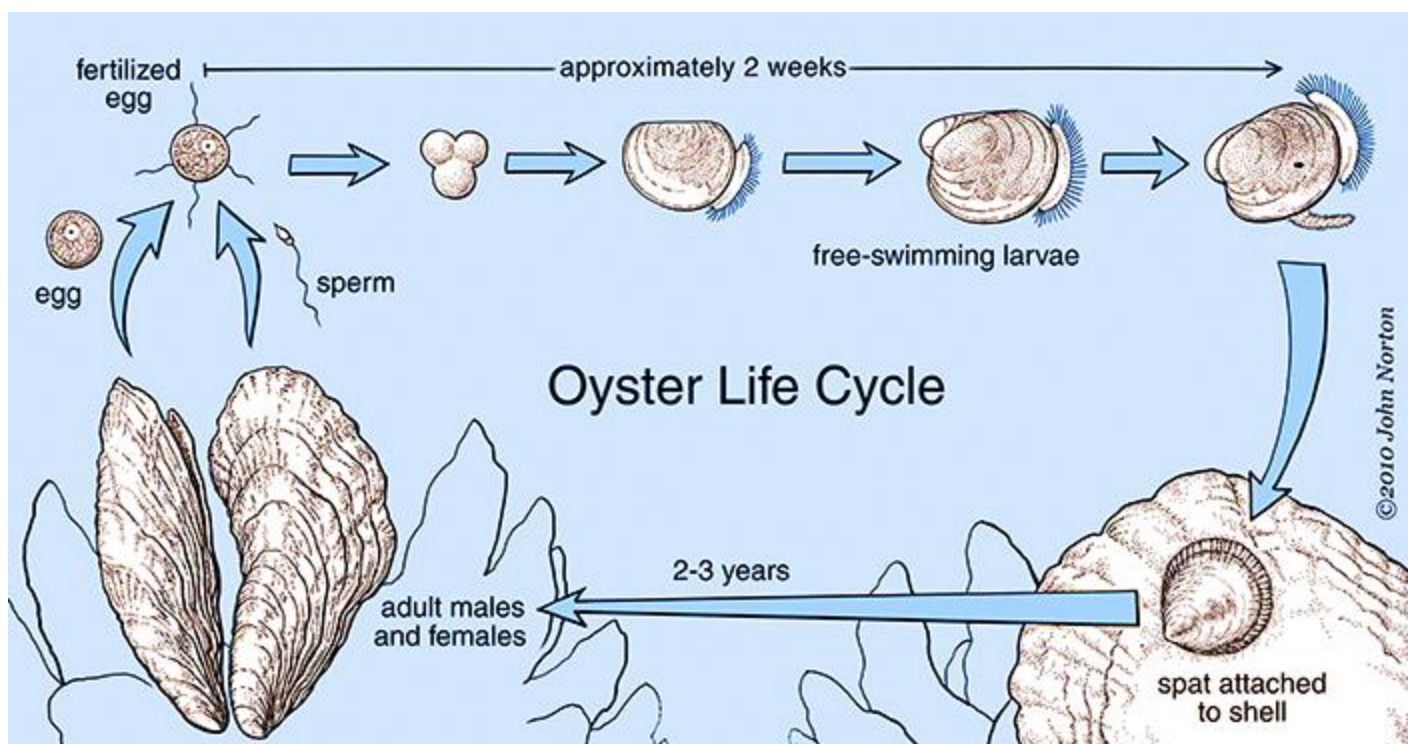
The project team supplies the oyster gardeners with juvenile oysters (called 'spat'), which has been settled onto specially dried (or cured) oyster shell (called cultch) in a shellfish hatchery. *Oyster Gardeners* then raise the juvenile oysters to adulthood over a six-to-twelve-month period, monitoring their progress and keeping the gardens clean. The oysters are then released onto the rocky foundations of the oyster ecosystem that the project has installed on the restoration sites.

Once released onto the restoration site, the oysters continue to grow to maturity, spawn and help recolonise the living reef ecosystem, effectively Helping to kick start the ecosystem restoration.

What to expect

Rock oysters take about 18 months to reach maturity. Rock oyster growth rates, however, can be extremely variable.

Oyster gardeners only need to support the growth of young oysters for 6 to 12 months until their shells harden and are generally large enough to avoid being eaten on mass by predatory fish such as bream.



From Goldsborough and Meritt (2001), Maryland Sea Grant.

What are rock oyster ecosystems?

Rock oyster ecosystems are complex marine habitats formed by the amazing ecosystem engineers, rock oysters. Rock oysters of the genus, *Saccostrea*, create habitats by grouping together in large colonies.

Oyster ecosystems can vary in physical nature, from consolidated structures with high vertical profiles (oyster reefs), to low profile structures with little differentiation in relief from their surrounds (oyster beds), and substrate profiles of shell-rich muddy bottoms (oyster accumulations).

Rock oyster ecosystems – benefiting all

Rock oyster ecosystems are different from the small clusters of oysters often seen growing on pylons and jetties in many Australian estuaries today. Oyster ecosystems are generally much larger in area, have a greater diversity of other shellfish and marine life present, and provide a range of ecosystem services beyond filtering water.

Rock oyster ecosystems provide safe havens for fish, help maintain fish populations and can protect shorelines from eroding. Along with seagrasses, mangroves and saltmarshes, rock oyster ecosystems play an important role in supporting healthy populations of birds, fish, and other marine life such as crabs, tunicates, and algae. Oysters also filter huge volumes of water, improve water quality, and reduce nutrient levels and water pollution.

The Sydney rock oyster

The most well-known rock oyster is the Sydney rock oyster (*Saccostrea glomerata*), which today is most commonly seen growing in aquaculture farms or sold as seafood. In the wild however, Sydney rock oysters and their relatives were once the basis of a thriving biological communities that covered vast areas of coastal waters in both temperate and tropical regions. Sydney rock oysters were much more than seafood. They were the keystone species which help shaped the estuaries in which they lived.



Rock Oyster ecosystem, with a visiting silver bream (*Acanthopagrus australis*). Photograph © Francisco Martinez-Baena.

Where have all the rock oyster ecosystems gone?

Rock oyster ecosystems, along with flat oyster and mussel-dominated ecosystems have virtually collapsed globally. Scientists estimate that more than 85 percent of shellfish ecosystems have been lost or are severely degraded across Australia. Many causes of these collapses happened a long time ago through a combination of over-harvesting, disease, sediment loading of estuaries, pollution and human modification of estuaries.

Your role

As a valued *Oyster Gardener*, you will be directly helping restoration practitioners restore rock oyster reef ecosystems in your local estuary. To learn more about the importance of restoring shellfish reefs, please visit www.shellfishrestoration.org.au

Thank you for your generous help and support



Sydney rock oyster reef. Photograph © Francisco Martinez-Baena.

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Section 2. Getting started

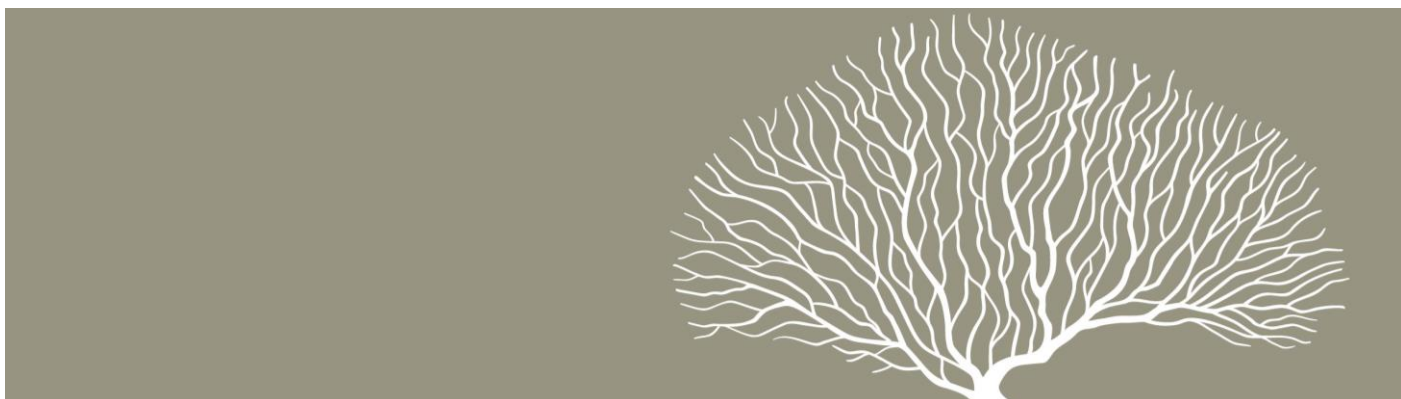
Registration

The first step to becoming a local *Oyster Gardener* is to register your interest with your local oyster gardening Project Coordinator. The Project Coordinator's contacts are provided with this guide.

The Project Coordinator will talk you through the project and arrange a visit to your premises or preferred oyster gardening site. The Project Coordinator will assess whether your site is a best match for the project's requirements. If the match is good, you will have the opportunity to formally register and enter the project as a bona fide *Oyster Gardener*. If the project is over-prescribed however, then you will be placed on a waiting list.

Once registered you will receive official sign-up documentation and an Oyster Gardening Kit.

Sign up documentation includes an official registration form and information related to your agreement. The *Oyster Gardening Kit* includes oyster baskets, ropes, record sheets and personal protective equipment.





An oyster gardener ready to deploy the garden. Photograph © Alex Western.

Obligations

Oyster Gardeners must adhere to all project obligations. These obligations include conditions placed on the project by government under a permit issued to the project to proceed. Obligations include:

1. Formally registering with your local oyster gardening project.
2. Providing your name, residential address, and the exact location of your oyster gardening site.
3. Reading, accepting and signing a project agreement.
4. Confirming that you will adhere to the project obligations and accept any reasonable direction given to you by the Project Coordinator.
5. Allowing the Project Coordinator to have a reasonable level of access to the oyster garden.
6. Notifying the Project Coordinator in a timely manner if you encounter a problem with your oyster garden or wish to withdraw from the project.

Please note that adherence to the project obligations is essential. Any breaches may risk revocation of oyster gardening permissions and possible exclusion from the project.

The oyster gardening Project Coordinator will explain all requirements and help ensure you have a successful oyster gardening experience.



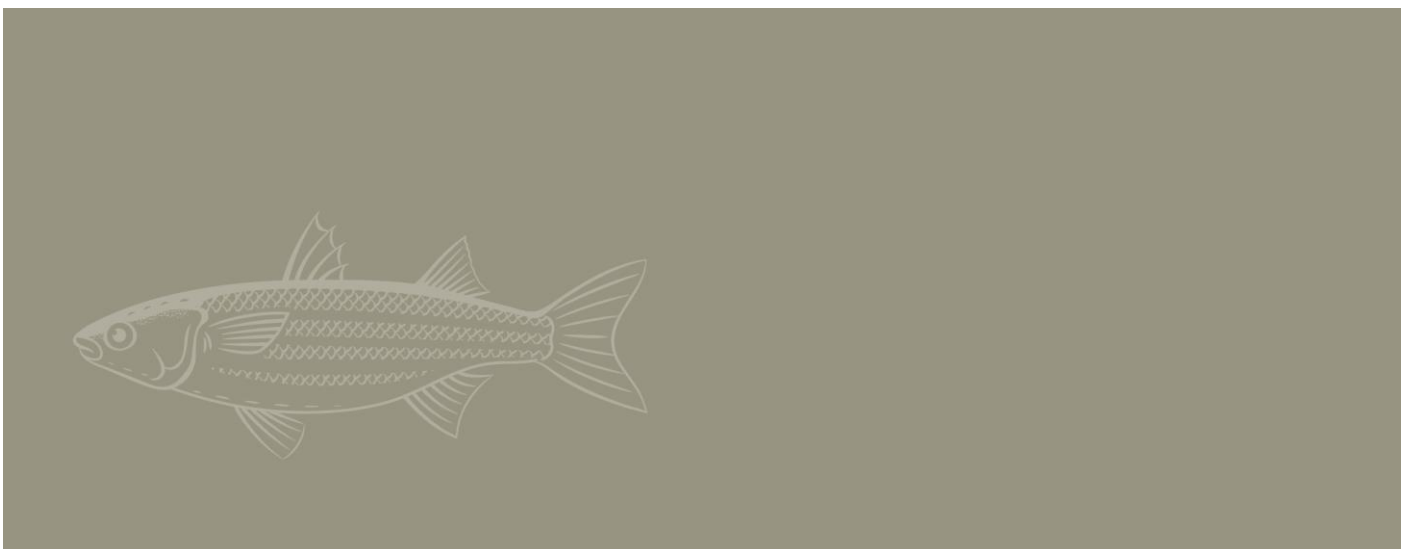
The Noosa River. Photograph © Craig Bohm

Safety

From the time an *Oyster Gardener* formally joins the project to the day the oyster garden is decommissioned, safety is paramount.

Potential hazards with oyster gardening include:

- Working with oyster shells
- Interaction with other marine life i.e., crabs, stonefish, blue-ringed octopus
- Manual handling of oyster baskets
- Slippery or uneven surfaces i.e., jetties and pontoons
- Working in sun / extreme temperatures
- Working on / near water
- Interaction with boats / vessels



Potential consequence of interaction / exposure to hazards and what to do:

Cuts and Scratches

Oyster shells are sharp, particularly once barnacles attach to them, and have the potential to cause cuts and scratches. Care is required when handling any equipment. If you are scratched or cut, apply an antiseptic wash to avoid infection. Seek medical attention if the cut is severe or the wound becomes infected. Ultimately, you are your best safety rule: IF IT DOES NOT FEEL RIGHT, STOP!

Bites, stings, and squirts

When handling an oyster garden always wear gloves. Look carefully before placing your hands on or inside an oyster garden. There may be harmful organisms present such as large crabs, juvenile stonefish, blue-ringed octopus or *Lyngbya* algae. Marine animals are native to the waterway and should be respected and left alone. They will not impact the overall success of on your oyster garden. If you have concerns, please consult with the Project Coordinator.



Oyster garden with Estuarine Stonefish (*Synanceia horrida*). Stonefish have a venomous dorsal fin spine that can inject venom when touched causing pain. Photograph © Ben Diggles.

Strains or sprains

Oyster gardens can become heavy as oysters grow and algae attaches. Care should be taken when lifting your oyster garden basket. Please seek assistance, if necessary. If you are unsure of anything, please stop and consult with the Project Coordinator.

Trips or falls

Jetties can be slippery and will become wet when oyster gardens are placed onto the jetty or pontoon surface. Oyster garden lines can also become a tripping hazard. Caution should be taken when tending your oyster garden. Please be sure someone knows that you are checking your oyster garden. Preferably have your mobile phone handy or have someone to help you, or watch you, as you check your oyster garden.

Sunburn or dehydration

SLIP, SLOP, SLAP! Please take care, when in the sun. If just hanging out with your Oyster garden, or observing marine life taking an interest in the garden, please take care by wearing a long-sleeved shirt, long trousers, a wide-brimmed hat, and use high-protection sunscreen. Drink plenty of water and take care of yourself first.

Heatstroke/hypothermia

In summer, you will need to be aware of the risk of heat-related stress, both to yourself and your oyster garden. Work in the shade, early morning, or late afternoon, avoiding the hottest times of the day.

Avoid working with your gardens during inclement weather. If you can hear thunder, or see lightening, please leave the gardening site, and tend to it at a safer time. In winter, dress up, stay dry and avoid working in icy winds or when feeling unwell.

Illness or injury

If you are unwell or injured, please ask for help to tend your oyster garden. If you have health issues, which may prevent you caring for the oyster garden over the course of the project, please notify the Project Coordinator. Your Project Coordinator can work with you to plan for others to help or have the oyster garden relocated.

Consuming your oysters

The oyster gardening program is for the purpose of growing oysters to support oyster ecosystem restoration, not for human consumption. PLEASE DO NOT EAT YOUR OYSTERS.

If oyster gardening inspires you to eat oysters, please source them from a local seafood supplier. In this way, you are supporting your local business and eating oysters that have been purified and are safe for human consumption.



Oysters found at the Noosa River Mouth. Photograph © Craig Bohm.

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Section 3. Oyster garden set-up



An oyster gardener checking their garden. Photograph © Ben Diggles.

An oyster garden is made of UV stabilised mesh, shaped into a basket with an opening top. The garden is suspended by ropes from a jetty into the local waterway. The number of oyster gardens per household may vary depending on the conditions of the jetty and interest and capacity of the *Oyster Gardener* to care for the gardens.

Each oyster garden contains juvenile oysters ('spat') which has been set onto dried oyster shells (cultch) in a shellfish hatchery.

The Project Coordinator will supply 'seeded oyster cultch' to you for your oyster garden. The Project Coordinator will be available to help stock the oyster garden and deploy it into the waterway.

The *Oyster Gardener* maintains the garden for 6 to 12 months and works with the Project Coordinator to monitor the growth and survival of the oysters in the garden.

The *Oyster Gardener* may support the project further by keeping records of oyster growth, maintenance activities, and plant and animal observations in and near the oyster garden. The Project Coordinator can provide guidance on ways of monitoring your oyster garden and what to look for.

Oyster gardening kit



Oyster garden kit. Photograph © Ben Diggles.

The Project Coordinator provides each *Oyster Gardener* with an *Oyster Gardening Kit* and will demonstrate how to use the kit.

The kit includes the following:

Oyster garden baskets (usually 2)

Basket constructed of UV stabilised plastic mesh

Basket dimensions are approximately 60cm x 30cm x 25 cm

Each basket will contain up to 10kg of seeded oyster cultch

Gloves

Gloves are an *Oyster Gardener's* most important personal protective equipment. Always wear thick gloves when working with oysters and Oyster gardens.

Zip-ties

Zip-ties are provided for re-closing or repairing the oyster bags.

Rope

Rope is used to suspend oyster garden from a jetty. The Project Coordinator will demonstrate how to suspend the oyster garden using lengths of marine rope supplied in the kit. The Project Coordinator will demonstrate how to tie and release the rope from the oyster garden and jetty/pontoon.

Tags

- All oyster gardens must have a numbered, colour coded identification tag attached.
- The tag includes important registration information and states: "NOT FOR HUMAN CONSUMPTION".
- The other side of the tag is for the name and address of the *Oyster Gardener*.
- The *Oyster Gardener* is to complete any missing details on the tag. After filling out the tag, relock it, use 2 or more zip-ties and secure the tag to the top of the basket. The Project Coordinator can assist if required.
- The tag will either be green or blue.

A green tag indicates that the oyster garden contains seeded oyster cultch. The Project Coordinator supplies seeded cultch to the *Oyster Gardener*.

Green tagged oyster gardens do not rely on the recruitment of wild oyster spat onto the cultch in the garden.



Blue and green tagged Oyster gardens. Photograph © Ben Diggles.

Blue tags indicates that the oyster garden contains oyster cultch that has NOT been seeded with oyster spat in the hatchery.

Blue tagged oyster gardens rely on the recruitment of wild oyster spat onto the cultch in the basket.

Blue-tagged oyster gardens are used to test the level and frequency of natural oyster recruitment at the garden site, and to see what variety of wildlife are attracted to the oyster cultch and oyster garden.

Rock oysters that grow in green and blue tagged baskets will be released onto the local oyster restoration sites.

Record sheets

Record sheets are used to record when the oyster gardens are inspected and to make any interesting observations about their condition or creatures you discover living on or around the oyster garden. Monitoring can include recording other marine organisms (oyster “Associates”) such as fish, crabs, and marine plants. Monitoring may also include measuring live oysters and counting juvenile oysters and noting these on your record sheet. The Project Coordinator will supply record sheets for you.

At some point in time, the Project Coordinator may help identify some of the wildlife encountered and discuss its role in the natural ecosystem.

Rock oyster “Associates” common to oyster gardens.



1. Baby oysters and mussels, 2. *Alpheus* shrimp, 3. Sea-horse, 4. *Bedeva paivae* Sea snail. Photographs © Ben Diggles.

Stocking the oyster garden

The Project Coordinator will supply each *Oyster Gardener* with a manageable quantity of live oysters set on shell cultch.

It is important to place the oyster gardens containing seeded oyster cultch in the water on their arrival at the oyster gardening site. The Project Coordinator will work with each *Oyster Gardener* to coordinate and support this activity.



Oyster garden. Photograph © Ben Diggles.

Hanging the oyster garden

Each Oyster garden should be suspended in the middle of the water column; closer to the surface (where there is more oxygen) but never exposed to the air. This also keeps the oysters out of sight (discouraging theft), exposes the oysters to maximum food availability throughout the tidal cycle, reduces the oyster's exposure to direct sunlight and dampens the effect of surface wave energy on the oyster garden.



Submerged Oyster garden. Photograph © Ben Diggles.

It is important that Oyster gardens are always submerged. In advance of receiving your oyster garden, place a mark on the pylon of the jetty to indicate the extreme low water mark (Lowest Astronomical Tide). The oyster garden should be set in the water 0.5m below that line. The bottom of the oyster garden should still be at least 0.3m above the riverbed.

The distance from the jetty/pontoon to the line will also give an indication as to how long the tie ropes for the oyster garden should be.

If possible, securely tie your oyster garden where it will be mostly in the shade as this helps reduce algal growth.

Top tip

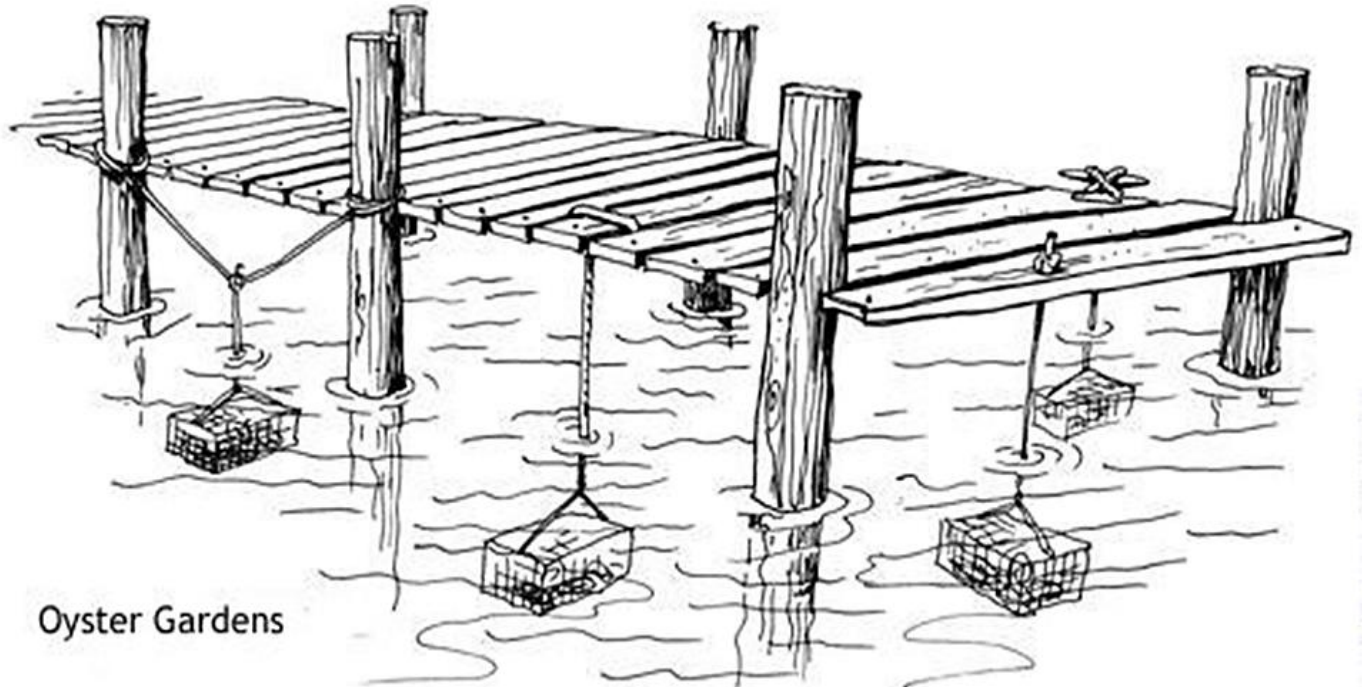
To avoid losing your oyster garden, check your lines every time you inspect your oyster garden, making sure both lines are in good condition especially after stormy weather. In places that look at risk of chafing, the rope can be pushed through a conduit of old garden hose to make a protective sleeve.



Tying the oyster garden basket to the jetty

Oyster gardens can be secured to a jetty or pontoon in different ways. The oyster garden must be attached with two ropes. This allows the oyster garden to be oriented horizontally in the water. It also gives a level of insurance in case a knot fails or a rope chafes through and breaks. The forces of waves and tides can cause oyster garden to move continuously. Lines and cables attached to the oyster garden continuously scrape against hard structures, slowly degrading ropes, and cables.

It is very important that the oyster garden does not hit against jetty pylons, as continuous battering can cause oysters to close-up, stop feeding, and allow predatory sea snails such as oyster drills to easily access your garden.



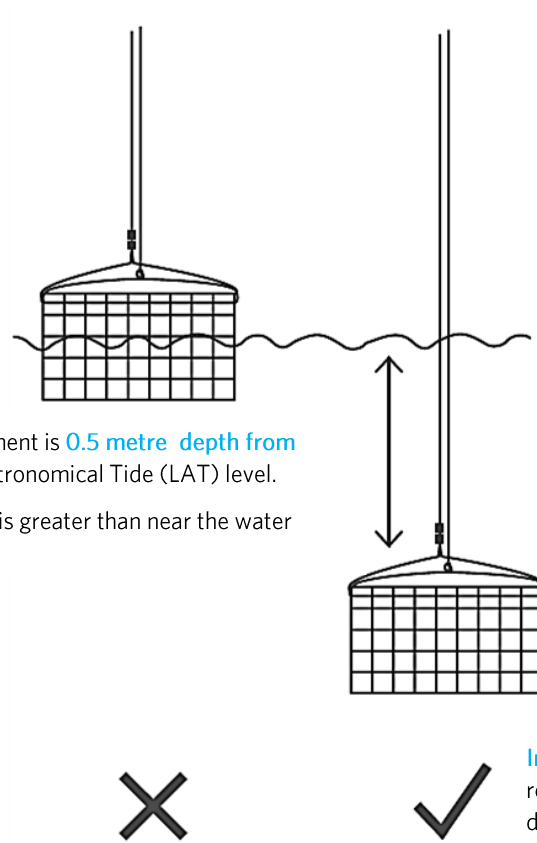
Examples of how best to secure and hang Oyster gardens from a jetty, pylon, or pontoon.



Deploying an Oyster garden. Note the protective black sleeves around the ropes. Photograph © Alex Western.

Ideal water depth for Oyster gardens

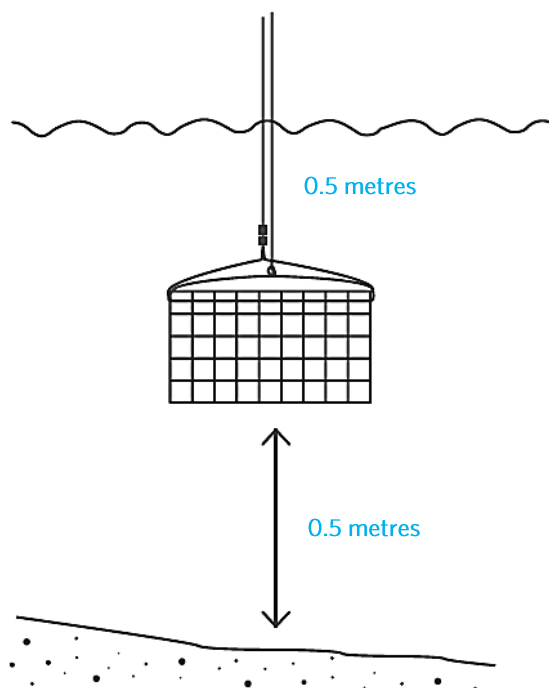
Oyster gardens should be attached with two ropes. This allows the basket to be oriented horizontally in the water. It also gives a level of insurance in case a knot fails or a rope chafes through and breaks.



Oyster garden placement is **0.5 metre depth from surface** of Lowest Astronomical Tide (LAT) level.

At this depth oxygen is greater than near the water surface.

Important - Keep Oyster gardens submerged to reduce vandalism and protect the oysters from desiccation



Measure total depth of the Oyster garden site before installation.

Suspend and secure Oyster garden approximately 0.5 metres below the water surface at LAT level.

When in doubt, **review oyster basket site at LAT times**, ensuring Oyster gardens are not exposed to air or touching the substrate sediment

Securing your Oyster garden to a jetty or pontoon

Tips for securing your oyster garden	
Jetties and Pontoons	<ul style="list-style-type: none"> • On some jetties you may wish to use heavier line, • Or double up the lines in strong current areas, • Or run lines through a section of old garden hose to prevent line chafing and breakage
Environmental Conditions	<p>Experience is the best guide for determining exactly where to set up an oyster garden at your site. Every pontoon site is different, because of:</p> <ul style="list-style-type: none"> • Tides • Currents • Salinity • water depth <p>Forces of waves and tides may cause the Oyster gardens to move continuously. Lines and cables attached to the basket will continuously scrape against any hard structure they are touching. This slow steady friction can cut through lines and cables surprisingly quickly.</p>
Top tips for hanging Oyster gardens	<ul style="list-style-type: none"> • Oyster gardens are hung horizontally to give the oysters maximum room to grow. • Oysters that sit too close to bottom sediment may become stressed or infected by mud worms (spionid polychaetes). • The objective is to keep Oyster garden baskets in the upper/ middle water column where the supply of planktonic food and oxygen is plentiful without excessive exposure to mud. • Oyster gardens baskets protect juvenile oysters from predators. Ensure they are closed with 2 or more zip-ties before placing underwater. • If any serious abrasion is seen, the rope should be replaced altogether. Where possible, secure an eye bolt or hook to the jetty to secure your Oyster garden baskets.



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Section 4. Oyster gardening maintenance



Oyster gardens need a good hose down monthly, especially if stop algal growth. Photographs © Ben Diggles.

Maintaining an Oyster garden is a straightforward activity, so long as regular inspections and a few basic maintenance tasks are carried out periodically.

After storms or floods, or every few days, inspect the Oyster garden to ensure the ropes remain secure and in good order. If you notice that a rope holding up the Oyster garden is chafing, fit a piece of garden hose over that section of the rope. Check the knots for security.

Look into the water to see if any debris, such as branches, seagrass, or rubbish, have become entangled in your Oyster garden. If so, remove the debris and inspect the Oyster garden for any damage. Affix repairs, if needed, and seek help from the Project Coordinator, if you are not sure what to do.

If your Oyster garden gets a tear or hole in it, this may allow unwanted oyster predators, such as small bream, to enter the garden and ravage your oysters, particularly when they are very small.

Managing sediment and pseudofaeces

Every few days give your Oyster garden baskets a shake to remove sediments that have settled on the oyster shells and which may have accumulated in the bottom of the baskets. Some of those sediments include faeces and pseudofaeces produced by the oysters themselves.

Once or twice, a month, lift the Oyster garden from the water and clean them with a stream of fresh or saltwater. A spray of freshwater will not hurt your oysters.

Some gardening sites will be more prone to sediment problems than others. You will work out the sediment load around your Oyster garden quickly. This should give a good indication of how often your Oyster gardens will need inspecting and cleaning. Check the bottom of the Oyster garden baskets for sediment. This will give further pointers. Remember if you see faeces and pseudofaeces, this is a good thing as it indicates that the oysters are feeding, growing, and actively filtering the water.

Managing predators (such as flatworms)

Once a month, when oysters are large you can place your Oyster gardens on land in the shade to dry out for 3 to 4 hours. This will not harm your oysters but will help kill off unwanted creatures, such as flatworms, that may be predating on your oysters. This desiccation process may help to kill off some unwanted algal growth as well. However, in the early stages of growth when oysters are small this process can desiccate small oysters and lead to death. Seek advice from your Project Coordinator before proceeding.

Controlling algae

Today, most urban estuaries have an over-abundance of dissolved nutrients, encouraging rapid algal growth (and sometimes harmful algal blooms), particularly where there is an abundance of sunlight. When we look around the estuary, we can often see rocks, sticks, pylons, and the hulls of boats covered in algal growth.

Oyster gardens are also vulnerable to being smothered by algae. An abundance of algae in an Oyster garden can smother young oysters or prevent them from feeding effectively. It is therefore important to monitor and manage algal growth in your Oyster garden. In some places the threat may be greater than in others.

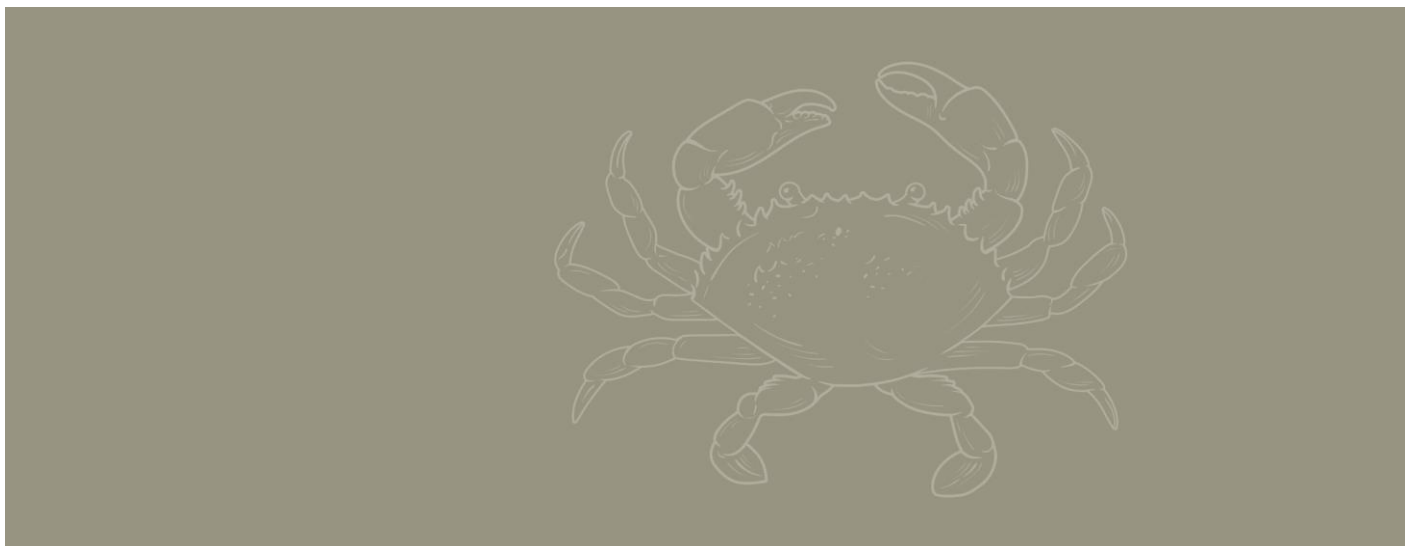
Steps you can take to protect your Oyster garden from algae include:

Providing shade - Shade your Oyster garden by keeping on the south side of the jetty or even under it.

Inspect and clean regularly - Maintain a regular cleaning schedule. Carry out weekly inspections.

Remove fouling organisms from the garden, but not oyster shells - You don't have to scrub fouling organisms off the oysters themselves unless algal growth is so heavy that it could impede the oysters from opening to feed. Just clean organisms from the basket surface to allow for maximum water flow around your oysters. If you are concerned, contact the Project Coordinator for advice.

Actively treat heavily fouled baskets - Heavy overgrowth by algae or other fouling organisms may require more direct action in the form of scrubbing your Oyster garden basket with a hard-bristle brush or high-pressure water blaster (using a low-pressure setting).





Heavily fouled oyster basket due to poor maintenance. Photograph © Ben Diggles.

Remember:

Every oyster gardening site is different. Experience will be your best guide in determining how often to clean Oyster gardens and with best techniques. When in doubt, speak with the Project Coordinator.

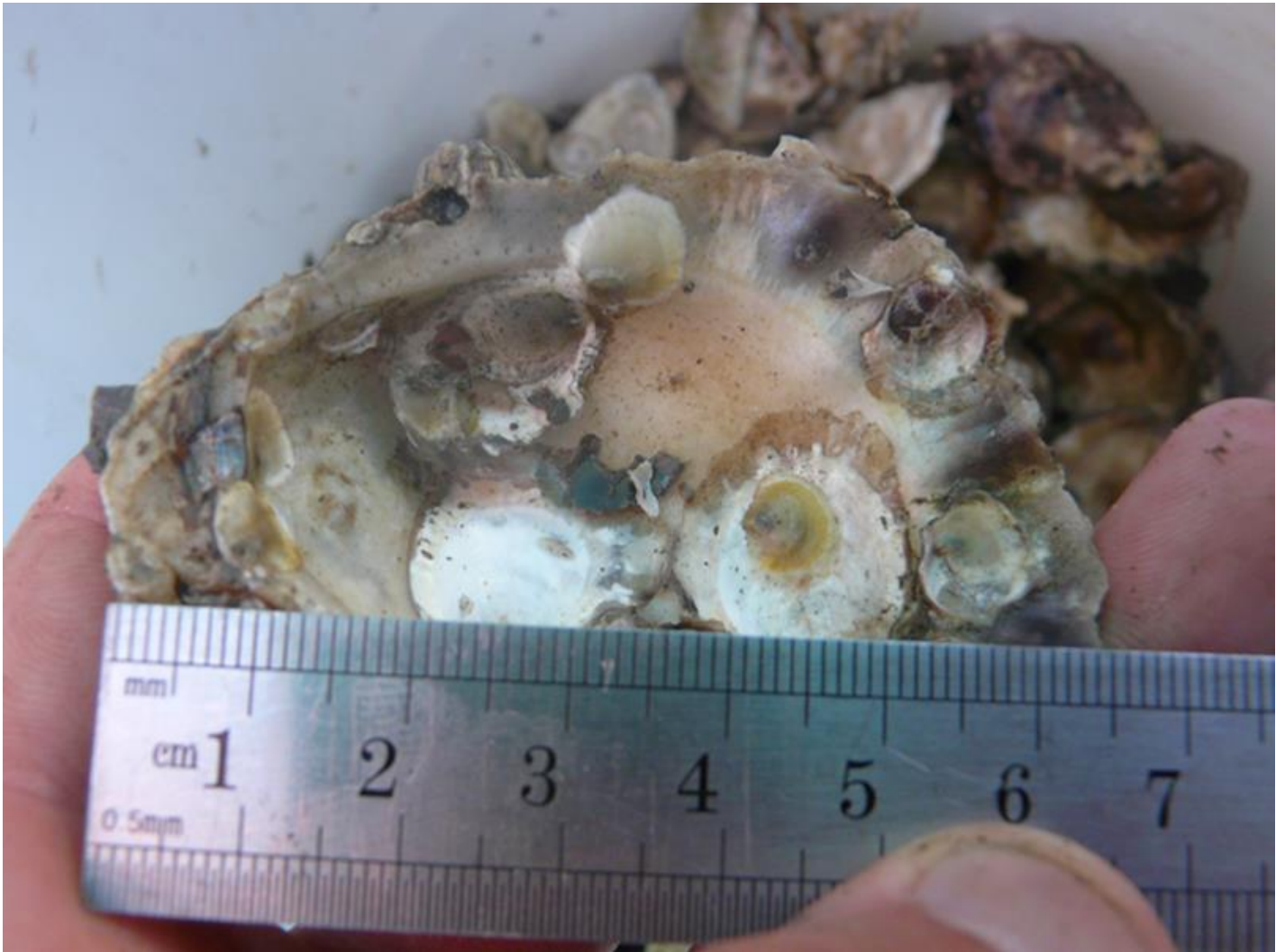
Maintenance checklist

1. Inspect Oyster gardens regularly particularly after storms, check ropes and knots and remove debris.
2. Affix any repairs needed, seeking help or equipment from the Project Coordinator, if required.
3. Remove sediment from the oyster garden baskets once or twice a month by hosing them clean.
4. Keep the oyster gardens clean and clear from fouling organisms such as algae.
5. If algal growth is a major problem, use a hard-bristled brush or high-pressure hose to remove the worst of the algae.



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Section 5. Monitoring - measuring success



Sydney rock oyster spat (*Saccostrea glomerata*) growing on shell. Photograph © Ben Diggles.

Each *Oyster Gardener* can expect at least one visit from the Project Coordinator, who will work with you to measure the growth of the oysters in your care.

Successful oyster gardening is critical to the success of local oyster ecosystem restoration. Oyster gardens provide the first generation of oysters to help 'kick start' the oyster recolonisation process on the restoration sites, and act as a back stop to low, and often highly variable natural oyster recruitment.

We encourage all *Oyster Gardeners* to report interesting or unusual things or concerns, about you're their oyster garden to the Project Coordinator and seek help whenever needed.

Equipment

- Gloves
- Callipers
- Monitoring Data sheet and pen
- Your phone or camera (to take photos)
- Thermometer
- Bucket with rope lanyard
- Species ID sheets

What to expect

Your oysters should continuously grow larger, but the rate of growth may vary widely. Some oysters in your care may die. While this is not ideal, it could be due to many and varied reasons. The better the maintenance regime and record keeping, the better chance the project team would have of predicting possibly reasons for oyster deaths.

The rate at which your oysters grow, and how many survive, will depend on many factors: Season (more growth over summer), availability of food, competition from other species, abundance of smothering algae, number of predatory animals such as flatworms, water temperature, water oxygen levels and sediment load. Your site may be ideal for growing oysters. With good record keeping, we can find out just how ideal.

The growth and survival of oysters can naturally vary substantially between sites separated by small distances (hundreds of metres). The community of species that settle and grow on the oyster garden can also vary. These may vary by location, the time of year that they appear, or between years. In addition to providing larger oysters to the oyster restoration site, the project team would like your help in understanding how different areas in the gardening program perform. The monitoring data will help us understand this variation.



Thriving oyster spat settled on an oyster shell. Photograph © L. Calvo/Rutgers.

Monitoring and recording observations

Observations and measurements from the routine monitoring are recorded on the data sheet provided by the Project Coordinator. Monitoring is completely optional.

If you wish to be part of monitoring, we ask that you try and submit one data sheet per month. If it appears that many oysters have died or if you are concerned about a situation that is unexpected, please contact the Project Coordinator to discuss and decide if further investigation is warranted.

Associates and Predators

There will be various small marine organisms moving around your oysters, such as worms, amphipods, crabs, shrimp, small fish and maybe even a Blue-ringed octopus. These species will begin to emerge and appear as you retrieve your oyster garden from the water. **Be careful and always wear your gloves as not all things may be visible immediately.**



Oyster cultch provides habitat for juvenile oysters and a myriad of other species including barnacles, encrusting algae, sea squirts, crustacea and colonial tunicates. Photograph © Ben Diggles.

It is important to observe the fauna associated within your oyster garden when raising it to the water surface. It is vital that the oyster garden is not out of water for long periods of time. The younger the oysters, the less tolerant to dehydration or heat stress they are. Keeping your oyster garden for anything less than 30 minutes is generally OK, but please treat this timeframe only as a guide. As your oysters mature, they will become more tolerant.

Begin by identifying and recording the abundance of species that you see. You can use the Species Identification Sheets provided by the Project Coordinator to help with identifying common groups of organisms. There may be lots of small invertebrates (e.g., amphipods, glass shrimp, gastropods, small crabs, etc.).

If so, estimate the number in categories.

- o 10 to 20
- o 20 to 50
- o 50 to 100
- o 100 to 500
- o Over 500

When an organism is unknown, take a photo and contact your Project Coordinator.

The fouling community and other associates and predators will be recorded separately on your data sheet but practically, observations of the outside of the oyster garden are made before opening the oyster garden and observing the species within.

Recording associates and predators

- Identify any of the main Rock oyster associates and predators before disturbing the Oyster garden.
- Record all organisms observed in the 'associates and predators' section of your monitoring data sheet.

Fouling Community

Estuaries are productive ecosystems, and an abundance of marine organisms will colonise your oyster garden like those living near and on jetties or pontoons. During the summer months, when water temperatures are warmest, you will notice maximum fouling. It is important to keep this fouling growth to a minimum to allow water to flow through the oyster garden so the oysters can feed.

Algae is the most persistent fouling organism which make handling your oyster garden dirty and difficult. Algae also impedes the ability of oyster spat (juvenile wild oysters in the plankton) to settle and grow on your oyster shells, while the build-up of algae can also restrict the flow of water food and oxygen around the growing oysters.

Recording fouling community

- o Determine the groups of organisms growing within the oyster garden.
- o Estimate the extent of cover on the oyster garden (as percent cover).
- o Record each in the space on your data sheet.
- o Observe in the oyster garden.

Oyster garden associates



Left, reef associated species the False scorpionfish (*Centrogenys vaigiensis*), harmless (non-venomous spines) even though they look like stonefish. Right. Pleated sea squirt (*Styela plicata*), invasive, not native to Australia, poor filter feeders compared to oysters, and will block water flow into the oyster garden.



ROCK OYSTER GARDENING GUIDE

Section 6. Oyster garden associates

What else may live in your oyster garden



Rock pool shrimp (*Palaemon serenus*), dead oysters provide refuge for crustaceans and other invertebrates. Photograph © Lisa Bostrom

Looking closely can reveal many things!

Over time you should begin to see other marine invertebrates in your oyster garden. These may include other shellfish species, such as leaf oysters and hairy mussels (bivalves), crabs and shrimp (crustaceans), marine snails (gastropod molluscs), sea squirts (tunicates), moss animals (bryozoans), and worms (annelids). These species are also part of wild oyster ecosystems, so it is great to see them thriving in local oyster gardens as well.

While some organisms, such as gastropod snails, may be predators of oysters, most invertebrate are not a threat to oyster survival and are therefore not a problem if encountered in your oyster garden.

Some species of shellfish, such as flat oysters and hairy mussels, are useful reef formers themselves, so it is great to encounter them in the Oyster gardens. Barnacles may also be plentiful and are unlikely to cause any problems unless they are extremely abundant. Barnacles feed on a different component of plankton, so do not compete with the oysters for food, and they do not predate on oysters, but do settle on them readily.

Small fish such as gobies, juvenile parrotfish, and wrasses may also make your oyster garden home. Dead oyster shells are a favoured spawning substrate for some species of fish, which will deposit their eggs inside the oyster shells.



Following is a brief list and description of potential shellfish garden fouling organisms, associates, and predators that you are likely to find within and near your oyster garden. If you encounter a species that is not listed, and you are confident of the ID, then please add it. If you are not confident of what it is, please take a few photos and submit it with your data sheet to the Project Coordinator. Most species listed below are abundant in both coastal waters and the more marine parts of estuaries in south-eastern Australia.

Please note that some of these species can be harmful to oysters, either because they are predators or have other ways of directly impacting oyster survival. The following table provides a simple colour-coding system.




Harmful to oyster colour-coding system

HARMFUL TO HUMANS?	No
HARMFUL TO OYSTERS?	No
HARMFUL TO OYSTERS?	Potentially, though are unlikely to cause major impact
HARMFUL TO OYSTERS?	Voracious predator




Oyster garden associates

COMMON NAME	Gastropod snail
GROUP	Molluscs
DESCRIPTION	<p>Role: Grazers.</p> <p>Gastropods are common in oyster gardens; they graze harmlessly on algal films.</p> <p>Highly diverse group of animals contains those with a single shell that houses a slug-like body, e.g., sea snails, periwinkles, whelks, abalone, limpets. The shell is coiled or spiralled, except in cases like the limpets which have a coiled shell as juveniles but develop a conical shell as adults. Unlike mussels or oysters which have two joined shells ('bivalves'), marine snails have only one shell ('univalves').</p>
	
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No. However, the venomous Cone shell is dangerous.
COMMON NAME	Swimming crab
GROUP	Crustacean
DESCRIPTION	<p>Role: Micro-predator</p> <p>Will use oyster shells as shelter. Small swimming crabs like Thalamita and Charybdis use oyster shells as shelter as they scavenge their omnivorous diet.</p>
	
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No




Oyster garden associates

COMMON NAME	Grapsid crab
GROUP	Crustaceans
DESCRIPTION	<p>Role: Micro-predator</p> <p>Grapsid crabs also live and hide around oyster shells set in shallower water.</p>
 <p>Photograph © Ben Diggles.</p>	
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No
COMMON NAME	Palaemonid shrimp
GROUP	Crustaceans
DESCRIPTION	<p>Role: Grazers</p> <p>Family: <i>Palaemonidae</i></p> <p><i>Palaemon</i> sp. are commonly found sheltering in-between oyster shells.</p> <p>There are many different species of shrimp that shelter and graze in-between oyster shells.</p>
 <p>Photograph © Ben Diggles.</p>	
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No
COMMON NAME	Gobies
GROUP	Fishes
DESCRIPTION	<p>Role: Residents</p> <p>Gobies will quickly take up residence in oyster shells (in a leaf oyster in this case). Gobies will lay their eggs inside dead oyster shells.</p>
 <p>Photograph © Ben Diggles</p>	
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No

Oyster garden associates

COMMON NAME	Parrotfish
GROUP	Fishes
DESCRIPTION	<p>Role: Grazers</p> <p>You may see juvenile parrotfish swimming in and around your garden grazing on algae.</p>
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No
COMMON NAME	Hairy mussel
GROUP	Mollusca
DESCRIPTION	<p>Role: Water filterer</p> <p>Name: Bivalvia</p> <p>The Hairy mussel (<i>Trichomya hirsuta</i>) will use Rock oyster shells as a habitat.</p>
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No
COMMON NAME	Leaf Oysters
GROUP	Mollusca
DESCRIPTION	<p>Role: Water filterer</p> <p>Name: Bivalvia</p> <p>Leaf oysters (<i>Isognomon ephippium</i>) will use Rock oyster shells as habitat.</p>
	Photograph © Ian McLeod.
HARMFUL TO OYSTERS?	No
HARMFUL TO HUMANS?	No

Oyster garden associates

COMMON NAME	Ascidians
GROUP	Sea squirts
DESCRIPTION	<p>Role: Smotherers</p> <p>Warning!</p> <p>Colonial tunicates like <i>Botrylloides</i> are water filterers. However, Rock oysters can become smothered if Ascidian growth gets too thick.</p> <p>Adult sea squirts are often attached to substrates such as reefs, rocks, or shells. The bodies of these animals are surrounded by a tube-like 'tunic' (from which these animals derive their broader name, 'tunicates'), which can range from thin and delicate to thick and tough and vary widely in colour.</p>
	
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	Yes. Smothers oysters
HARMFUL TO HUMANS?	No
COMMON NAME	Flatworm
GROUP	Flatworm
DESCRIPTION	<p>Role: Oyster predator</p> <p>Warning!</p> <p>Flatworms can kill your Rock oysters within weeks if left unmonitored. Regularly observe your oyster garden and dry them out regularly.</p>
	
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	Yes
HARMFUL TO HUMANS?	No
COMMON NAME	Mud crab
GROUP	Crustaceans
DESCRIPTION	<p>Role: Oyster predator</p> <p>Mud crabs > 5 cm carapace width can crush and eat whole oysters. Remove from your oyster garden ASAP!</p>
	
	Photograph © Ben Diggles.
HARMFUL TO OYSTERS?	Yes
HARMFUL TO HUMANS?	No

ROCK OYSTER GARDENING GUIDE

Section 7. Releasing oysters



Sydney Rock Oysters (juveniles) (*Saccostrea glomerata*). Photograph © Ben Diggles.

After 6 to 12 months, your oysters will be ready for release onto the local oyster ecosystem restoration site. At the restoration site, the TNC Project Coordinator, or professional contractors, will release the oysters and cultch for you.

The oysters and cultch will then settle into the reef foundations, continue to grow, mature, and eventually form part of the fabric of the oyster ecosystem.

Over time, the restoration team will carefully monitor the growth and survivability of the oysters at the restoration site and report the results back to you and the wider community.

Once the Project Coordinator has removed your oyster garden, your formal obligations to the project conclude. If there is an opportunity to continue in the Oyster Gardening Project, the Project Coordinator will let you know and would welcome your participation.

A quick check in

- Abide by the project obligations.
- Communicate regularly with the Project Coordinator.
- Never eat any of your oysters and ask others not to take from an oyster garden.
- Always wear gloves when handling oysters and Oyster gardens.
- Monitor and clean your oyster gardens every 7 to 10 days.
- Be ready to give your oysters back for reef restoration.
- Keep the Project Coordinator informed of interesting things, challenges, or curious observations.
- Share stories of your experience with your family and friends.
- Have fun!



A small blenny seeks shelter in a developing Rock oyster ecosystem. Photograph ©Ben Diggles.

THANK YOU

Acknowledgements

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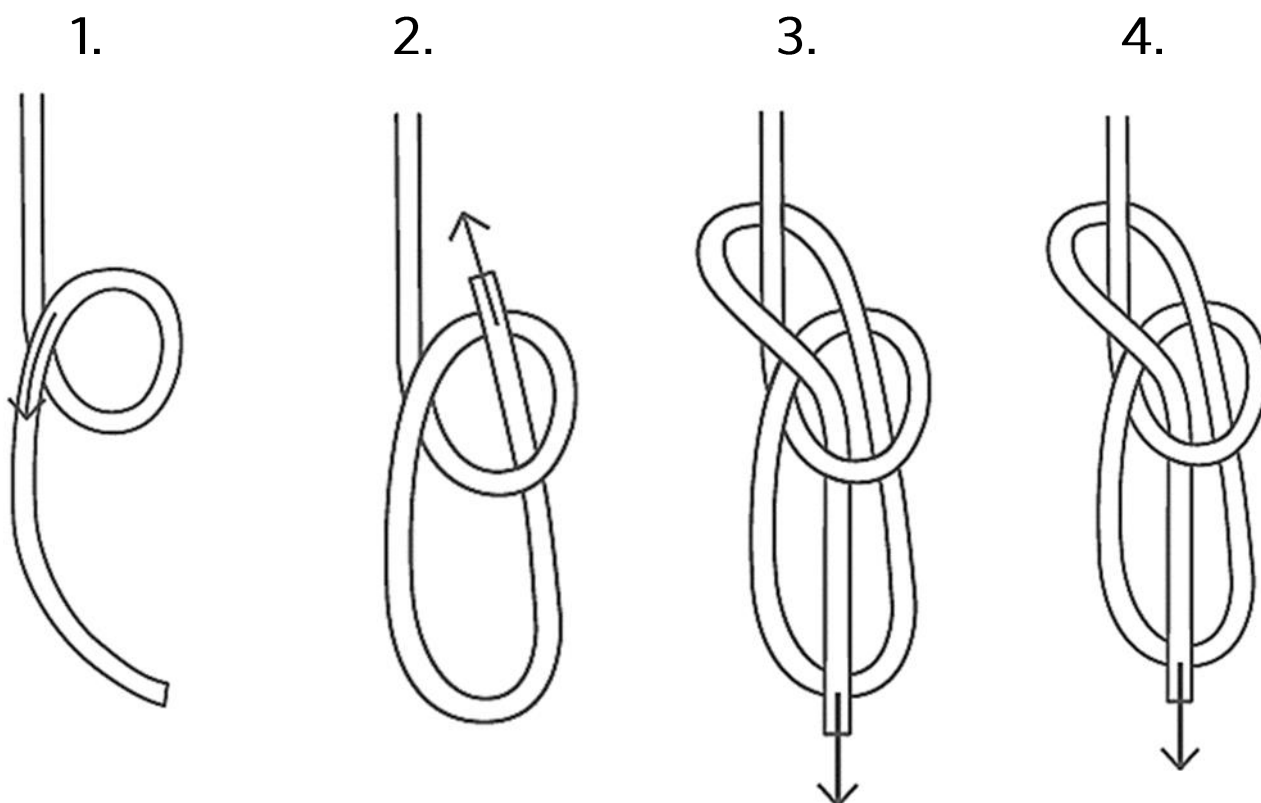
INFORMATION SHEET - 1

Rope knots for securing oyster gardens

The Bowline knot - securing oyster baskets to jetties

Tying secure rope knots for oyster garden baskets

The 'bowline' knot is a secure knot used to secure baskets to a jetty, pontoon, or pylon. When tied correctly this knot will never slip and holds extremely well under tension. Use the bowline knot to attach the line to the cage, and the cage to the dock.



1. Make a rabbit hole

2. The rabbit comes out of the hole

3. The rabbit runs around the tree

4. The rabbit runs back down its hole

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INFORMATION SHEET - 2

Rock oyster life cycle

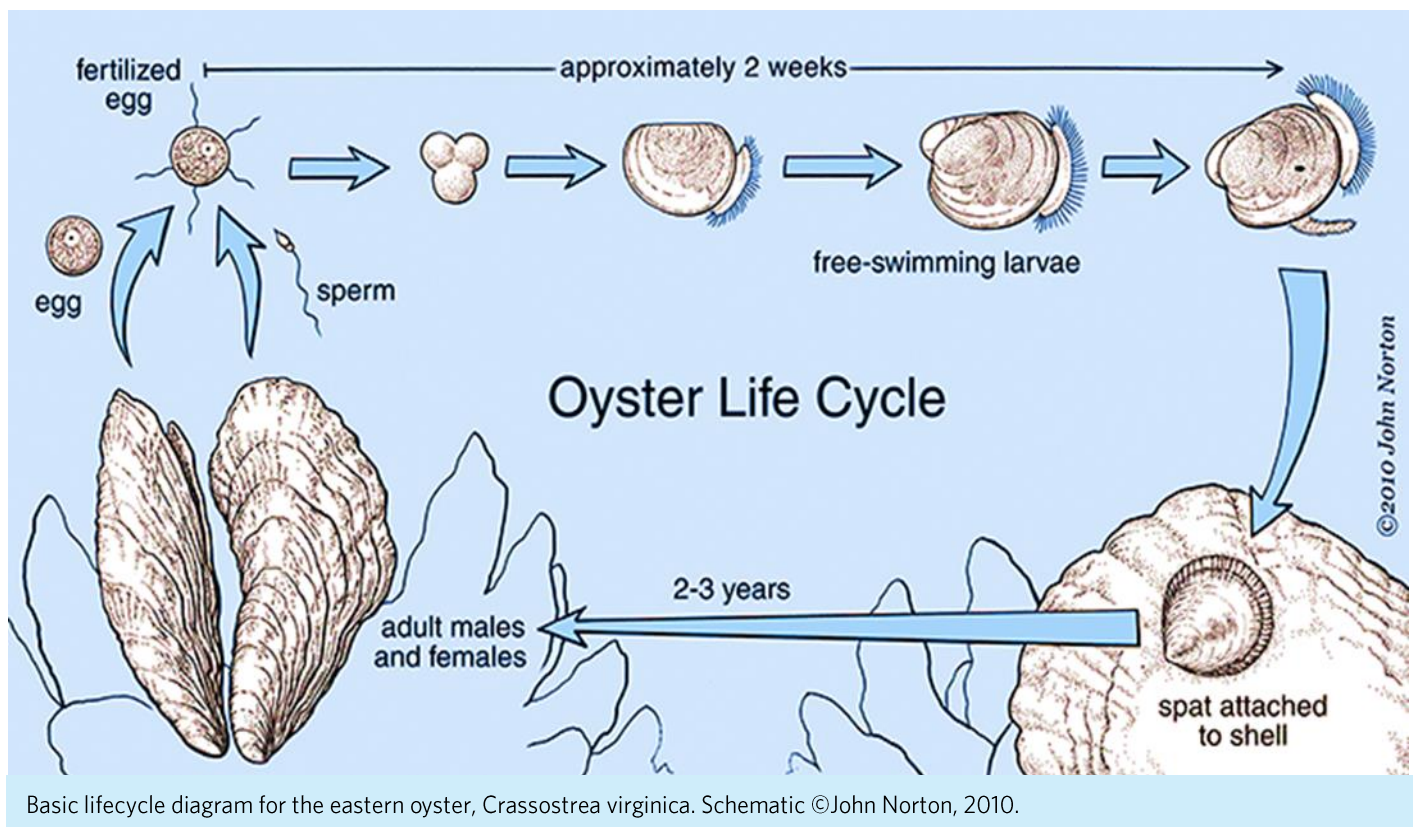
Oyster lifecycle

Spawning occurs when male oysters release sperm and female oysters release eggs into the water. This allows for fertilisation, and then larvae can form. Larvae are the free-swimming organisms created by spawning. The larvae will float and feed before becoming baby oysters called spat.

Spat (baby oysters) results when free-swimming planktonic larvae undergo metamorphosis then settle onto a hard substrate such as rock or other oyster shells. Once attached the spat grow to adult an oyster.

Cultch is any kind of hard material or substrate that oyster larvae can use for settlement. Oyster shells are mostly used as cultch, however spat can attach to any hard surface, such as rocks, mangrove roots, and concrete pylons.

Spat-on-shell happens as the spat settles and attaches to other shells. Once attached the spat on shell is called 'seeded oyster clutch' and can be used in shellfish reef bed restoration.



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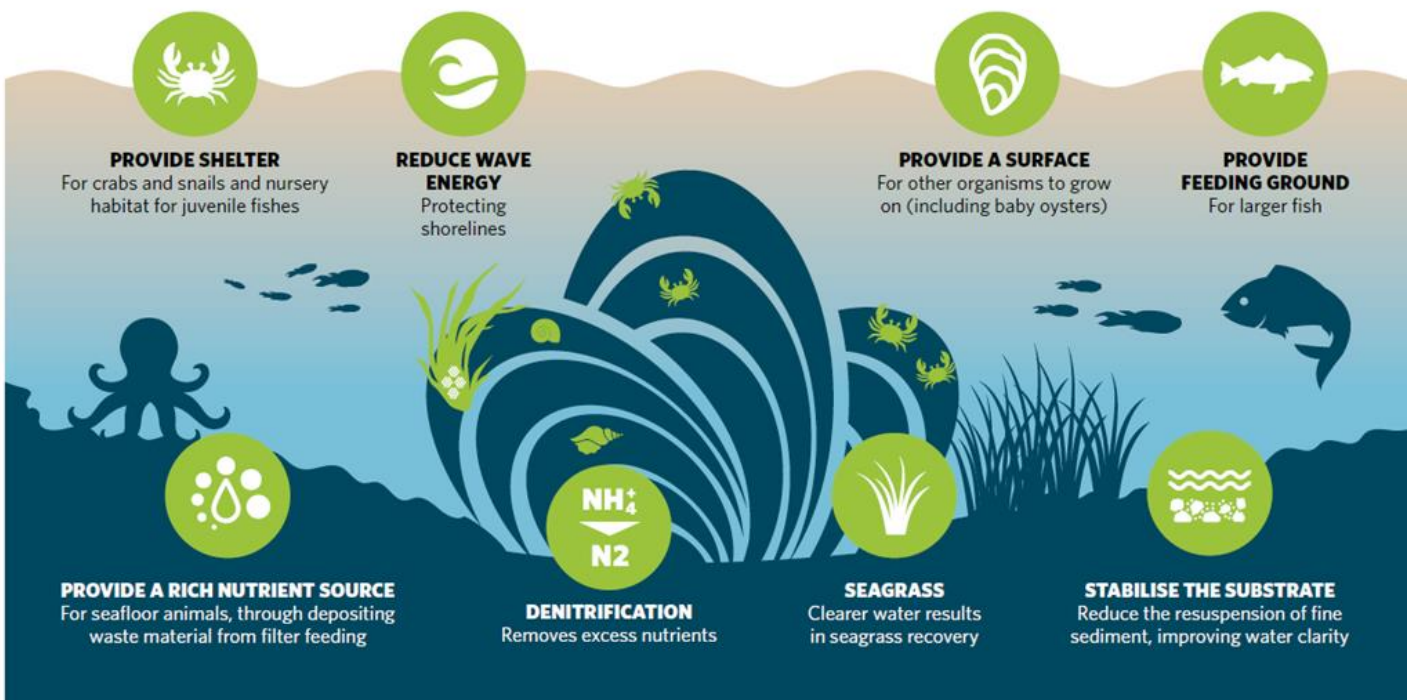
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Australia



INFORMATION SHEET - 3

Shellfish reef ecosystem services

Shellfish (specifically bivalve molluscs such as oysters and mussels) were once important habitat builders along Australia's southern coast, forming extensive beds and reef habitats and providing a range of ecosystem services.



Shellfish, much like corals, are known as 'Ecosystem Engineers' because they create an entire ecosystem that depends on the structure that they provide.

Shellfish habitats are not just important because of the shellfish that create them. Oyster reefs become homes for large numbers of other plants and animals. They also provide important benefits, or ecosystem services, to human communities. These benefits include filtering water, removing some of the nutrients that cause low dissolved oxygen events and fish kills, stabilising the sediment and producing large numbers of fish that rely on these habitats.

Some further information on these benefits can be found at:

www.natureaustralia.org.au/what-we-do/ourpriorities/oceans/ocean-stories/oyster-reef-habitat/.

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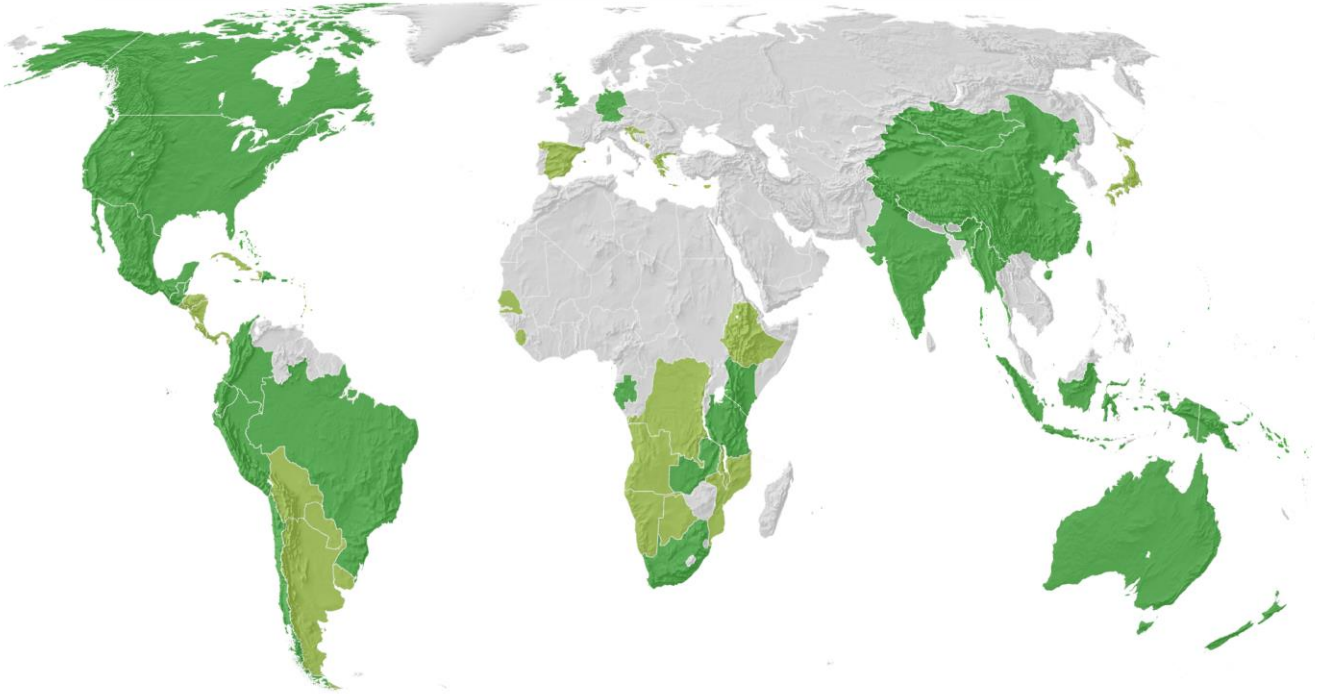
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Where we work



THE NATURE CONSERVANCY WORKS IN
75 COUNTRIES AND TERRITORIES:
37 by direct conservation impact and 38 through partners.



The Nature Conservancy has direct conservation impact in 37 countries and territories and works through partners and/or policy in an additional 38 countries and territories. TNC has offices in 35 countries and territories worldwide.

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INFORMATION SHEET - 5

Oyster gardening monitoring data sheets

INSTRUCTIONS

Record your oyster garden monitoring data and observations each month, then email to the Project Coordinator. Photograph anything you are not sure of and submit with the data sheet.

Name		
Site No/Address:		
Date:	Time:	Water temperature:
Describe any damage to the basket:		
Other noteworthy observations or concerns:		

Blue Tag - Oyster Basket number: _____

Measure live rock oysters only - shell length (mm)

Number	Shell length (mm)	Number	Shell length (mm)
1		12	
2		13	
3		14	
4		15	
5		16	
6		17	
7		18	
8		19	
9		20	
10		21	
11		22	

Associates observed		
Dead Oyster Tally Box	Name	Tally
	Fish Shrimp Crabs Gastropods Flatworms Other	

Total number of dead oysters = / 50

Green Tag - Oyster Basket number: ____-

Measure live rock oysters only - shell length (mm)

Number	Shell length (mm)	Number	Shell length (mm)
1		12	
2		13	
3		14	
4		15	
5		16	
6		17	
7		18	
8		19	
9		20	
10		21	
11		22	

Associates observed		
Dead Oyster Tally Box (only count dead Rock oysters)	Name	Tally
	Fish Shrimp Crabs Gastropods Flatworms Other	

Total number of dead oysters = / 50