

Ship groundings on reefs can have long term (70+ yr) impacts and create scars that may never return to pre-impact conditions, thus reducing ecological services provided.

However there are several important actions that can be taken to significantly reduce recovery time. It is even possible to restore damaged reef so that it is providing similar or even greater ecological services than pre-impact conditions.

Sustainable Oceans International (SOI) in conjunction with Reef Ball Australia has a team of experienced coral handlers that have considerable experience working on coral reef restoration and coral transplanting on projects in Antigua, Florida, Saudi Arabia, Indonesia, Thailand and United Arab Emirates.

What can be done?

The following outlines a typical response we take to ship groundings however each project is unique and strategies do vary.

Step 1: Emergency Triage and Assessment

Time is money and mobilising crews and vessels can be costly therefore every minute underwater at the impact site must be productive. The longer damaged corals are left, the greater the mortality and impact.

Typically two teams work simultaneously. **One team surveys and documents the damage** to accurately quantify the type of injuries, coral (species and size) and dimensions of the impact area. Surveys of surrounding reef are also conducted to provide a comparison to the impacted areas. This guides the development of the restoration plan.

Permanent transects may be established at this time for future monitoring and evidence.

Towed camera surveys may also be used to quickly cover large areas and provide 'bigger picture' evidence of the extent of damage and condition of natural un-impacted reefs. This footage is also excellent for briefing key stakeholders and teams.

The second team simultaneously conducts emergency triage. Toppled coral colonies will quickly start to die. Triage involves temporarily stabilising and/or righting toppled coral colonies to increase survival and reduce stress while planning is completed. A temporary 'nursery' may be required to safely hold the corals in calmer water until they can be relocated.

If time allows, these colonies are tagged and photographed for future reference. As far as possible, chips or rubble with antifouling paint are collected and removed.

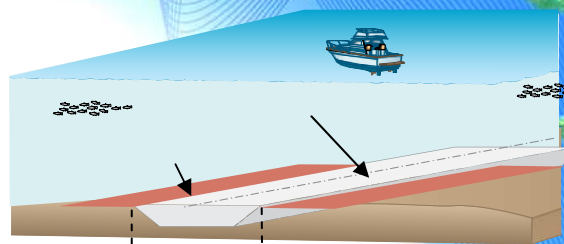
Photo and video documentation with relevant ID in frame is essential.



Our certified coral handler Mike Naugle relocating coral out of a dredge zone, Saudi Arabia. R: floating coral propagation station used to prepare coral fragments for transplanting (UAE).



Towed video with GPS overlay is used to cover the impacted area quickly and provide a useful overview plus comparison footage of adjacent un-impacted reef.



Graphical presentation of the damage is used to help develop restoration plans and present evidence and options to stakeholders.

Services

- Training
- Impact assessment and mitigation/restoration plans
- Design and supply of concrete reef modules
- Coral propagation and relocation
- Artificial reef design



Step 2: Preparation of Restoration Plan

A restoration plan takes into consideration key stakeholder values, natural recovery, ecological services before and post impact, priority colonies and actions, secondary impacts, resources, timing, regulatory requirements, sea conditions, budgets and aesthetics.

Step 3: Restoration Options

If the damage is limited, the coral rubble stable and the area conducive to rapid recolonisation then taking 'no action' is a viable option.

There is a variety of restoration options depending upon the objectives. Some common objectives include:

- a) Rescue of high priority colonies
- b) Stabilisation of coral rubble
- c) Restoration of reef 3D structure

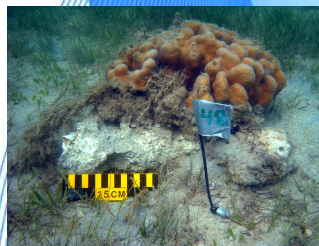
Toppled, fractured or broken coral colonies can be reattached to the natural reef substrate and/or suitably designed concrete modules. It may be necessary to relocate these colonies outside of the impacted area. Where aesthetics are important, such as tourism sites we prefer to use concrete modules that blend in with the natural reefscape where possible.

Stabilising coral rubble is very important as coral regrowth on loose mobile rubble is minimal and the rubble can move causing secondary impacts to the surrounding reef. Rubble can be placed within the void space of Reef Balls or under artificial modules or piled up and cemented into a stable structure. Concrete modules can also be used to 'corral' rubble to prevent it from moving in storms and causing further damage. Aquascaping an impacted reef is an art and science and we are able to recreate reefs that appear natural within 6-12 months.

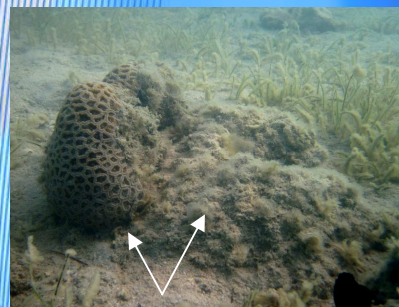
Restoration of 3D structure can be important for numerous reasons. Corals are slow growing and groundings wipe out hundreds of years of growth. Reef height and complexity is directly linked to species abundance and diversity and loss of habitat can leave fish vulnerable to predation. To mitigate this, suitably designed artificial structures such as Reef Balls or custom reef units can be used to quickly restore complexity and protective habitat for fish and mobile species and substrate for corals, sponges and other fauna and flora to settle on.

Asexual coral propagation is a useful restoration tool used to rescue imperilled corals, preserve the gene pool, and increase the number of colonies from one parent (donor) colony. While this can be a very beneficial technique not every coral species lends itself to this approach and can be counterproductive if not done properly.

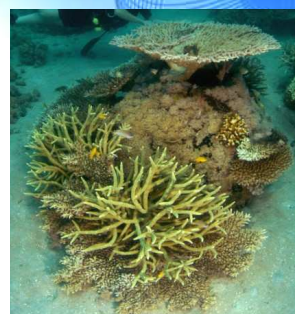
Monitoring is an important step in any mitigation project and 'success' criteria must be defined. During the critical early stages (first two months) monitoring should be every two weeks. Budgeting for this step and subsequent monitoring at 6-12 months intervals helps ensure success and provides valuable data for stakeholders, regulatory bodies etc.



Top photo shows a coral colony removed, tagged and ready for transplanting. Photo right shows the colony after replanting. Final planting should aim to maintain a natural appearance.



Small coral colonies or fragments can be anchored to concrete bases. Our strategy is to construct bases that have a natural appearance after 6 months as demonstrated in this photo.



Examples of Reef Balls with 8 and 4 years of coral growth in Indonesia and Thailand - deployed to mitigate blast fishing and repair tsunami damage. Reef Balls can be used to quickly restore shelter and structural complexity to damaged reefs and prevent coral rubble from moving and causing further damage.

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