



Additional Questions & Answers from the Restoration Techniques for Non-Branching Corals: Lessons from Around the World Webinar

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Answers provided by Dr. Phanor H Montoya-Maya (Corales de Paz and CEMARIN), Sam Burrell (Coral Restoration Foundation), Andrew Taylor (Blue Corner Marine Research) and Dr. Shai Shafir (Oranim College of Education).

1. What software do you use for photogrammetry? Do you use a specific software to calculate the area of corals?

- a. "We build photomosaics in Agisoft Metashape and use Photoshop or Image J to estimate surface area." ~Phanor

2. What kind of drill are you using in Israel?

- a. "In the beginning we used a pneumatic driller with air tanks, about 60 holes per tank. Keep in mind that if you are drilling on a coral rock, there are always natural holes and cracks that help a lot for easy and fast drilling." ~Shai

3. What techniques do you recommend for fragmenting corals in-water? Which techniques have been successful, and which techniques have failed?

- a. "For underwater work (in-situ), hammer and chisel are the simplest easiest tools for fragmenting corals. I haven't had much success with scissors or metal cutting tools. They are just too small for those large, massive corals." ~Phanor
- b. "CRF uses diagonal Husky cutters for all fragmentation in-water, especially for boulder corals. We use loppers for thicker pieces of staghorn or elkhorn corals." ~Sam
- c. "For in-water fragmentation we use a small hammer and chisel with a negatively buoyant cutting board for fragging upon." ~Andrew

4. Do you have experience moving large coral colonies for relocation? If so, what methodologies are effective for increasing survivorship?

- a. "I don't have much experience relocating large coral colonies. Only that gained from savaging hurricane damage colonies. We only had to move them a few meters away, put them back in place and use cement to fix them. It was a straightforward activity that require a lot of human resources." ~Phanor

- b. "We have not had experience moving large coral colonies. We do some mitigation work for moving corals as large as a basketball, in which case we have 20-gallon blue bins we fill with seawater for boat transportation to our in-water nurseries." ~Sam
- c. "Relocating large coral heads takes careful rigging with lift bags. Be sure to have lift bag work done by divers who are properly trained in lift bags, ropework and working underwater - as lifting large objects underwater can be hazardous. When righting overturning coral heads, they usually survive. However, relocation to new sites stress and survivorship will depend on how great a change of water conditions the coral is exposed to." ~Andrew

5. If mother corals cannot be obtained from disturbances, what percentage of harvest from the natural population is considered sustainable?

- a. "From our experience in the Seychelles monitoring over 34 species of donor colonies, we found that taken 10% or less of the whole colony is a good percentage to harvest (none to very few negative effects on donor colonies). This same percentage is today suggested in the literature (see Edwards 2010 and others.)" ~Phanor
- b. "Florida's Coral Reef is protected, meaning we need special permits to collect corals of opportunity (corals obtained from disturbances). To my knowledge, it is illegal in Florida to fragment natural, wild colonies of corals still attached to reef substrate because they are endangered species. That being said, I know the general consensus for harvesting from wild colonies in places such as the Maldives, where wild coral harvest is not illegal, is to take no more than 10% of the colony. I would stress checking local regulations, and whenever possible the collections should be these corals of opportunity. Any fragmentation from wild colonies increases the prevalence of coral stressors, regardless of the amount you take." ~Sam
- c. "For our projects we are able to source enough original stock from corals of opportunity; then increase stock in nurseries. Different countries may have strict legal regulations regarding harvesting of corals from natural populations. So when planning a restoration project, if wild harvest may be required for that particular project then proper harvest permits must be obtained. If harvesting from parent colonies the rule of thumb used by most practitioners is less than 10%... however this would be depend on species (for example



10% of a colony with tiny polyps like Porites would cause much less colony stress or mortality than 10% of a solitary large-polyped Trachyphyllia!).” ~Andrew

6. How do you deal with different genotypes when working with fragments of opportunity when you attach them in the same structure?

- a. “Having different genotypes in the structure is good as you are increasing the genetic diversity in your project/culture. So we don't do anything more than tag and document the different genotypes. If they happen to be clones or genetically similar (e.g., adjacent fragments fuse) we identify them as being part of the same genotype and take note for when outplanting them.” ~Phanor
- b. “CRF keeps genotypes separate from each other so we can outplant in monogenetic clusters with better chances of fusing into one colony.” ~Sam
- c. “This is a big issue working with corals of opportunity! We aim to cover a structure with a single genotype, and often that is possible when we find larger corals of opportunity from damaged areas of reef - as these can be fragmented down in size. However smaller corals of opportunity need to be grown out in the nursery first to reach a size that is then suitable to fragment across a frame.” ~Andrew
- d. “Corals are fighting for space among species and between species. Therefore we try, as reef aquariums scholars are doing, to give space for each coral. If we start with about 7 cm diameter colony, we space them at least 20-25 cm apart. At the nursery we keep each genotype apart.” ~Shai

7. How quickly do you see outplanted corals self-attaching to the reef?

- a. “As fast as three months we see corals self-attach to the reef (i.e. cement is overgrown and tissue starts growing over the substrate) provided proper fixing has been achieved (i.e. no wiggle of the coral).” ~Phanor
- b. “We see staghorn corals self-attach as soon as 6 months, however elkhorn and boulder corals take longer, at least a year. It depends on the substrate and how well we are smoothing out the marine epoxy. The more time you take upfront to properly attach the corals, the quicker they will skirt their tissues and eventually attach to the reef.” ~Sam



- c. "Our best success has been using cable ties as they can make immediate tight contact between outplant and structure. Within a month the skeletal bonding starts, then within 3 months the skeleton will have grown over cable tie and securely self attached with the structure." ~Andrew
- d. "This is species related, from 3 months to a year" ~Shai

8. In the Seychelles, we are starting to use the spiders and we want to test coated and non-coated spiders. Do you have any recommendations on that?

- a. For the last 4 years we have done about half of each type of frame - uncoated & coated. Coated frames (using epoxy and sand) are preferable because they seem to become colonized completely with coralline algae sooner (after 4-6 months in our environmental conditions here in Bali). It also seems that the outplants self-attach onto the coated frames a bit quicker and with higher success rates. However, coating the frames is an extra expense and takes a lot of work. The uncoated frames eventually do become colonized by a layer of coralline algae also 6-8 months... then once the frames are covered with coralline algae they act the same." ~Andrew

9. What about rebar frame time sea erosion weight of coral eventually crushes frame and back to square one?

- a. "The idea of using a rebar frame is to provide a temporary starter block that provides stable substrate above rubble (as we cannot outplant directly onto shifting rubble because they will just become smothered). Once the outplants grow large enough they have enough mass to spread across the rubble area on their own and the rebar frame is no longer necessary so just becomes crushed into the limestone matrix of the reef. Initially we assumed the rebar would erode after just a couple years however 4 years into our restoration project and most frames are still in place providing anchor points for the colonies which have now grown well beyond the frame. At the 4-year mark it seems that most exposed areas of frame are less than 30% eroded so they seem to be lasting long enough to fulfill their purpose." ~Andrew