Lessons Learned:

- You can pre-set, bundle, tape and bag everything but the anchor, then simply tie the anchors, fill the bottles, and cut the tape and allow the nursery to find its shape. Adjust and bury the anchors.

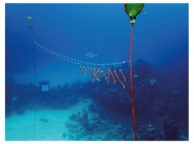
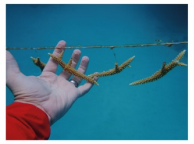
- The length of the drop-line is a tradeoff between fouling and tangling risks. A longer drop will separate the coral from the primary fouling of the horizontal line; however, it increases the risk of entanglement between corals and lines.

- The horizontals will sag as the corals grow. Keep your systems light, balanced and buoyant - pruning or harvesting regularly and adding buoys when necessary.

- Buoys should not be added to the middle of the horizontal lines.

- Nylon and polypropylene are subject to water and UV damage, expect to decommission or rebuild every 24-months.

- Line nurseries have entangled wildlife. It is strongly recommended to keep horizontal lines taught by maintaining proper buoyancy.


For more information: www.seascapecarib.com

This document is part of the Coral Restoration Consortium's Guide to Coral Reef Restoration: Methods to Optimize Efficiency and Scale.

Coral Nursery Structure Designs

Coral Restoration Consortium

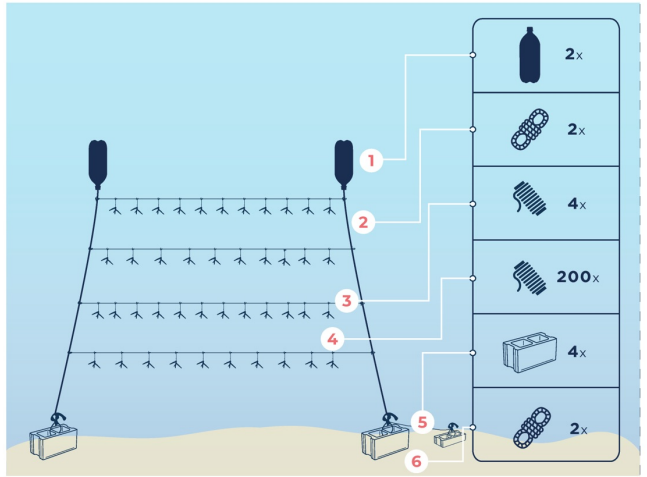
Buoyant Drop-line Line Nursery (BDL)

Description of the Nursery

Prior to the development of the more commonly used floating structures such as the Coral Tree™ or midwater platforms, line, clothesline, or buoyant drop- line nurseries were widely used, and still are in many places. First trialed in 2005, based on concept inputs from Bowden-Kerby (pers. comm.) and Soong and Chen (2003), the device is constructed of two anchors, two primary vertical lines, two mid-water support buoys, and one to several horizontal lines supporting the corals hanging from short drop lines (Ross, 2012). The basic components can be changed according to availability, thus line nurseries are achievable almost anywhere, on any budget. Line nurseries have minimal physical structure, which reduces cleaning efforts and fouling stress on corals. They are easy to put together and therefore can be assembled on-site or pre-assembled and bundled for deployment. Like many of the other floating structures, they are transportable, modular, and expandable; however, they deform with weight and are not recommended for larger corals or long-term installations.

The following are instructions for building a Buoyant Drop-line Line Nursery that holds **200 corals**, with a secondary anchor, floating approximately **2.5 m above the bottom** at a **sandy** nursery site with a **depth of 8 m.**

Diagram:



Supplies Needed:

1		2x	**Buoys** – 2 L soda bottles with caps; see Chapter 1: Floats/buoys
2		2x	**Vertical Line** – 6 m segments of 6 mm polypropylene twisted line
3		4x	**Horizontal line** – 5.8 m segments of 100 lb test nylon monofilament
4		200x	**Drop-line** – 18 cm segments of 30 lb test nylon monofilament (make cuts at an angle)
5		4x	**Anchors** – 20 cm x 20 cm x 40 cm (17 kg) cement block; see Chapter 1: Anchor Types and Anchor Line Types
6		2x	**Secondary anchor line** – 2 m segments of 6 mm polypropylene twisted line

Details of Construction and Installation:

I. Prepare the buoys. Drill a 6 mm hole in the center of each bottle cap. Thread one end of a vertical line through the hole and secure in the cap with a square knot. Glue the knot in place with silicone or hot-glue- waterproofing the hole.

II. Prepare the vertical lines. Mark the lines at 20, 100, 180, and 260 cm from the cap using a permanent marker. Tie a square knot at the other end of the line to prevent fraying.

III. Prepare the horizontal lines. At 45 cm from the end of each line and then every 10 cm, attach a drop-line by wrapping one end around the horizontal line three times then securing with a modified clinch knot, leaving 15 cm free at the other end. Use dull pliers to slide the knot tight to the horizontal line then tighten until it will not slide on the line. Trim knot tail to 2 mm. Coil each line separately and secure with tape.

IV. Install the anchors. Place concrete blocks on the seafloor approximately 6 m apart.

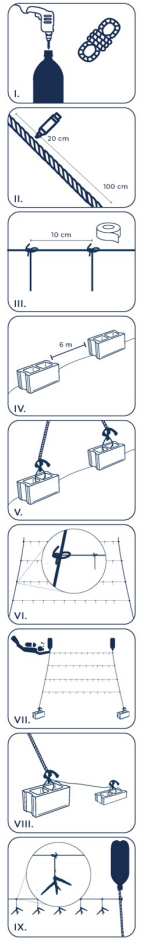
V. Attach the vertical lines. Loop the free end of the vertical line through the cement block twice and secure with a loose modified clinch knot (to be tightened in the final stages). Inflate the bottle to 50% capacity and secure to the cap.

VI. Attach the horizontal lines. Attach a horizontal line at each of the markings on the vertical lines by threading 35, 30, 25, or 20 cm of the horizontal line (top line to bottom line, respectively) through a twist in the line, wrap once around the line above the horizontal line, wrap twice around the line below the horizontal line, and secure with a modified clinch knot. Trim excess or thread into and around the vertical line.

VII. Final adjustments. Finish filling the bottles with air and adjust the vertical lines and anchor locations to square the lines. Tighten lines to anchors.

VIII. Install secondary anchors. Place an additional concrete block approximately 1 m to the outside of each primary anchor, and tie the secondary anchor line through each of the blocks. Bury anchors by at least 50% in sand.

IX. Add corals. Wrap a drop-line around the coral's center once and secure it with a modified clinch knot. Press the knot tight to the coral with dull pliers, the line should cut into the coral slightly. Trim ends. Spread corals evenly across the nursery to ensure that it is not deforming due to uneven weight, as this may cause entanglements.



Lessons Learned:

- If the PVC spine is too thin (gauge and schedule), old (oxidized) and/or holes for the branches were not drilled straight through, the trunk may break (Figure 1). Other common failure points include snapped tree arms and frayed lines.

- Coated wire does not work well for hanging corals on trees (as the drop-line). It has a tendency to break due to metal fatigue, especially in high-energy events or storms (Figure 2). In addition, the color coating on the wire may fade quickly, making it problematic if color was used to mark genotype, bleaching or other programmatic characteristics.

- Tracking individual corals on trees can be difficult because branches don't have a distinct 'starting' end to indicate which coral is '#1" on each branch, and tagging each coral is expensive. Adding a cable tie to each branch by the spine can indicate to data collectors which side of the branch is the starting end (Figure 3). Placing cable ties on the same side of the branch in the same plane will serve as a double check if cable ties become lost. These also help with taking consistent tree photos.

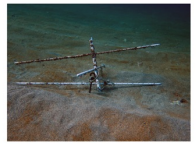


Figure 1

Figure 2

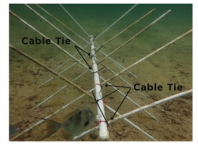


Figure 3

For more information: Nedimyer et al., 2011

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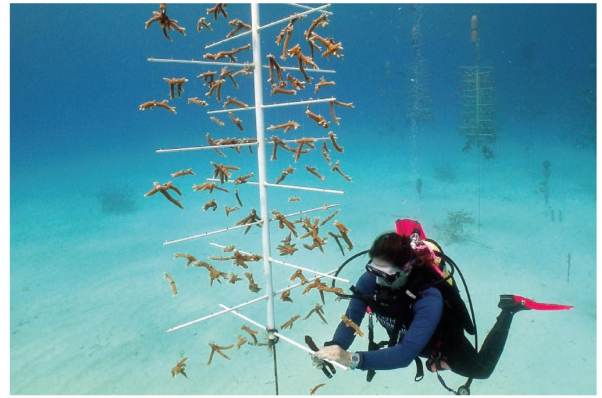
Coral Nursery Structure Designs

Coral Tree™ (v. 1)

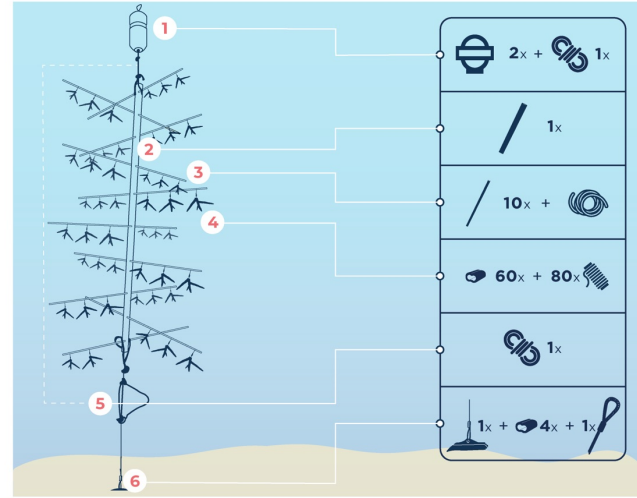


Description of the Nursery

Among floating structures, the Coral Tree™ nursery has become widely adopted as the preferred nursery method in the Caribbean where conditions are suitable. The Coral Tree™, first pioneered by Coral Restoration Foundation (Nedimyer et al., 2011), is simple, low cost, easily built and installed, and has the capacity to grow large numbers of corals within a single structure. The Coral Tree™ provides a rigid framework that allows coral to develop in the water column. Corals are attached to "tree branches" and are either hung from holes in each branch or installed on pucks secured directly to branches or on trays secured to the branches. The standard design of a tree nursery can hold 60-120 corals and allows for 360° of water circulation and movement of the tree.

The following are instructions for building a coral tree that holds 80 hanging corals, without a secondary anchor, floating approximately 1.5 m above the bottom, and at a sandy nursery site with a depth of 10 m.

Diagram:



Supplies Needed:

1		**Buoys** – see Chapter 1: Floats/Buoys
1		**Bouy Line** – 1/4" double braided polyester line or 3/8" black polypropylene cut to 1.2 m
2		**Trunk** – Schedule 80 1" PVC - 1.5 m (5 ft)
3		**Branches** – Sunguard fiberglass rods in 1/2" pre-drilled, 1/2" self-drilled, or 3/8" self-drilled (Kencove Fencing)
3		**Black sprinkler wire** - 18 ga single strand plastic coated wire cut to 20 cm lengths
4		**Hanging monofilament** – 100-200 lb test cut to 20 cm lengths
4		**Hanging crimps** – Size G (1.3 mm) or Size F (1.5 mm)
5		**Anchor Line** – 1/4" double braided polyester line or 3/8" black polypropylene cut to 2.5 m lengths
6		**Anchor monofilament** – 3.6 mm (1000 lb. test) monofilament cut to 1.2 m
6		**Anchor crimps** – 3.9 mm crimps
6		**Earth anchor** – 1100 lb capacity, 68 duckbill anchor - see Chapter 1: Anchor Types and Anchor Lines for other options

Details of Construction and Installation:

I. Prepare the trunk. Drill the first hole at 8 cm (3 in) from the top of the trunk. The rest of the holes will be 16 cm (6.5 in) apart and perpendicular to one another, turn the trunk 90° between each hole, for a total of 10 holes.

II. Prepare the branches. The fiberglass arms can be purchased pre-drilled . If using self-drilled branches, from the middle of the branch drill a 5mm hole at 2 cm, then every 5 cm until the end.

III. Prepare the anchor system. Secure one end of the anchor monofilament to the Earth anchor (duckbill) and create a loop with the opposite end using two 3.9 mm crimps on each end.

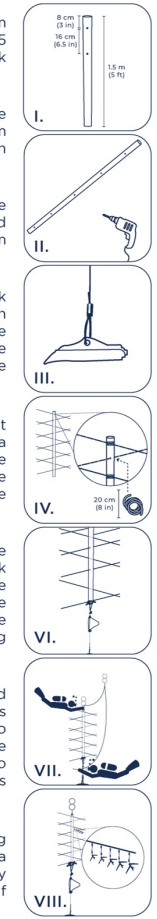
IV. Asemble the trees. Install the branches in the trunk and secure using coated wire by placing the wire through the two closest holes to the trunk and twisting the wire around the trunk to tighten. To avoid strain on the tree branches, or to save space during transit, this can also be completed in the nursery.

V. Install the anchor. Using a pointed rebar stake that easily fits inside the duckbill, pound the duckbill using a sledge hammer or post-driver to a depth where the monofilament loop is just out of the sand. Remove the rebar and pull up on the monofilament loop to turn the anchor, securing it.

VI. Attach the tree. Tie one end of the anchor line to the anchor loop and the other end around the trunk and back onto itself above the bottom branch. A slip knot can be used on the bottom so that the tree can be lowered in the water column for storm season. Anywhere that the line interacts with another surface, consider adding chafing protection.

VII Add buoyancy. Pull the buoys down to the desired depth, by threading a line from the surface with buoys attached through the anchor loop or a weight bag to create a pulley system to the bottom. Loop the buoy line around the trunk under the top branch and tie back onto itself. Take caution to not get gear tangled in the tree as it floats.

VIII. Add corals. Create a loop with the hanging monofilament through the branch hole and secure with a crimp. Loop the other end of the monofilament tightly around the coral and secure with a crimp. The order of these two steps can be flipped.



Lessons Learned:

- Bolts are used to secure the corners of the frame (Image below) instead of PVC corners since the PVC corners are susceptible to damage during storm events .

- If monofilament is not available, other types of lines can be used like parachute cord, Dyneema, or Spectra.

- Do not hang corals from the bottom of the PVC frame. This piece protects the corals from hitting the bottom during storms or if there is not enough flotation. If corals are hanging from this piece, they may be damaged or die from abrasion during such events.

- The length of the drop-line is a trade-off between the expected fouling and the potential for corals to interact or be entangled during storms; corals hanging from lines that are too long are likely to be damaged from storms or similar events.

- When hanging corals, the 18 ga coated copper single strand cable wire (image below) can be installed faster than monofilament, but it won't last as long and is not as strong. If you plan to grow corals for longer than one year, monofilament would be better.

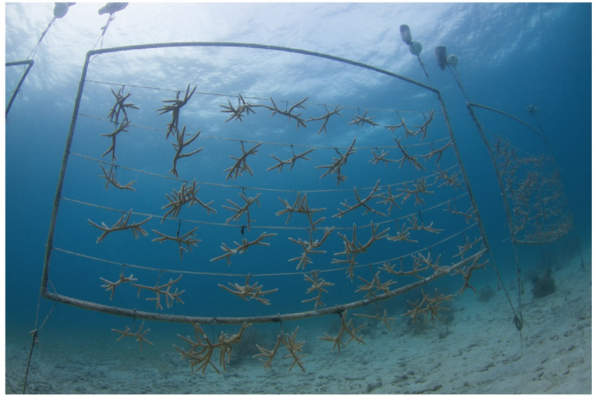
For more information: Griffin et al., 2012.

This document is part of the Coral Restoration Consortium's Guide to Coral Reef Restoration: Methods to Optimize Efficiency and Scale.

Coral Nursery Structure Designs

Coral Restoration Consortium

Floating Underwater Coral Array (FUCA)

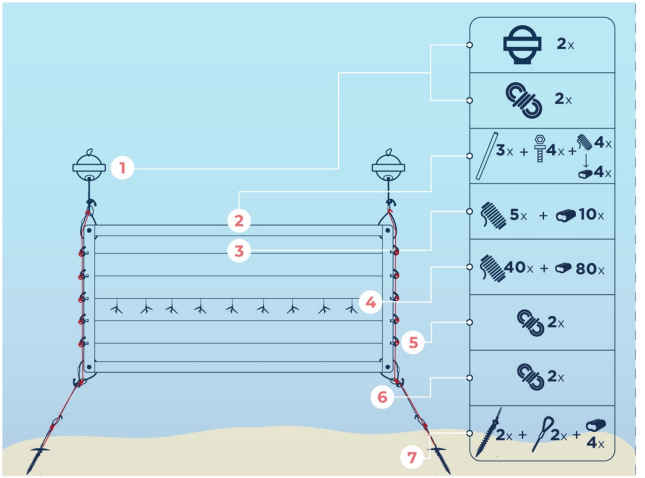


Description of the Nursery

Floating Underwater Coral Arrays (FUCA) have been used primarily for *Acropora cervicornis* in 6-15 m depth, though other genera like *Meandrina, Dendrogyra*, and *Porites* have also been grown on these structures - Case Study #1.2 in Chapter 1. This design was modified from the common line nursery and buoyant drop line nursery designs (Appendix 1) to include a rigid PVC frame to help reduce sagging as corals grow bigger and heavier, allowing corals to remain in the system longer. The frame may also reduce tangling of corals in storms and entanglement of marine life. The standard design of a FUCA can hold 40-100 corals.

The following are instructions for building a FUCA that holds **40 hanging corals**, with **secondary anchor lines**, floating approximately **1.5 m above the bottom** at a **rubbly** nursery site with a **depth of 10 m**.

Diagram:



Supplies Needed:

1	2x	**Buoys** - 19 cm round styrofoam buoys; see Chapter 1: Floats/buoys
1	2x	**Buoy Line** - 60 cm segments of 9.5 mm black polypropylene
2	3x	**PVC pipe** – 3m Schedule 80 ¾" (20 mm) PVC; 1 cut in half
2	4x	**Bolts and Nuts** - 9.5 mm
2	4x	**Loop monofilament** - 1000 lb test monofilament cut to 45 cm length
2	4x	**Loop Crimps** - 3.9 mm aluminum crimping sleeves
3	5x	**Horizontal lines** – 3.2 m segments of 600 lb test monofilament
3	10x	**Horizontal line crimps** - 3.3 mm aluminum crimping sleeves
4	40x	**Monofilament** - 100 lb test monofilament cut in 20 cm pieces
4	80x	**Hanging crimps** – Size G (1.3 mm)
5	2x	**Secondary anchor line** – 3.4 m segments of 9.5 mm black polypropylene
6	2x	**Anchor line** - 1.2 m segments of 9.5 mm black polypropylene
7	2x	**Anchor monofilament** – 1.2 m segments of 1000 lb. test monofilament
7	4x	**Anchor crimps** – 3.9 mm aluminum crimping sleeves
7	2x	**Anchor** – Penetrator screw; see Chapter 1: Anchor Types and Anchor Line Types

Details of Construction and Installation:

I. Prepare the frame. On each 1.5 m pipe, drill 6.4 mm holes starting from the top at 4, 10, 38, 66, 94, 122 cm, rotate the pipe 90 degrees and drill a 9.5 mm hole (for the bolt) 1.3 cm from the top and bottom of the pipe. On each 3 m pipe drill a 9.5 mm hole 1.3 cm from each end, rotate the pipe 90 degrees, and drill a 6.4 mm hole 5 cm from each end.

II. Assemble the frame. Insert bolts through the 9.5 mm holes on both the horizontal and vertical PVC pipes creating a rectangle. Tighten nut onto bolt. Thread the monofilament cut for the loops through the holes closest to the corner on both the vertical and horizontal pipes and create a loop by crimping the ends together.

III. String the horizontal lines. At one end of each line crimp a small loop using less than 7.5 cm of monofilament. Thread the other end through one of the sets of 6.4 mm holes on each vertical pipe. Pull the line taught and crimp in place.

IV. Prepare the anchor system. Secure one end of the anchor monofilament to each of the anchors and create a loop on the opposite end using two 3.9 mm crimps.

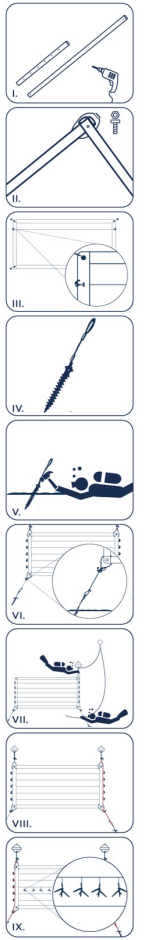
V. Install the anchors. Using a sledgehammer, pound a penetrator anchor into the rubble at a distance just wider than the frame. Penetrator screw anchors can be removed with a wrench.

VI. Attach the FUCA. Attach the anchor line to each monofilament loop on the anchor and to the loop at the corner of the base of the frame using bowline knots.

VII. Add buoyancy. Thread a long line with buoys attached through the anchor loop or a weighted bag to create a pulley system from surface to bottom. Pull the buoys down to the bottom. Tie a buoy to each corner loop no more than 20 cm away from the frame and at least 3 m below the surface to reduce entanglement risk and avoid navigational hazards.

VIII. Add secondary anchor lines. Run the secondary anchor line from the anchor through the corner and horizontal line loops to the buoy.

IX. Add corals. Hang coral fragments from the horizontal monofilament lines using monofilament drop-lines and crimps. Tightly wrap the lines around the horizontal lines.



Lessons Learned:

- It is also possible to assemble the nursery onboard a boat and push the completed assembly overboard at the desired location, then just do fine rope adjustment underwater.

- While tiles between the coral and the structure could make removing the corals from the structure for outplanting easier, they make it much more difficult to attach the corals to the structure and result in higher losses. Also, coral bases will add weight and therefore more buoyancy will be needed.

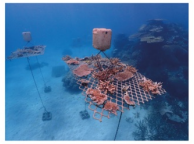
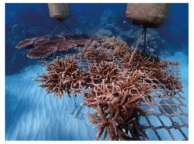
- It is possible to attach corals in a tank of seawater on the boat (for example if non-dive helpers are involved).

- Where cable ties are used, they can be preinstalled on the frame to make attaching corals easier. Larger corals can be wedged into the mesh and self-attach within several weeks (avoiding the use of plastic).

- The frames can be moved from a nursery or growing site to an outplant site with careful towing.

- If the corals on the frame grow to become particularly heavy, the frame can be converted into a table nursery by mounting on legs or blocks.

- To help protect against bleaching, a shade can be added over the frame in situ by using a shade cloth tensioned in a 25 mm pvc pipe rectangle which is the same size as the aluminum frame. Thin rope ties at each corner can be used to secure the frame level with the top of the floats.

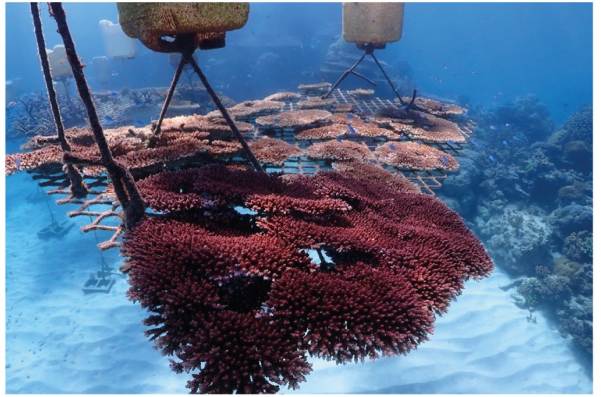

For more information, reach out to John Edmondson, Wavelength Reef Cruise and see Suggett et al., 2019b and Case Study #2.4 in the Guide.

This document is part of the Coral Restoration Consortium's Guide to Coral Reef Restoration: Methods to Optimize Efficiency and Scale.

Coral Nursery Structure Designs

Coral Restoration Consortium

Floating Underwater Platform

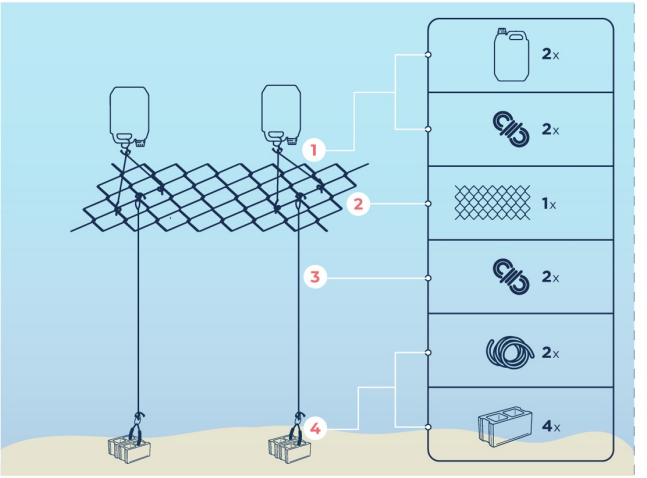


Description of the Nursery

A blend between the FUCA and the underwater tables/BUCAs discussed in the fixed nursery structure section, a floating underwater platform provides a table-like structure that is suspended in the water column. This design has been used exclusively as an easily (re)movable and low impact nursery in tourism-led propagation on the Great Barrier Reef for over 30 Indo-Pacific species spanning tabulate, plating, branching, corymbose/bushy and massive morphologies (e.g. Howlett et al. 2021). The system has been equipped with a shade during recent heat waves (2020) and easily lowered to rest near the bottom during extreme weather. Most frames typically carry a stock of >30 large colonies (but have been seeded with as many as 200 small fragments) at any one time. Floats (or pruning of colonies) are used to control the buoyancy and hence depth.

The following are instructions for building a **2 x 1.1 m** Floating Underwater Platform that holds **70 corals**, floating approximately **3 m above the bottom** at a sand/rubble nursery site with a **depth of 6 m**.

Diagram:

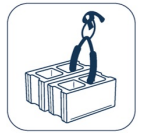


Supplies Needed:

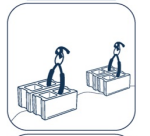
1		2x	**Buoys** – 20 L floats; see Chapter 2: Floats/buoys
1		2x	**Buoy Line** – 2 m segments of 8 mm 3-strand polypropylene or braided line
2		1x	**Frame** – 2 x 1.1 m off-the-shelf aluminum diamond mesh panel (as used for making security screens)
3		2x	**Anchor Line** – 4 m segments of 10 mm 3-strand polypropylene or braided line
4		2x	**Hose** – 50 cm segments of 12 mm garden hose
4		4x	**Anchors** – 20 x 20 x 40 cm (17 kg) cement blocks; See Chapter 2: Anchor Types and Anchor Line Types
5		70x	**Coral Attachments** – Cable ties or wires for corals (optional)

Details of Construction and Installation:

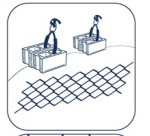
I. Prepare the anchors. Tie a small loop in one end of each anchor line. Slide the hose over the line and thread each line through the center of two cement blocks and through the loop on the other end. Position the hose to act as a chafe-guard.



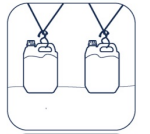
II. Install the anchors. Drop the anchors in place on sand or rubble.



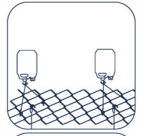
III. Deploy the frame. Drop or lower the aluminum mesh frame to the seabed at the same place as the anchors.



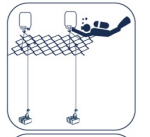
IV. Deploy buoys. Attach buoy bridle lines by using a clove hitch in the middle of the rope, leaving two rope tails coming off of each jerry can handle. Fill the jerry cans with water and take to the seabed.



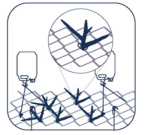
V. Assemble the platform. Attach each buoy bridle to the frame about 30 cm in from the frame edges, forming inverted Vs with the floats at the apex. Tie an anchor line to the frame midway between each bridle.



VI. Add buoyancy. Partly inflate the floats to lift the frame to position and adjust the anchor and bridle lengths to ensure the frame is at the desired depth and is horizontal. It is customary to install the top of the platforms at least 4-6 m below the lowest tide to avoid creating a boating hazard. Add air to the floats until they are about half full.



VII. Add corals. Corals can be wedged into the mesh or secured using cable ties or wire.

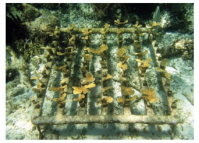


Lessons Learned:

- This type of nursery was designed for areas near to reef crest, able to stand currents, and designed for *Acropora palmata*; however, *Acropora cervicornis* tend to grow really well too.

- This size has proven to be the most stable and resistant for wave energy. Larger tend to be weaker. For stronger currents, rivets can be installed on the joints.

- It is important to check the diameter of the pipes, because dimensions of the final structure (for the ensemble time) could change.


Additional details in Nava-Martínez *et al.* (2015).

This document is part of the Coral Restoration Consortium's Guide to Coral Reef Restoration: Methods to Optimize Efficiency and Scale.

Coral Nursery Structure Designs

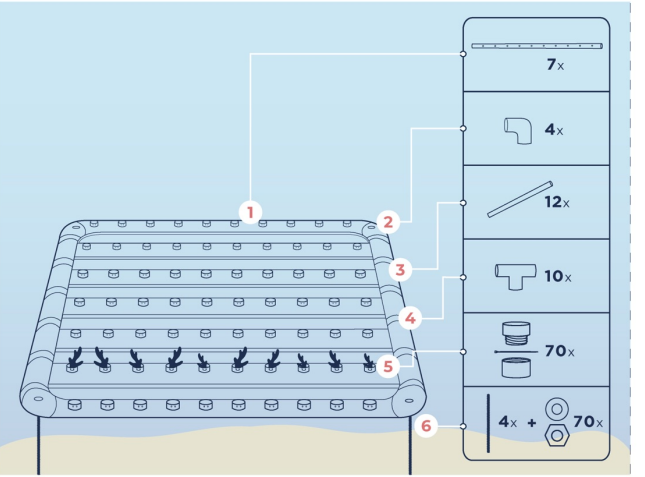
Grid-Type Nursery

Description of the Nursery

It was originally designed for the coral species *Acropora palmata* (although it has also been used successfully for *Acropora cervicornis, Porites porites* and *Agaricia tenuifolia*). This structure can serve as a production or stabilization nursery. This type of nursery can be adapted to all water depths.

The following are the instructions for building a **1.45 x 1.25** m grid-type nursery that holds **70 corals**, with 4 anchor points on **hardbottom** in a **depth of 1 m.**

Diagram:

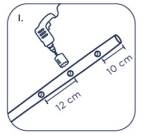


Supplies Needed:

1		7x	**PVC pipe** - 1.3 m segments of 5 cm hydraulic PVC
2		12x	**PVC pipe** - 13 cm segments of 5 cm hydraulic PVC
3		4x	**PVC Elbow** - 5 cm hydraulic PVC connector
4		10x	**PVC T** - 5 cm hydraulic PVC connector
5		70x	**PVC male adaptor** - 19 mm adaptor
5		70x	**PVC female adaptor** - 19 mm adaptor
5		70x	**Cable ties** - 18 cm long 4 mm wide cable ties
6		4x	**Threaded rods** - 50 cm long ½" diameter stainless steel or galvanized rods
6		8x	**Washer** - ½" stainless steel washers
6		8x	**Nut** - ½" stainless steel lock nuts

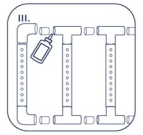
Details of Construction and Installation:

I. Prepare the frame. For each of the 1.3 m pipes beginning 10 cm from the end, drill a 1 ¼" hole every 12 cm (10 total holes).



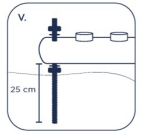
II. Prepare the adaptors. In each hole glue a female adaptor using PVC glue. Drill two 7/32" holes at the top of each male adaptor about 3.5 cm apart. Starting from the outside insert a cable tie in one hole and out the other of the male adaptor, leaving a loop in the inside.

III. Assemble the frame. Glue a T connector on both ends of 5 of the pipes. Glue elbow connectors on both ends of the remaining 2 pipes. Glue the 13 cm pipes between each of the connectors to complete the frame.



IV. Drill anchor holes. Drill a 1/2" hole through the center of each elbow.

V. Install the frame. Drill a 1/2" hole 25 cm deep in the reef for each of the four corners. Pound the threaded rod into the hole. On each rod place a nut and washer to hold the frame off the substrate. Add the frame then another washer and nut.



VI. Add corals. Place the coral piece in the loop in the male adaptor and cinch the cable tie tight to the coral, trim the end. Secure the male adaptor with the coral onto the female adaptor.

Lessons Learned:

- Tying directly to the reef is not recommended as it is more likely to abrade and be lost.

- Larger lines require cleaning maintenance as corals do not overgrow the line or do not overgrow it quick enough to mitigate fouling impacts.

- Longer, straighter branches are more efficient. On a bent branch, you may wrap the line around the branch between top and bottom loops to maintain contact.

- During disease seasons or outbreaks, it is strongly recommended to visit the nurseries regularly. Where disease is noted, break the continuous tissue line a few centimeters above and below the disease front, taking care to not cut the line.

- Remove the dead material before it attracts fouling. It is not advised to replace the dead as the line could be seeded with disease. For longer-term sets of high-value material or high-disease areas or seasons, set gaps in the continuous (coral) tissue.

- As the system is dynamic, not all branches will fuse but rather abut with a fault line. Such fissures do not appear to hinder health nor system durability, but fusing may be forced with a stabilizing tie or wire.



For more information: www.seascapecarib.com/ US Patent No.US20170196206A1

This document is part of the Coral Restoration Consortium's Guide to Coral Reef Restoration: Methods to Optimize Efficiency and Scale.

Coral Nursery Structure Designs

Coral Restoration Consortium

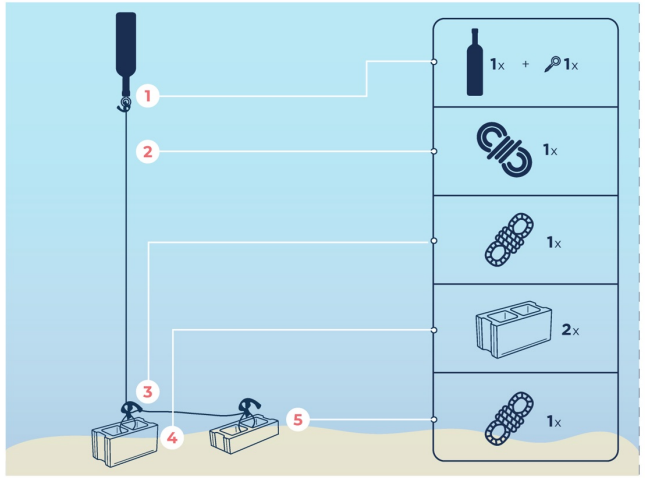
Vertically Tensioned Line Nursery (VTL)

Description of the Nursery

The Vertically Tensioned Line Nursery is a rapid-set system that can serve as a main nursery structure and is useful for emergency triage following storm or grounding damage. These structures also allow for a set and forget approach, where the corals grow large enough to sink the line and corals onto suitable substrate, thus self-outplanting. The basic components can be changed according to availability, are achievable almost anywhere, and on any budget. They are easy to put together and therefore can be assembled on-site or pre-assembled and bundled for deployment. This system is best suited for staghorn corals and similar morphologies with the ability to quickly overgrow substrates. As designed, coral tissue will overgrow the structure, eliminating fouling for a maintenance-free coral nursery.

The following are instructions for building a Vertically Tensioned Line Nursery that holds **40 corals**, with a secondary anchor, floating approximately **40 cm above the bottom** at a **sandy** nursery site with a **depth of 8 m**.

Diagram:



Supplies Needed:

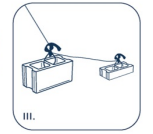
1		1x	**Buoy** – 750ml glass bottle with cork; see Chapter 1: Floats/buoys
1		1x	**Screw Eye** – diameter that the vertical line can fit through
2		1x	**Vertical Line** – 4 m segment of 80 lb braided UHDPE (SpectraTM/DyneemaTM) fishing line
3		1x	**Anchor line** – 1 m segment of 6 mm polypropylene twisted line
4		2x	**Anchors** – 20 cm x 20 cm x 40 cm (17 kg) cement block; see Chapter 1: Anchor Types and Anchor Line Types
5		1x	**Secondary anchor line** – 2 m segment of 6 mm polypropylene twisted line

Details of Construction and Installation:

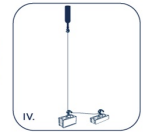
I. Prepare the buoy. Install a screw eye into the cork. Place glue around the cork and secure it in the bottle to form an air-tight seal.

II. Install the anchor. Tie a loop in one end of the anchor line then double-tie the other end through the concrete block and place it in the nursery.

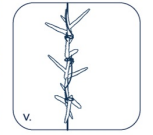
III. Install the secondary anchor. Place an additional concrete block approximately 1 m to the side of the primary anchor, and tie the secondary anchor line through each of the blocks. Bury anchors by at least 50% in sand.



IV. Install the vertical line. Tie one end of the line with a double wrap through the screw eye in the glass bottle and secure with a clinch knot. Tie the other end of the line to the anchor loop with a double-wrap and clinch knot.



V. Add corals. Because the goal of this nursery is for the corals to fuse together, all fragments on the same line should be of the same genet. Untwist a portion of the line and install the fragment approximately 1 cm from the end of the branch, such that the coral is entwined. Hold the fragment along the line and insert 1 cm of the other end of the fragment in another twist. Make sure that each fragment is tightly secured at both ends. Repeat with the next fragment immediately below the first, such that they overlap. Continue until either your source coral or your line is exhausted.



NOTE: For use in outplanting, remove the buoy and anchor and lay the line across the reef allowing corals to self-attach, or tie, nail, screw or cement to secure immediately.

Lecciones aprendidas:

- Este tipo de vivero fue diseñado para áreas cercanas a la cresta arrecifal y es capaz de soportar corrientes. Aunque su diseño original fue pensando para la especie de coral *Acropora palmata*, *Acropora cervicornis* tiende a crecer muy bien también.

- Este tamaño ha demostrado ser el más estable y resistente a la energía de las olas, los viveros de mayor tamaño tienden a ser más débiles. Para corrientes más fuertes, se pueden instalar remaches en las juntas.

- Es importante verificar el diámetro de las tuberías porque las dimensiones de la estructura final (para el momento del montaje) podrían cambiar.

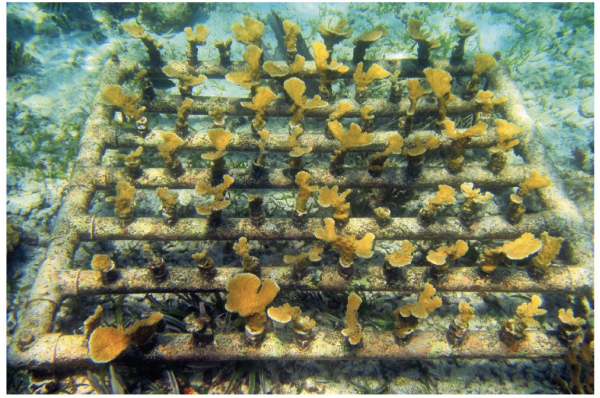
Detalles adicionales en Nava-Martínez *et al.* (2015).

Este documento es parte de la Guía del Consorcio de Restauración de Coral para la Restauración de Arrecifes de Coral: Métodos para Optimizar la Eficiencia y la Escala.

Diseño de estructuras para viveros de coral

Coral Restoration Consortium

Vivero Parrilla

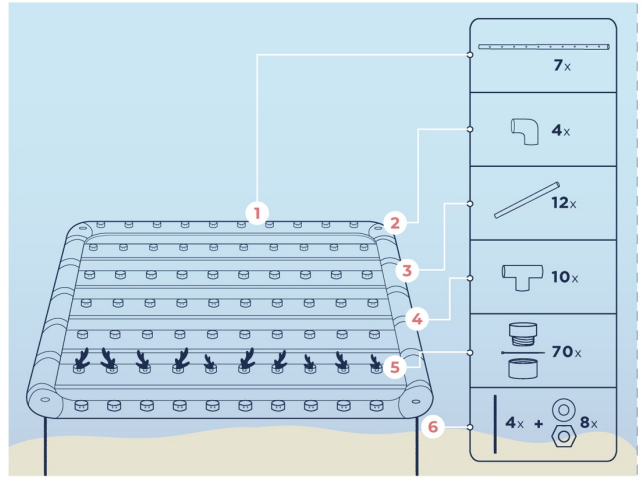


Descripción del vivero

Diseñado para corales de la especie *Acropora palmata* (aunque ha sido utilizado también con éxito para las especies de *Acropora cervicornis, Porites porites* y *Agaricia teunifolia*). Está diseñado para ser instalado en profundidades de 1 a 5 m en áreas cercanas a la cresta arrecifal.

Estructura rectangular construida con tubos de PVC (Policloruro de vinilo) de **6 cm** de diámetro con capacidad para **70 colonias de coral** (puede servir como vivero de producción o estabilización).

Diagrama:

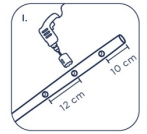


Materiales necesarios:

1		7x	**Tubos de PVC** – segmentos de 1.3 m de PVC hidráulico de 5 cm
2		12x	**Tubos de PVC** – segmentos de 13 cm de PVC hidráulico de 5 cm
3		4x	**Codo de PVC** – conector de codo de PVC hidráulico de 5 cm
4		10x	**PVC T** – conexión T de PVC hidráulico de 5 cm
5		70x	**Adaptador de PVC macho** – adaptador de 19 mm
5		70x	**Adaptador de PVC hembra** – adaptador de 19 mm
5		4x	**Varilla de rosca** – segmentos de 50 cm de ½" varilla de acero inoxidable o galvanizada con rosca
6		8x	**Rondanas** – ½" rodanas de acero inoxidable
6		8x	**Tuercas** – ½" tuercas de acero inoxidable
6		70x	**Cinchos** – Cinchos de 18 cm de 4 mm

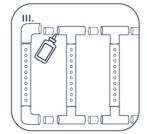
Detalles de Construcción e Instalación:

I. Preparación del marco. Marque los tubos de 1.3 m (la primera marca a 10 cm del extremo del tubo y luego cada 12 cm) y perfore los orificios de 1 ¼" (10 orificios en total).



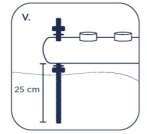
II. Preparación de los adaptadores. En cada agujero pegue un adaptador hembra con pegamento para PVC. Taladre dos orificios de 7/32" en la parte superior de cada adaptador macho con una separación de aproximadamente 3.5 cm. Comenzando desde el exterior, inserte el cincho en un orificio y sáquelo por el otro del adaptador macho, dejando el amarre en el interior.

III. Ensamblar el marco. Pegue un conector en "T" en ambos extremos de 5 de los tubos. Pegue los conectores de codo en ambos extremos de los 2 tubos restantes. Pegue los tubos de 13 cm entre cada uno de los conectores para completar el marco.



IV. Perforar agujeros para el anclaje. Perfore un orificio de 1/2" en el centro de cada codo.

V. Instalar el marco. Con una bronca de 1/2" haga un agujero de 25 cm de profundidad en el arrecife para cada una de las cuatro esquinas. Golpee la varilla roscada en el agujero. Para cada varilla, coloque una tuerca y una rondana para mantener el marco separado del sustrato. Agregue el marco y luego otra rondana y tuerca en cada varilla.



VI. Agregar los corales. Coloque el fragmento de coral dentro del adaptador de PVC macho y asegúrelo bien con el cincho. Recorte el restante del cincho.