Department of Primary Industries
and Regional Development

Oyster cultivation best practice guidelines

Raft construction

Best practice for the use of raft cultivation in the NSW aquaculture industry

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Raft cultivation systems

Raft systems are a popular cultivation technique that has been used in NSW since the early 1980s. This system allows farmers to cultivate a large volume of stock, where the water is deep and the lease area is restricted in size. In deep water a raft can be used to stack several oyster trays atop another and lowered in the water for an extended period of time.

All rafts must be constructed and used in accordance with the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS). This includes lease tidiness requirements and obtaining approval from the NSW Department of Primary Industries and Regional Development (DPIRD) if you wish to use rafts to mark lease boundaries.

Raft design is usually a function of the type of oyster-growing tray that will be suspended from the raft and the hydrological characteristics of the site, such as depth and prevailing current regime. Rafts have historically been constructed of timber beams (Figure 1). Recent innovations funded by the Storm and Flood Industry Recovery Program have led to the development of rafts constructed of aluminium, which offers structural advantages, especially in challenging environments such as storms and floods (Figure 1).

Figure 1. Examples of oyster rafts used on oyster leases in NSW: A marine grade aluminium raft, with custom polyethylene rota moulded floats, made from Qenos (left). A drum raft constructed of a recycled 200-litre plastic drum floatation supporting a timber frame (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Vertical stacks of trays (Figure 2) are suspended beneath the rafts by sets of sling ropes, one extending from each corner of the tray stack. The trays are often separated vertically from one another by spacers to ensure good water flow. Suspended tray stacks may consist of between three and 15 trays, depending on depths and current flow.

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Continuously submerged trays and oysters are quickly biofouled through the colonisation of other marine organisms, such as barnacles, mussels, cunjevois, and ascidians. To control biofouling, trays stacks are removed from the water and replaced to dry on top of the racks for periods ranging from four to 14 days (Figure 2). Drying time depends on the time of year, weather conditions and type of biofouling being controlled.

Figure 2. Ten-tray stacks of HDPE plastic trays (930 x 910 x 100mm) being air dried to control biofouling (left). Seven timber tray stacks being air dried to control biofouling (centre). Trays stacked on one side only of an aluminium raft (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

The most common oyster tray used in rafts is a 930 x 910 x 100mm black high-density polyethylene (HDPE) tray. This UV-stable tray is made exclusively for oyster aquaculture and has open mesh surfaces to allow water flow through the tray. Trays designed for post and rail systems may also be used; these include 1800 x 900 x 75mm and 2400 x 900mm x 75mm timber-sided trays with an HDPE mesh bottom or commercially available 1800 x 930x 50mm HDPE trays.

The typical stocking densities in clean dry weight for common tray sizes are:

- 10kg (approximately 20 litres of oysters) for a 930 x 910 x 100mm tray
- 20kg for a 1800 x 930 x 50mm tray
- 30kg for a 2400 x 900 x 75mm tray

Due to the volume and value of the crop, (grown beneath or dried atop), the raft should be stable, sufficiently durable and securely moored to cope with prevailing environmental conditions at the lease site. The raft must also serve as a safe work platform for the loading, unloading, drying and other husbandry activities for the stock.

Standard raft design and construction

Oyster rafts need to be designed to withstand structural stresses caused by a wide range of environmental conditions, including tidal and flood currents, strong winds, and waves. This design must be able to withstand these stresses, whether the stock is submerged or on top of the raft during drying.

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Aluminium designs

Aluminium oyster rafts are a modern design that may offer structural advantages. The bolting of aquaculture flotation devices into the raft's frame reduces the risk of flotation device loss during extreme weather events, such as storms and flooding. Additionally, the use of screw piers for mooring may enhance the stability and the holding capacity of the raft, which is essential for supporting stock that is both growing and air-drying amid challenging environmental conditions. The design also provides a wide flat area to ensure easy stacking. Aluminium rafts may reduce long-term costs associated with replacement and maintenance due to their corrosion-resistant properties.

Timber designs

Timber rafts must be constructed of good-quality, structural-grade hardwood. All timber cross members should also have a minimum cross-sectional dimension of 150 x 50mm and be constructed of a single continuous length of timber. Where possible, longitudinal timbers should also be a continuous length. Where longitudinal raft timbers need to be joined, they should be braced on either side by similar timber of the same dimension, bolted together with a minimum of six bolts, three on each side of the join (Figure 3).

All structural cross members and longitudinal raft timbers should be fixed using good-quality galvanised bolts or stainless steel (SS316) having a minimum diameter of 10mm. Good quality heavy-gauge galvanised or stainless-steel washers should also be used. In areas prone to flooding cross timbers should be attached to longitudinal timbers using aluminium brackets (Figure 3) to improve structural integrity, as vertical through-bolt holes may cause timbers to fail in extreme conditions.

Technical tip: *Galvanised bolts should be greased over their full length with a marine-grade grease prior to installation to assist their removal during raft maintenance or repair.*

Technical tip: *It is essential that the raft design allows for some raft flexibility while still maintaining a square configuration without compromising the overall strength of the raft. The use of a shallow (15mm deep) mortise notch in the raft cross timbers at their points of attachment to longitudinal raft timbers greatly assists in maintaining the raft in a square configuration under normal conditions.*

Important note: Nails should never be used to secure or join structural raft timbers.

Figure 3. An example of timber bracing system used to join cross timbers to longitudinal raft timbers (left). An example of an aluminium bracing bracket for areas subject to periodic flooding (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Common raft designs and dimensions

The following is a guide to the common raft designs. In practice, these basic designs will vary between farms to suit the needs and preferences of the individual farmers.

Important note: Novel raft designs that differ significantly from the designs described in this document MUST be approved by NSW DPIRD before they can be deployed on an existing oyster lease.

When designing a raft, the prevailing and potential environmental conditions for the site must be considered. The depth will limit the number of trays suspended below the raft, and the current regime and the area's vulnerability to severe weather events will determine the overall raft design and size.

While water depth is an important consideration, the size and number of the tray stacks the raft system can hold will ultimately be determined by the total weight of the biofouled trays being supported by the raft floatation during drying.

Aluminium rafts

There are currently three standard designs for aluminium rafts (Figure 4, Table 2). The ladder frame is fabricated from high-quality materials, including 101 x 51 x 8mm 6082 T5 channel, 130 x 80 I-beam, and 8mm plates, all made from 6082/6061 aluminium alloy, ensuring strength and durability.

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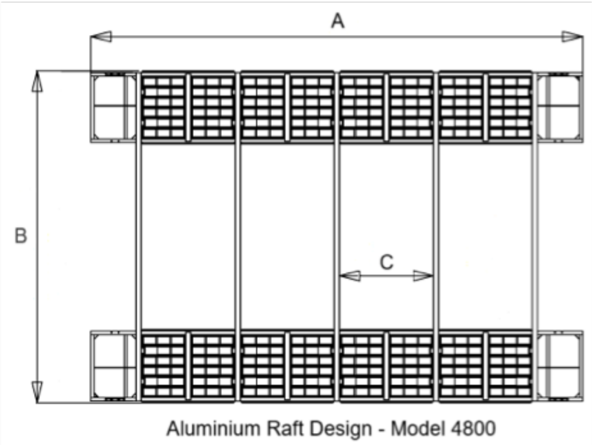
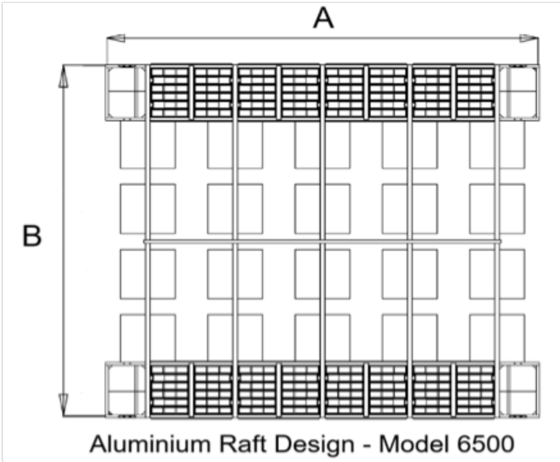
All fasteners, including Nyloc nuts, bolts, and washers, are made from 316-grade stainless steel to provide corrosion resistance.



A = 7350mm **B** = 4850mm **C** = 1400mm



A = 7350mm **B** = 6350mm

Figure 4. An example of the standard design for aluminium rafts. Aluminium raft model 4800, which can support 10 oyster modules and 100 oyster trays (left and refer to Table 2). Aluminium raft model 6500, which can support 20 oyster modules and 200 oyster trays (right and refer to Table 2.) Multiple versions of the same model can be linked together to create extended rafts. The width of the floats is 970mm. Image source Armstrong Oysters.

Timber rafts

In areas with low current flow, a four-bay raft design featuring larger spacing between tray stacks may be more appropriate than a five-bay design (Figure 5). This four-bay setup helps prevent overstocking of the raft and allows for individual tray stack handling, as each tray stack has a single attachment point (Figure 6). This enables lifting a single stack without disturbing adjacent ones.

In contrast, in areas with strong water flow, a five-bay or six-bay design (Figure 5), offering various tray module configurations, may be more suitable. Five- and six-bay designs can potentially enable a higher raft stocking density to be achieved.

When designing a timber raft, considerable savings can be made by restricting the raft timbers to standard commercially available timber lengths and dimensions. In most cases hardwood timber is readily available in lengths of up to 6m (usually supplied in multiples of 0.3m). While lengths longer than 6m can be obtained, they are usually considerably more expensive.

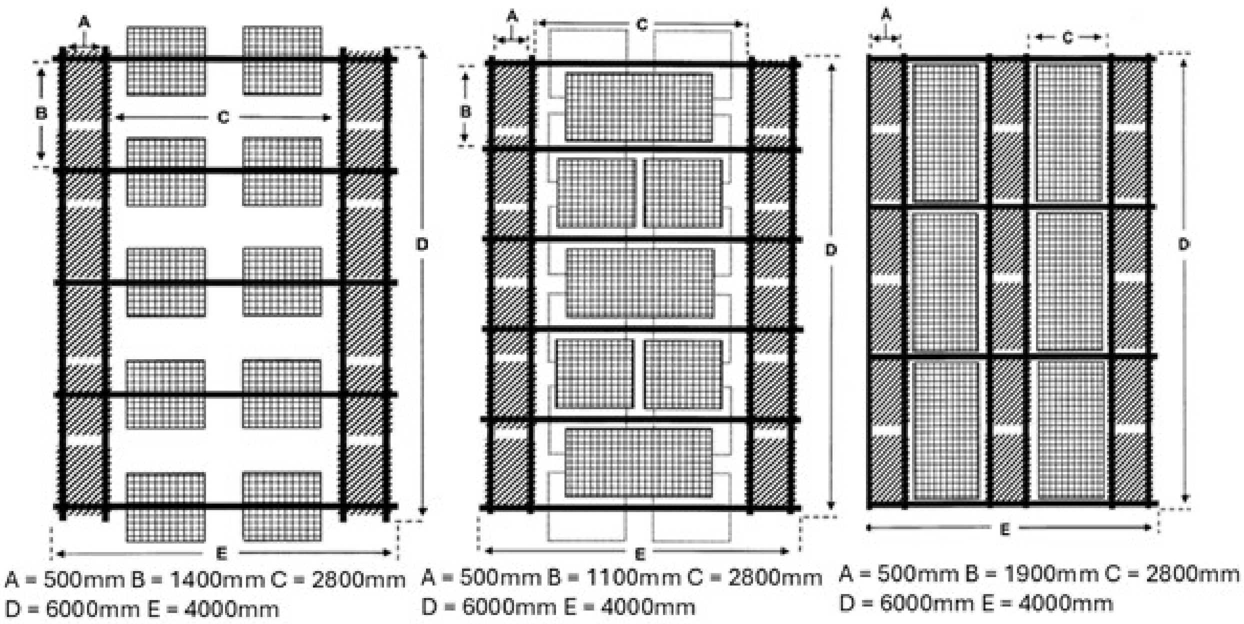


Figure 5. Examples of standard timber raft designs. A four-bay design suitable for low currents (left), a five-bay design suitable for good current flow conditions (centre) and a six-bay raft design suitable for good current flow conditions (right).

Technical tip: *In areas of significant tidal flow the prevailing current may cause tray stacks to slew in the direction of the prevailing current making it difficult, if not impossible, to vertically lift the tray stacks out of the bays without snagging the cross timbers. In such conditions suspending the tray stacks from a single cross timber (Figure 7) using a non-spin hook or increasing the bay width may provide a solution.*

Attaching tray stacks to a raft using tray hooks

When deciding on an attachment method, you need to consider the weight and shape of the tray stack, the configuration of lifting gear and whether you wish to have the ability to lift individual tray stacks without the requirement to move other tray stacks. To reduce mechanical stress it is important to ensure that the tray stack loading is balanced and evenly spaced.

Tray stacks are supported by four diagonally opposed sling ropes, usually one at each corner of the tray stack. The individual ropes pass though the tray stacks and are either attached to the bottom tray or to a cross-timber support beneath the trays. There are a number of options for the attachment of tray stacks to a raft.

Tray stacks are attached to a raft cross-timber or aluminium member using SS316 stainless steel hooks that are considered optimal for aluminium rafts or a galvanised steel tray hook for timber rafts (Figure 6 and Figure 7). This design means that each module can be lifted and placed by the hooks and can be quickly deployed and retrieved using common lifting devices installed in oyster

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punts. A properly designed and well-fitted tray hook will also securely lock the tray stack in place on the raft cross member.

Unless a non-spin tray hook (Figure 6) is used, tray stacks should be attached to the raft cross member by at least two sling hooks (Figure 7). Non-spin tray hooks (Figure 7) separate pairs of sling ropes on an individual tray stack and thus prevent the stack spinning and also provide a single pick-up point when used with 910 x 930mm plastic tray stacks. Non-spin tray hooks can also be used in pairs to stabilise tray stacks in areas of high current flow. Tray hooks can be made on farm with the aid of a bending jig using 12mm galvanised steel rod or reo-bar.

Figure 6. 3D isometric diagram of SS316 hooks (left). SS316 hooks being used to suspend oyster modules on an aluminium raft (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Technical tip: *A single point of attachment to raft cross timbers for the four tray stack sling ropes should be avoided. A single point of attachment for the four sling ropes can lead to tray stacks slowly spinning in tidal or flood currents, often resulting in sling rope failure and trays being spilled from the raft.*

Figure 7. Examples of tray hooks used to suspend tray stacks beneath timber rafts. A standard sling hook used with trays for single or double sling rope attachments and an anti-spin tray hook for double or quadruple sling rope attachments (left). An anti-spin hook that is suitable for a single point of attachment for two pairs of sling ropes used to attach 910 x 930mm tray stacks to a timber raft (centre). Two anti-spin hooks used to attach 910 x 930mm trays to two cross members of a timber raft in a high current flow area (right). Image source NSW DPIRD Aquaculture Management.

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Raft stocking density

Raft design will impact stocking capacity. Overstocking, apart from causing poor and variable oyster growth and condition, may also stress the oysters, rendering them more susceptible to diseases and increasing mortality when drying. Overstocking may also lead to an increased variation in oyster growth rate within individual trays, and needing for more frequent grading.

Due to the variation in the availability of suspended planktonic oyster food, the optimal carrying capacity will also fluctuate. It is important to determine a stocking regime for each raft that will return optimal seasonal oyster growth and condition. It is good practice to start at a low stocking density and gradually increase the stocking density over time until an optimal stocking regime for the rafts is determined. The farmer will need to fine-tune the biomass or volume of oysters per tray as well as the inter-tray and tray stack spacing, to suit the specific raft areas' growing conditions

Floatation

It is essential that a raft has sufficient floatation to securely support the total weight of the tray stacks when they are being air dried on the raft to manage biofouling. Floatation can be in various forms which include recycled food-grade 200-litre plastic “Mauser” type drums (Figure 1), end-capped large diameter PVC pipe or end-capped ribbed polyethylene pipe, or the newer custom rota moulds which are used to support the larger aluminium rafts (Figure 9).

Sufficient floatation should ensure that the raft does not exceed a half-submerged condition when a full load of trays is being air dried on the raft. This will provide an available flotation safety margin to deal with unplanned events, such as the loss or puncture of a flotation device, moderate accumulation of biofouling, or an accumulation of river-borne debris against the raft. Table 1 provides a guide to assist in the estimation of the amount of floatation required when designing a raft.

Table 1. A guide to the displacement and floatation capacity of various floatation devices used in the construction of oyster rafts. Calculations based on floatation in fresh water. *Calculated per meter of pipe.

Floatation type	Float displacement (litres)	Half-submerged loading (kg)	Sinking loading (kg)
Drum	200	100	200
Drum	220	110	220
Pipe 250mm	49*	24.5*	49*
Pipe 300mm	60*	30*	60*
Rota mould Aquaculture Floatation Device (AFD)	600	300	600

To calculate the maximum tray stack load of a raft, the total weight of the raft needs to be considered. When making this calculation it is important to factor in the increase in weight gain of

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the growing oysters as well as the accumulated biofouling and silt that deposits on the raft stacks. As a rule of thumb, an increase in weight due to biofouling should, at the very least, be estimated at 40% of the initial total weight of the stocked raft.

Aluminium raft floatation

There are currently three models of aluminium rafts used in NSW. Each model is designed with sufficient flotation to ensure that, even when fully loaded with trays and modules, it remains balanced and buoyant. This is particularly important for maintaining the raft's performance during periods of heavy use or adverse weather, as stability is essential to protect both the oysters and the equipment.

Table 2 provides a guide to the weight of aluminium oyster rafts based on the density of grade 6082/6061 aluminium alloy and will assist in the calculation of maximum loads the specific raft design can accommodate.

Table 2. A guide to the weight of aluminium rafts based on three common designs. Weight is based on the density of grade 6082/6061 aluminium alloy. Weight represents the total weight of the raft without any oyster equipment. Data supplied by Armstrong Oysters.

Raft Model Number	Dimensions (M)	Raft Weight (kg)	Oyster modules	Oyster trays	Aquaculture floatation devices	Intended use
AO 4800	7.35 x 4.85 x 0.59	604	10	100	8	High flow
AO 5600	7.35 x 6.65 x 0.59	621	15	150	8	Medium flow
AO 6500	7.35 x 6.35 x 0.59	655	20	200	8	Low flow

Timber raft floatation

The weight of hardwood timber is a function of its density and moisture content. Table 3 provides a guide to calculating the weight of timber used in a raft design and will assist the calculation of the maximum tray stack load that the specific raft design can accommodate.

Table 3. Guide to the weight of hardwood timber. Weight based on the density of Spotted Gum Corymbia citriodora (740kg/m3).

Dimension	Weight kg/m	Length 4.0m	Length 6.0m
100 x50mm	3.7	14.8 kg	22.2 kg
150 x50mm	5.55	22.2 kg	33.3 kg

Dimension	Weight kg/m	Length 4.0m	Length 6.0m
200 x50mm	7.4	29.6 kg	44.4 kg

Sealing floatation devices

Failure of floatation devices can lead to raft instability and partially flooded floatation devices can considerably increase loading and stresses on the raft during wave and wind action.

Due to their flexible nature, raft drums are subject to considerable internal pressure variations caused by loading and unloading of the raft, tidal currents, wave action, direct heating by sunlight and diurnal temperature changes. These variations can cause raft drums to expand and contract and the variations in internal drum pressures can act as a pumping mechanism that will cause the drum to slowly flood or collapse if it is punctured, cracked or not properly sealed.

To reduce the risk of floating devices flooding it is essential that all drum bung ports are kept above the water line and that they are sealed with silicon based sealants. Raft drums can also be pressurised using compressed air via a valve placed in the top of the drum to reduce the risk of the drum flooding. All raft drums and other floatation devices must be checked regularly for cracks or abrasion damage and replaced if they are suspected of leaking. To prolong the lifespan of drums used as floatation devices, walking on them should be avoided. The exception is rota moulded aquaculture flotation devices used in aluminium rafts, that are specifically designed with a grip surface, allowing farmers to walk on them without causing damage to the device. The rota moulded aquaculture floatation devices also have a 5mm hole in the top side surface to allow for expansion and contraction.

Securing floatation devices

The loss of a floatation device from a raft can also lead to raft instability. Drifting floatation devices such as partially submerged drums can also pose a threat to safe navigation and have other detrimental environmental impacts.

To minimise the mechanical damage to drums caused by the longitudinal raft timbers above the drums, two cushioning top shoulder straps are recommended for each drum (Figure 8). To reduce the likelihood of loss of a partially flooded drum or other floatation device from a raft, each floatation device must be secured to the raft.

Rota mould aquaculture flotation devices uses in aluminium rafts are bolted into the raft's frame. This configuration may reduce the risk of flotation device loss during extreme weather conditions. By minimizing the potential for displacement or detachment, this design is thought to improve the overall durability and operational longevity of the raft, particularly in regions prone to severe weather.

For rafts which utilize drum floatation, each drum must be secured to the raft’s longitudinal timbers above the drums by at least one girth strap (Figure 8). A girth strap or other floatation fixing system should be of sufficient strength to retain a partially flooded drum or other floatation device in-situ preventing it from floating from beneath the raft or being dislodged from the raft from wave action or strong tidal or flood currents.

Rafts also need to be stable when a full load of trays is being air dried on the raft. Where rafts are located in areas subject to strong winds and wind and boat generated waves, it is important to ensure that the individual tray stacks are secure to prevent slipping, slewing or tipping, regardless of the raft design. Unstable tray stacks could lead to dangerous situations when loading or unloading the rafts and may result in trays being lost from the raft during adverse conditions. The use of girth straps also assists the stability of tray stacks when being dried and reduces the risk of oysters being spilled from a tray stack should individual sling ropes fail. Straps will also enable the tray stacks to be recovered intact, in many instances without significant loss of oyster stock. If using aluminium rafts, the floatation device will be securely bolted into the frame (Figure 8).

Technical Tip: *The use of one or more tray stack girth straps will assist in: preventing tray stacks breaking up and spilling stock should a tray stack sling rope or sling hook fail; the recovery of tray stacks should they be lost from the raft; and, stabilising tray stacks during loading, unloading and air drying.*

Figure 8. A 200 litre plastic drum secured to longitudinal raft timbers by two cushioning top shoulder straps and a drum girth strap (left). A 200-litre plastic drum secured to longitudinal raft timbers by two drum girth straps (centre). Eight 600 litre rota mould floatation devices bolted into the frame of an aluminium raft (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Marking floatation drums

Floatation devices must be marked to indicate that the device is aquaculture infrastructure. Floatation drums that break free from a raft may be partially flooded. Where an unmarked drum containing liquid is found in the environment, concerns may be raised as to its contents and may result in a hazardous material (HAZMAT) response by Fire and Rescue NSW. Over the years there have been several instances where drums have been found in mangroves following floods that have been found to contain dangerous substances. To prevent oyster raft floatation drums that have broken free from an oyster raft instigating a HAZMAT response, all raft floatation drums must be marked in a way that clearly identifies them as an oyster aquaculture floatation device. It may also be advantageous to mark or tag the drum with the aquaculture permit number of the owner to enable the drum to be returned.

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Drums may be easily marked by a printed plastic cattle tag identifying it as an Aquaculture Floatation Device attached to the bung port by a good quality UV stable cable tie. Aquaculture flotation devices may be inscribed with a label during the manufacturing process (Figure 9).

Figure 9. Examples of aquaculture floatation devices. An end-capped ribbed polyethylene pipe (top left). An aluminium raft with rota-moulded float providing a walking surface (top right). A food grade pickle drum used for timber rafts marked as an aquaculture floatation device using a cattle tag (bottom left). A rota mould aquaculture floatation device used on aluminium rafts and labelled during the manufacturing process (bottom right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Mooring systems

The movement of water through a raft system can generate enormous pressures on the raft structure and its moorings, particularly when the raft system is fully stocked with submerged tray stacks with a high level of fouling. It is essential that moorings are adequate to secure the raft in position wholly within the surveyed lease boundaries under adverse loading as well as adverse environmental conditions such as those experienced during storms or floods.

The following is a guide only for the moorings for rafts, or raft complexes (a series of rafts joined together) that are less than 20m in length. Where rafts or raft complexes exceed 20m, particular attention needs to be given to providing additional adequate moorings to secure the raft within the lease area at all times.

Important note: Where doubts arise as to the adequacy of moorings the advice of a marine mooring contractor should be sought.

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Screw piers

Screw piers offer potential flood resistance advantages, including increased holding capacity and reduced movement during flood conditions. Depending on the size of the raft, screw piles with a 300 mm diameter helix and a 2000mm shaft are recommended.

Formal engineer testing has shown that a screw pier with a 250mm helix is at least 3 times resistant to movement as a 1 tonne concrete block and can take up to 9 times the force compared to a 1 tonne concrete block. A 300mm helix is recommended to allow for extreme circumstances. The screw pier also sits beneath the riverbed and does not slide across its surface or have the footprint of a concrete block.

Figure 10. Screw pier anchors. Image source Armstrong Oysters.

Ropes and fixings

Ropes used for mooring rafts must be of good quality, have a minimum diameter of 24mm, have a high abrasive resistance and should be UV stable. While cheap rope is often available, it is often of inferior quality with an unknown or unrated tensile breaking strain. Good quality rope of 24mm should have a rated breaking strain of at least 6 tonne.

In some instances, floating ropes are an advantage. Floating ropes have less tendency to entangle suspended raft infrastructure than sinking ropes such as nylon. Alternatively, where navigation or boat manoeuvring is an issue ropes may need to sink to reduce the risk of propeller entanglement. This can be achieved by the attachment of a small cement block to the mooring rope a few meters from its point of attachment to the raft. Silver rope or black polypropylene rope is the preferred choice for raft moorings.

Standard marine mooring practices should be used when attaching raft mooring lines to mooring blocks and/or anchors. All knots and splicing should show good seamanship and wherever wear is expected appropriate metal thimbles, shackles or rope abrasion protectors should always be used.

Important note: Mooring ropes should be attached to major longitudinal raft timbers behind one or more major horizontal raft timbers. Mooring ropes should not be attached solely to the leading horizontal raft timber, which may fail and detach from the raft in high adverse load

conditions. On aluminium rafts, anchor ropes are attached to a custom brace on the leading edges of the rafts and mooring ropes are attached to cleats.

Mooring blocks and anchors

Due to the enormous pressures that may be exerted by the raft on mooring gear, insufficiently anchored rafts can drag their moorings into other rafts, deeper water where the mooring gear is less effective or, in extreme situations, break free posing a serious navigation hazard and cause damage to other rafts, boats and, other marine infrastructure.

Important note: All floating cultivation and all associated moorings must at all times remain wholly within the surveyed oyster lease boundaries.

A rope moored raft, or raft complex, must be attached at the very least at the four corner points to suitable mooring devices. Where current flows are such that a raft needs to be attached to single serial chain of mooring blocks, a minimum of three blocks must be used, and each leading corner of the raft must be attached to the first mooring block by an independent mooring rope. Depending on the size of the raft, mooring blocks should be between 0.5 to 1.5 tonne each.

To ensure that the mooring block operates properly the length of all mooring ropes should be at least three times the depth of water under the raft. In moderate flow regimes this should be increased to five times the water depth and in strong current velocity areas this should be increased to at least seven times the water depth. In areas that are subject to periodic flooding, the calculated length of the mooring rope should be increased to account for the expected flood water depth.

Important note: A raft must not be moored at either end via a single mooring rope to a mooring device.

Important note: All mooring devices and anchors must be removed if the lease is terminated, unless otherwise approved by the NSW DPIRD.

Flood safety moorings and flood posts

In areas that are subject to periodic flood events special care must be given to the design of raft mooring systems. In areas that are at risk of a build-up of flood debris or high flood current velocities or both, flood safety mooring systems should be used. A flood safety mooring system, often known as “dead man anchors”, are substantial mooring systems located on the lease area close to the shore on the upstream side of the raft complex that are capable of pulling the raft closer to shore and out of the debris or current steam in the event of either the raft dragging or breaking free of its moorings during a flood event. A flood mooring post must have a minimum diameter of 200mm and be driven deeply into the substrate to which a substantial raft mooring rope capable of holding the raft in adverse conditions should the normal mooring system fail to hold the raft at its location. The flood safety mooring rope should be attached to the post as close to the bottom as possible.

Important note: All mooring blocks, mooring anchors and mooring posts must be located within the surveyed lease boundaries.

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Post moorings

Large diameter posts may be used to moor a raft within a lease area (Figure 11). Mooring posts must be located within the lease boundary and, unless approved by NSW DPIRD, must be independent of lease boundary marks.

Posts may also be part of the raft superstructure and allow the raft to move freely vertically with the rise and fall of the tide with the aid of an adequately secured friction collar (Figure 11). Posts used to moor rafts within a lease boundary must have a minimum diameter of 200mm and a pair of parallel posts should be installed at least every 25m. Post mooring systems are not suitable for use in areas prone to flooding or in areas deeper than 2m at low tide.

Figure 11. A post moored raft complex that has been approved by NSW DPIRD to incorporate white navigation marking on a raft directly adjacent to a navigation channel (left; see navigation marking requirements below). A car tyre sliding collar on a post mooring system suitable for use in shallow areas (right. Note: tyre double bolted internally through a reinforcing plate and reinforced raft module end plate). Image source NSW DPIRD Aquaculture Management.

Linking raft modules

In some instances, it may be appropriate to join two or more individual raft modules to form a single raft complex. Due to the stresses placed on moorings in areas subject to periodic flood flow events, no more than three 6m rafts should be joined together in line to form a single raft complex without additional compensatory moorings being installed. In such areas, all moorings must be appropriately adjusted to accommodate the increased stress loadings caused by flood flows and flood debris accumulation and strikes.

The aluminium raft specifications with screw pier anchors and joins allow up to 3 rafts in tidal, fast-flowing waters, and up to 5 joined together in low flow areas (e.g. lake areas).

Where individual rafts are joined, each raft should be separated by a shock absorbing device such as raft connectors for aluminium rafts (Figure 12) or small car tyres fitted at the end of each set of longitudinal timbers on either side of the raft (Figure 12). Shock-absorbing devices should be capable of returning the raft to a “straight” state after conditions cause the set of rafts to flex. The

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use of shock absorbing devices also prevents the individual joined rafts from climbing on top of one another under differential adjoining raft load conditions.

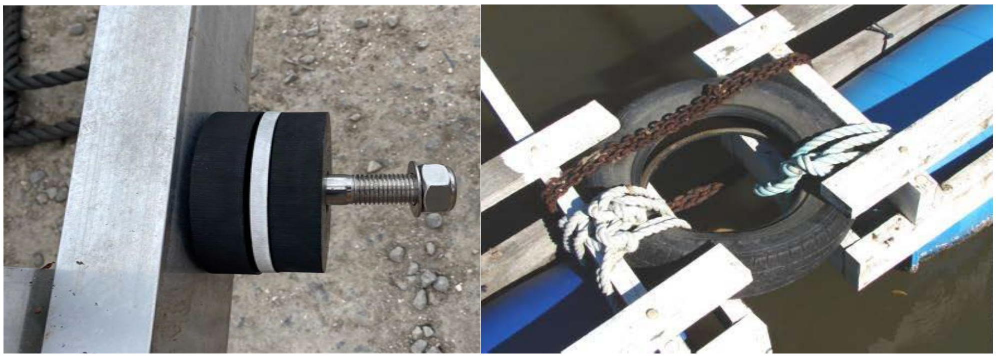

Figure 12. Shock absorber connected to aluminium raft join (left) and car tyre connected to longitudinal timbers either side of a timber raft (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

If car tyres are used as shock absorbers or sliding mooring collars, they must be firmly fastened to the raft timbers. Additionally, large diameter holes should be drilled into the lower sidewall of the tyres to ensure efficient water drainage. When attaching car tyre shock absorbers to rafts, the tyres should be secured to the cross timbers using galvanized through-bolts, with a reinforcing plate placed inside the tyre for added stability (see Figure 13).

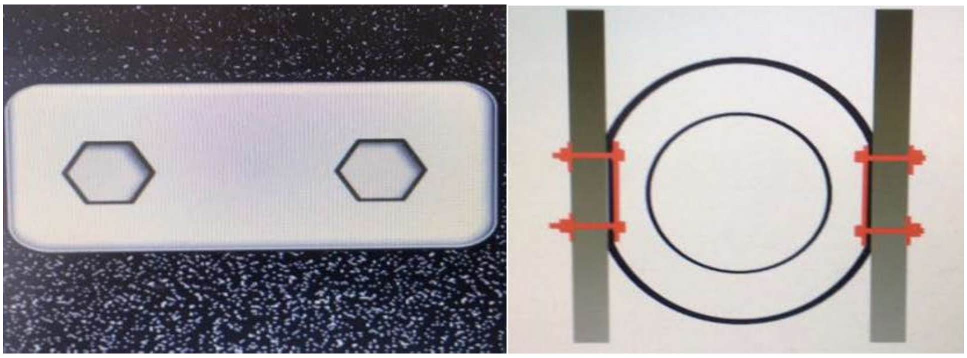

Figure 13. A plate bolted internally between rafts (left). In practice each tyre should be attached at four diagonal points, two in each adjoining timber raft to minimise sideslip (right). Image source NSW DPIRD Aquaculture Management and Armstrong Oysters.

Technical tip: *It is good practice to install a secondary safety chain or large diameter safety rope between the modules in conjunction with each shock absorbing device to prevent the raft separating should a cushioning device or its fixing fail.*

Important note: Single ropes without a fixed shock absorbing device should not be used to join raft modules.

Debris loading

The major damage to oyster rafts during floods is from forces caused by debris loading. The design of the raft and how deep it sits in the water can contribute to how much floating debris collects on the upstream end of the raft, building up until in some cases it causes catastrophic failure. Failure of

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rafts during floods is costly in many ways to the farmer but the biggest cost can be in the value of the stock that is lost when the raft fails.

The aluminium rafts have undergone stress analysis and can withstand high debris loads. To further ensure their viability during flood events, it is recommended the leading raft in a connected line incorporates a buffer.

The AO 4800 and 5600 rafts can use a buffer of aluminium, 160x106x6mm section.

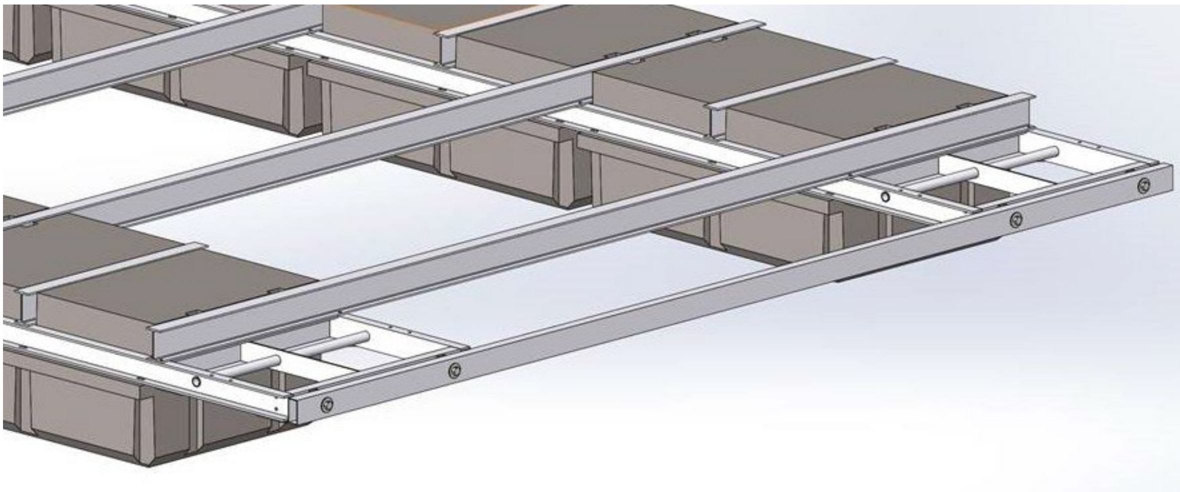

Figure 15. Aluminium raft with a buffer. Image source Armstrong Oysters

A rope buffer of 24mm nylon rope is sufficient to support the debris load case on an AO 6500 raft as this raft is recommended to be utilised in slower water moving areas, such as lakes.

Environmental issues

The following environmental issues must be considered in the use of oyster raft cultivation systems.

Use of recycled plastic drums

The inappropriate use of recycled plastic drums as floatation devices on an oyster raft poses a number of environmental issues. Plastic drums are used to store and transport a wide range of products, some of which can pose a serious threat to human health and the environment.

As plastic drums used on oyster rafts can often leak it is essential to ensure that, prior to their installation on an oyster raft, there are no potentially dangerous residual products within the drums.

To ensure that drums are safe to use, drums must only be sourced from licensed drum recyclers and manufactures that produce aquaculture floatation devices. Licensed drum recyclers are required by law to flush and wash drums to an approved standard before they can be offered for sale. Under no circumstances should used drums that have been acquired directly from the agricultural or the manufacturing sectors be used.

Important note: Only plastic drums sourced from a licensed drum recycling company or manufactured for this purpose may be used for oyster raft floatation.

Good neighbour policy

The NSW oyster industry is an integral part of many NSW coastal communities. Oyster farming businesses not only generate economic benefits, but also make a positive and constructive contribution to the social fabric of these communities.

Oyster farmers appreciate the wider social responsibilities of their businesses and aim to be recognised in their communities as good corporate citizens and environmentally responsible, professional primary producers. Safeguarding water quality is a primary driver for oyster farmers.

Oyster farmers recognise that the land adjacent to leased areas is either community-owned public land or private land. In either case, this land is treated with respect and oyster farming activities are conducted to minimise any existing and potential impact on this land.

Visual impact and prohibited materials

The general neat and tidy provisions that apply to all aquaculture leases in NSW are specified in the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) which can be found at:

www.dpi.nsw.gov.au/fisheries/aquaculture

The following OISAS neat and tidy provisions apply specifically to oyster rafts:

- rafts must be constructed of materials that are long lasting in the marine environment and pose no risk of significant environmental harm
- rafts must be constructed with marine grade fastening systems
- rafts must not be used to store waste, infrastructure or materials
- plastic drums and floats must be adequately secured to the raft at all times and replaced if broken or leaking
- rafts must be low in height and must be designed and constructed to float horizontally to the water surface
- the use of steel or concrete flotation devices is prohibited
- rafts must be constructed of either good quality structural grade hardwood or aluminium, or equivalent
- only plastic drums sourced from a licensed drum recycling company may be used for oyster raft flotation
- black coloured floatation is preferred but blue flotation drums are permitted
- small sized securely fixed tyres may be used for raft buffers or post sleeve collars
- broken or damaged rafts must be removed from the lease area or repaired as soon as possible
- broken or damaged rafts must not be stored on any oyster lease or any public water land.

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Navigation marking requirements

The full requirements for the marking of an aquaculture lease are specified in the Fisheries Management (Aquaculture) Regulation 2024 and are also outlined in OISAS Chapter 7.

Important note: Where an oyster farmer wishes to incorporate lease boundary marks into a raft structure, an application must be made to NSW DPIRD to vary the lease marking conditions of the lease.

Important note: In some areas Transport for NSW may require that the location of raft mooring blocks be identified by a clearly visible float attached to the mooring block and may also require other navigation aids to be fitted to an oyster raft. When in doubt contact your local Transport for NSW Marine Safety Officer.

Areas deemed unsuitable for raft cultivation

The following areas are deemed to be not suitable for raft cultivation:

- where the depth of water under the raft footprint is less than 0.5m at low tide
- where the bottom substrate will not allow the raft and all mooring devices to be maintained wholly and securely within the lease area, particularly in areas prone to flood scour
- where the dimensions of the lease and the available lease footprint are insufficient to maintain the raft and its moorings wholly within the lease area at all stages of the tide and in all wind conditions
- where rafts would pose an unreasonable risk to safe navigation
- where raft cultivation would not be in the public interest.

Routine maintenance

A poorly maintained oyster raft can:

- pose a significant threat to safe navigation
- drag their moorings or break free and cause significant damage to other rafts, marine infrastructure and property
- result in significant loss of stock
- attract compliance action from both NSW DPI and Transport for NSW
- reflect poorly on the environmental credentials of the NSW oyster industry.

It is therefore important that regular maintenance checks be carried out by all owners of oyster rafts.

Regular checklist

The following checks should be carried out whenever a raft is attended or at a minimum of every three months:

- the location of the raft within the lease boundary, with reference to a known shore position or shore feature
- missing, flooded or popped drums (forced up between the longitudinal timbers due to deflation
- abrasion, cracks, general damage or leaks in floatation devices
- mooring rope attachments to rafts for UV damage, abrasion or cuts
- the structural integrity of timbers and timber fixings at the point of attachment of all mooring ropes
- all navigation aids and signs are in place
- three months after initial construction, check timbers for shrinkage and adjust bolts and other fixings where necessary
- the degree of fouling on raft components.

Annual checklist

The following checks should be carried out at least annually:

- the structural integrity of all raft timbers and metal fixings
- all mooring block and flood safety anchors at their points of attachment for wear or corrosion
- all mooring ropes from their points of attachment at mooring blocks or flood safety anchors to the point of attachment to the raft for damage or fouling by submerged objects.

More information

Contact: Fisheries NSW, Aquaculture Management on (02) 4916 3900 or at aquaculture.management@dpi.nsw.gov.au.

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