MDC Pervious Oyster Shell Habitat: Construction Manual

Abby Frey [1, 2]
Tess Sailor-Tynes [1]
Dr. Linda Walters[2]

[1] Marine Discovery Center, 520 Barracuda Blvd., New Smyrna Beach, FL 32169, USA; abby@marinediscoverycenter.org; tess@marinediscoverycenter.org
[2] University of Central Florida, Department of Biology, 4000 Central Florida Blvd., Orlando, FL 32816, USA



Marine Discovery CENTER



Introduction

Marine Discovery Center Pervious Oyster Shell Habitat (MDC POSH) is a biodegradable breakwater material constructed using recycled oyster shell and a pH balanced cement. These units are designed to buffer wave energy, accrete sediment, recruit larval oysters, and to provide habitat that will appreciate over time. The mixture of shell and cement is highly versatile and can be altered in shape or size to meet the needs of different habitat types. The POSH structure has an optimized surface area with void spaces that are ideal for oyster recruitment. It mimics natural reef structure, providing suitable habitat for juvenile fish, crustaceans, and invertebrates. The dimensions of these specific units were designed to buffer wave energy in a medium energy, estuarine environment without severe degradation.

The original POSH designs were developed by researchers at the University of North Florida whose goal was to fill the gap in the use of non-plastic alternatives in living shoreline construction for high-energy systems (Matthews et al., 2023). This module was considered a more efficient, cost-effective alternative which included an effective use of recycled shell as compared to other novel restoration units (i.e. oyster ball, gabions, oyster bags). Construction of these units was considered more labor intensive than bag or gabion methods and required extensive curing time (Matthews et al. 2023). These original POSH modules are being tested at sites within the Northeast Florida region and are continually being evaluated for success in mitigating erosion and bed stress reduction (Cope et al., 2024).

We identified POSH as a promising experimental substrate to deploy in Mosquito Lagoon for oyster reef and shoreline restoration efforts. When testing POSH construction for the first time, we followed the construction manual by University of North Florida, 2024. We found the construction process did not fit the community-based restoration needs we practice. To adapt, we developed a simplified, volunteer-friendly construction process to deliver MDC POSH for restoration use which resulted in an altered POSH design. This new design is simplified:

1. Use of a rapid set cement with a lower alkalinity to reduce curing time by 93%.
2. Modified molds which reduce efforts needed for cleanup and staging of MDC POSH.
3. Modified molds which reduce the likelihood of breakage during staging, transport, and deployment.
4. No need for the use of an admixture in cement, reducing the number of steps in the construction process.

The original POSH was designed with the intention of restoration practitioners to build modules which meet the needs and scale of their respective projects (University of North Florida, 2024). We intend to share this additional manual to further guide restoration practitioners in the planning and design of projects utilizing MDC POSH as a novel material.



Marine Discovery Center POSH Services

Marine Discovery Center (MDC) is a 501(c)3 non-profit that strives to protect coastal ecosystems and provide habitat restoration materials to support conservation efforts along the Indian River Lagoon and beyond. MDC implements community-based restoration practices that engage public volunteers in the creation and maintenance of materials. In addition to this construction manual, MDC offers these habitat restoration units, like MDC POSH, for purchase pending permits and project scope contracts. Details can be found below in the materials catalogue:

Consultation & Support Services

For practitioners interested in MDC POSH but would benefit from extra startup support, or flexible vendorship options, we offer the following:

- **Consultation:** Staff to provide on-site guidance for POSH creation
- **Vendorship:** Purchase materials directly from MDC to avoid startup costs

Other Services

- **Transport:** transport of materials to staging or restoration site is available based on capacity
- **Deployment:** Deployment support for restoration projects is available based on capacity
- **Monitoring**: Monitoring support for restoration projects is available based on capacity

*Cost of services depends on material types, total travel distance required, and staff time. See Catalogue for more info.

Material Catalogue

Unit details, specifications, and pricing can be found here:

To submit a material request, fill out the order form here:

Materials and Startup procedure

The outline for materials needed to construct a POSH module is included below. The quantities of each item are based on how Marine Discovery Center currently operates volunteer workshops to make 30 POSH per three-hour event. Construction site, staff capacity/availability, and volunteer logistics are all important considerations to determine quantities of materials needed. Please note the difference between materials that may be a 1-time purchase (tools), seasonal or replacement purchases (PPE, molds, buckets, etc.) or continual purchase (cement/shell).

Material	Quantity
Molds	
Plywood bases (2'x8'): 18”x18” pieces (variety of options)	30
1" lumber pieces (8' long): triangular or square options also suitable	90
HDPE plastic sheets: ~1/8” thick (can be pre-cut by manufacturer)	30
15-gallon plant pots: check with local nurseries for cheaper options	30
POSH	
Recycled oyster shell (access and prices vary by region)	-
RapidSet Cement All (55lb bags): 10 bags for 30 units; pallet delivery for 150 units	50*
Construction Process	
4 cu ft concrete mixer	2
4 cup measuring scoop	2
5-gallon buckets: dedicate some to dry cement, wet cement, water, & oyster drain (holes drilled in bottom)	20
Box cutter	1
Transfer shovels	2
pallets	2-4
25' hose: length dependent on workspace	1
Hose sprayer nozzle	1
Rubber mallet/hammer	2
25' extension cords: length dependent on workspace	2
Personal Protective Equipment	
Cement gloves	15*
Respirator masks	1*

*item will require multiple purchases depending on total number of units needed

Material Preparation

Molds

1. **Determine the size of structures you plan to build:** POSH units are versatile and can be molded to the desired size by altering mold shape or dimensions. MDC POSH units were designed to resemble the same dimensions as another frequently used biodegradable restoration material that is 18” in diameter and 8-10" in height. These dimensions create POSH units that are about 50 pounds.
2. **Plastic plant pots are used as MDC POSH molds. Choose a size that best fits your desired structure dimensions.** To create POSH units 18” in diameter, we chose #15 plant pots (~13.66 gallons) to use as molds. Its dimensions are as follows: 18" wide x 16" height. Smaller plant pots have been used to create MDC POSH samples for outreach and biofouling experiments. Plastic pots should be sturdy, yet semi malleable to allow for removal later in the POSH making process.
3. **Cut out the bottom of the plant pot and the lip at the top of the pot (if present) using a box cutter or exacto knife.** Removing the bottom of the pot will create a cylindrical mold while removing the lip of the pot will prevent catching and difficulty in the removal of the molds.
4. **Wooden boards with slats, and HDPE plastic sheets are used as bases to the mold.** Wooden bases can be constructed out of plywood sheets cut to 18”x18” squares or equivalent diameter of the mold. Glue and nail wood slats (scrap wood or stakes [triangular/square] work best) underneath the plywood base to allow for easier lifting later in the construction process. . HDPE (high density polyethylene) sheets are cut to the same size as wooden bases (18”x18”) and are utilized on top of wood to allow POSH to pop off with ease after curing is complete.

Materials and Proportions

1. **Shovel recycled oyster shells into 5-gallon buckets with drain holes:** Be diligent in removing any trash from oyster piles. Buckets should be filled to the top, and drainage holes are necessary for the next step. Note: this is a great opportunity to recycle cracked buckets instead of discarding them!
2. **Rinse the buckets of oyster shells to remove excess dirt.** This is done over a stack of pallets to allow for easier drainage. The rinsing both cleans the shells and makes it so the dry cement can coat them well once in the mixer.
3. **Optional: pre-proportion your shell and cement materials.** This step is optional for efficiency throughout the construction process. It will make it easier to “grab and go” at the start of each MDC POSH unit.
    a. **For shell:** 1 ¼ buckets of shell are used per 1 MDC POSH unit (equivalent to ~38 lbs of shell)
    b. **For cement:** 1/3 of 55lb cement bag per 1 MDC POSH unit (1 bag divided between 3, 5-gallon buckets)





Figure 1. Plywood bases are layered with high density polyethylene sheets to act as the base of the MDC POSH molds.

Figure 2. Triangular slats (1") are attached to the plywood bases using wood glue and nails.









Figure 3. 15-gallon plant pots (a) act as the MDC POSH mold by removing the bottom and lip of the pots and orienting it upside down on top of the base (b).



Construction

Unit Creation

wear dust mask, cement gloves, and eye protection for all steps!

1. **Turn on the cement mixer and pour in 1 ¼ buckets of rinsed oyster shell.**
2. **Pour 1/3 bag of dry cement into the mixer.** Allow to mix until all shells are well coated in the dry cement powder (~30 seconds).
3. **Slowly pour 4 cups of water into the mixer.** It is important to note that environmental conditions (i.e. outside temperature) can create a need for alterations to the amount of water added. Begin with the 4 cups and add water as needed to achieve desired consistency of cement and coverage of shell. This process can take 3-5 minutes.
4. **Place base and mold underneath the cement mixer for pouring.** Place the wooden base with slats first, then the plastic sheet, and then the mold on top (wider side down). The base should line up between the bolts on the wheels of the mixer to prevent spillage.
5. **Once the cement has reached desired consistency and all shells are well coated, stop the mixer and pour the cement/shell mixture into the mold.** One person must hold the mold steady during this process, so it does not get displaced from the base. Another person is responsible for scooping the mixture from the cement mixer into the mold. This process should be done relatively quickly so that there is a nice layer of shell down prior to excess cement pouring out. This time frame is dependent on the consistency of the cement. Cement consistency should be thick, but not muddy (similar to a semi-viscous material like dish soap or paint).
6. **Ensure the top of the POSH module is level by adjusting the placement of shells.** Prevent smoothing the surface of the module during this step. The rough surface increases surface area available for recruitment and mimics the substrate of a natural reef.
7. **Use a team lift to carry the unit to a drying area.** This is a rapid set cement, so curing time is only a few hours, however POSH units are typically left curing until the next workshop takes place (~48 hours).
8. **This process constructs 1 MDC POSH and should be repeated as many times as possible within the allotted work time frame or until materials are exhausted.** Our typical work time frame is 2-3 hours, which can produce 15-35 POSH modules. Multiple mixers can be run simultaneously if capacity is available (15-20 units with 1 mixer and 25-35 with 2 mixers).
9. **After the POSH have cured, molds can be removed and the units can be stacked 3 high for storage.** The molds should slide right off but occasionally they will need extra effort using light taps with a mallet around the bottom edge. When moving or transporting, always pick up POSH from the bottom of the unit where it is most stable.

Lessons Learned and Troubleshooting

MDC POSH Construction

1. The order in which materials are placed in the cement mixer (shell, dry cement, water) has allowed for more even coverage of the oyster shell and has minimized issues with the cement clumping.
2. The cement and oyster shell tend to stick in the back of the cement mixer and build up throughout the construction period. This can make the mixer less effective and much more difficult to clean. To avoid this, we recommend cleaning the mixer after every 4-5 POSH modules using the following process:
    a. Add the ¼ bucket of shell and 4 cups of water only
    b. Allow to mix for a few minutes to break up contents stuck within the mixer.
    c. Dump water out of the mixer into a 5-gallon bucket to be used later.
    d. Add the full bucket of shell into the mixer and continue with the normal process.
    e. Water removed can be added back into the mixture after dry cement is added.

    We have found that this cleaning method takes minimal effort and is the least disruptive to the flow of unit making.
3. Tilting the mixer forward occasionally while it is spinning helps evenly distribute the cement over the shell. This also releases any dry cement stuck in the back.
4. If adding more water into the mixture is required, always start small and allow time for it to mix before deciding to add more. This will help to avoid adding too much and making a runny mixture/less stable unit.

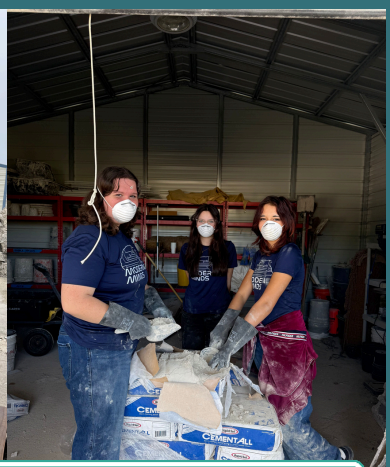
Moving and Transport

1. Always lift the POSH modules from around the base to prevent breakage. POSH are structurally sound but sometimes have “pressure points” which can cause pieces of the unit to crumble when pressure is applied.
2. POSH can safely be stored stacked 3 high, but we do not recommend transporting them in this manner. The added movement and forces at play are likely to cause damage.

Volunteer Management

1. We have found that the ideal number of volunteers assisting in these workshops is 4-10. When at the higher end of that number, we will operate 2 cement mixers at a time.
2. We have found greater efficiency by splitting volunteers into stations: Shoveling oyster shells, rinsing and pre-proportioning oyster buckets, pre-proportioning dry cement buckets, and operations at the mixer.
3. We cannot make POSH modules larger than this, as weight begins to be a major factor in volunteer capabilities.



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Additional Resources

- University of North Florida POSH Construction Manual
- Marine Discovery Center POSH Construction Video
- MDC Habitat Restoration Material Catalog

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POSH Deployments

Initial deployments of MDC POSH began in summer 2025 as a pilot project. 50 MDC POSH were deployed on the perimeter of 3 restored reefs as breakwater materials for wave attenuation. Each unit had minimal gaps between to prevent washout. Deployments continued into the 2026 summer season where 958 MDC POSH were deployed across 8 reefs as exterior breakwaters. 1 of the 8 reefs consisted of MDC POSH as the sole material to accomplish both wave attenuation and oyster recruitment. Gaps were left between each unit to allow for oyster growth overtime. Mini-MDC POSH were constructed and deployed across 4 of the 8 reef sites for ongoing research (30cm wide and 10cm tall). This is a test of the versatility of the MDC POSH mixture for a susbstrate focused project application.



MDC POSH deployed as exterior breakwaters to protect cement-jute rings and BESE oyster mats on interior of a 2026 restored oyster reef.



MDC POSH deployed as primary substrate material on a 2026 restored oyster reef.



Mini-MDC POSH deployed on an experimental reef as part of an on-going student project.

Monitoring

1-year monitoring of MDC-POSH wave breaks on 3 intertidal Crassostrea Virginica (Eastern Oyster) reefs in Mosquito Lagoon, FL occurred in May 2026. 5 replicates (full MDC POSH units) per reef (n=15) were selected haphazardly and examined for *C.virginica*. Shell heights for the first 50 live individuals were recorded and all remaining were tallied to obtain a total abundance.

1-Year Performance

Mean # live *C. virginica* per unit: 293.6±31.4 SE

- Minimum # per unit - 104 oysters
- Maximum # per unit - 479 oysters
- 1,788 oysters/m^2 (extrapolated from mean)

Mean shell height of live *C. virginica*: 46.0mm ± 1.2 SE

- Min - 5mm
- Max - 91mm



MDC POSH 1-year post restoration

References

- Mathews, H., Uddin, M. J., Hargis, C. W., and Smith, K. J. 2023. First-Year Performance of the Pervious Oyster Shell Habitat (POSH) Along Two Energetic Shorelines in Northeast Florida, Sustainability, 15, 7028.
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