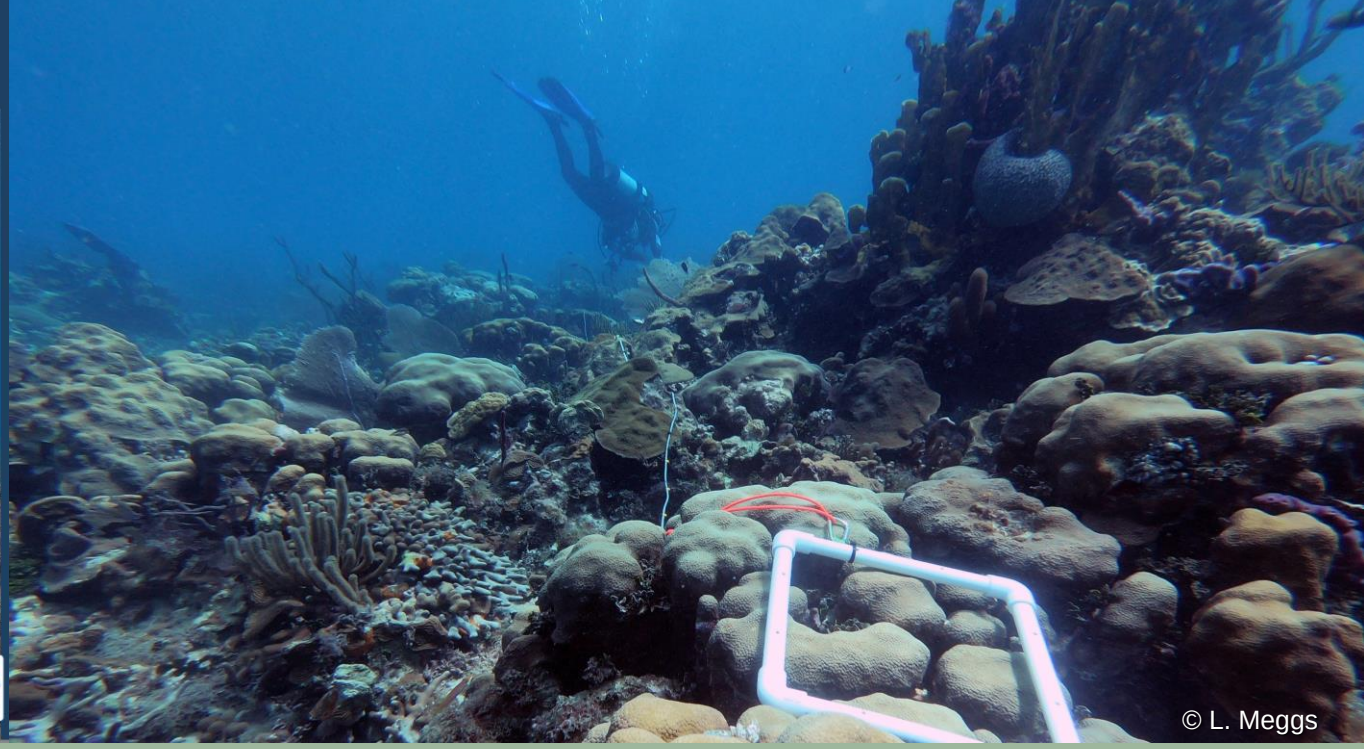
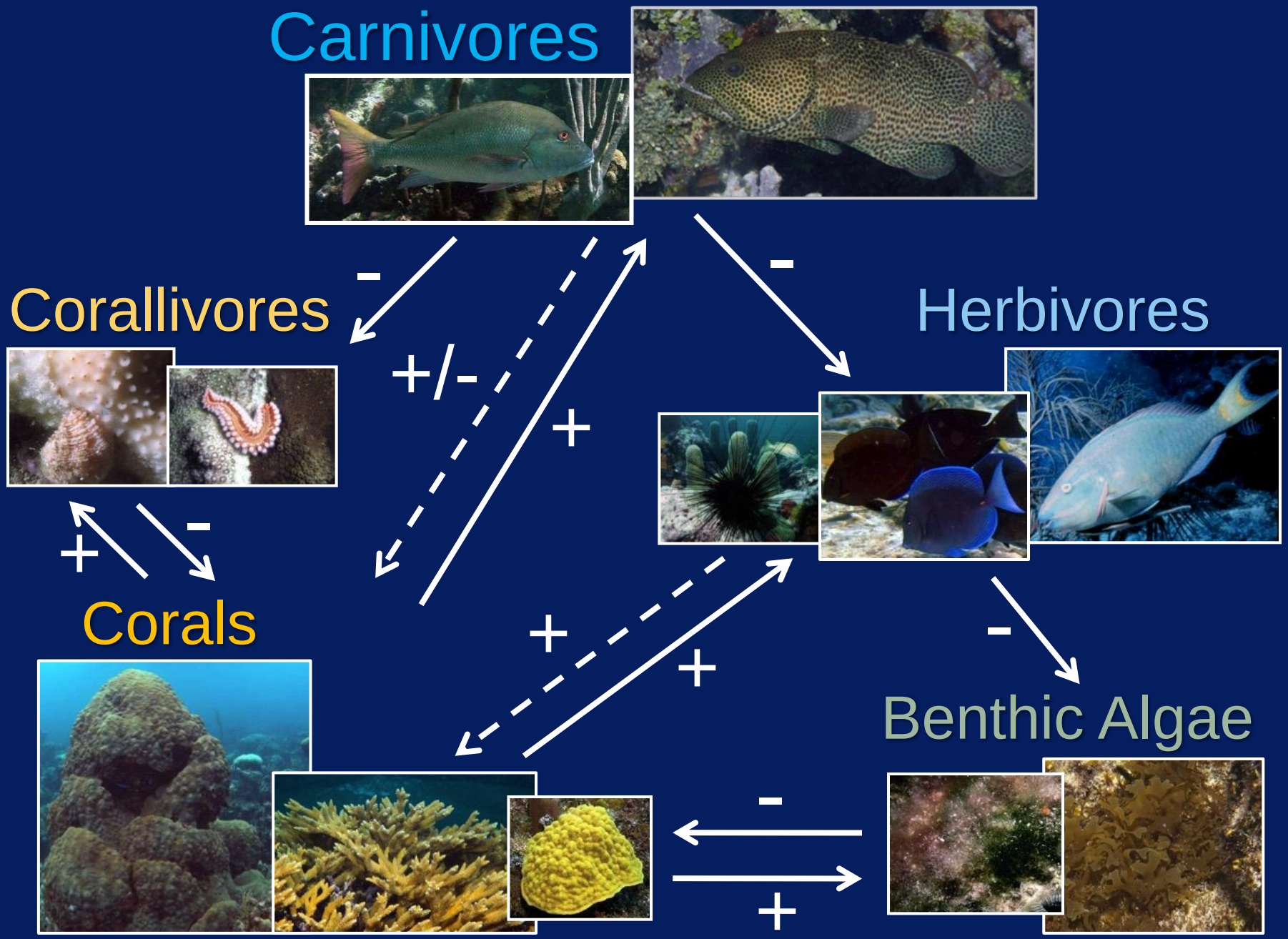


Guiding Coral Rescue with Monitoring Data

Judy (Judith C.) Lang
jlang@riposi.net

Atlantic and Gulf Rapid Reef Assessment

June 10, 2024



Modified from P.R. Kramer; © photos: A. Bruckner, R. Ken, J. Lang, K. Marks, M. Moe, J. Schulke, R. Steneck

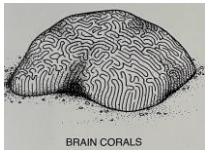
* Given what you know about the condition of the corals on your reefs in 2024, which species most need rescue, and why?

You may include > 1 reason: susceptible to disease or bleaching or post-bleaching mortality; naturally rare; iconic; culturally valuable.

?acroporid: elkhorn (APAL) staghorn (ACER) fused staghorn (APRO)

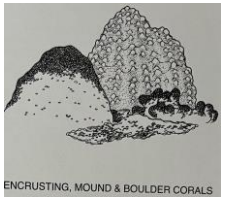
?meandrinid: pillar (DCYL) + maze (MMEA, MJAC)
+ smooth flower (EFAS) + elliptical star (DSTO)

?brain: boulder (CNAT) grooved (DLAB)
symmetrical (PSTR) knobby (PCLI)

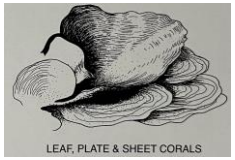


?star: lobed (OANN) mountainous (OFAV)
boulder (OFRA) great (MCAV)

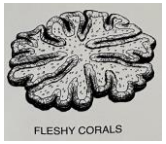
?starlet: massive (SSID)



?plates: lettuce (AAGA) thin leaf (ATEN) any other?



?mussid: cactus (MYCE species)
+ spiny flower (MANG) + mushroom (SCOL species)



Artwork: Humann & DeLoach. 2013. Reef Coral identification. 3rd Ed.

* What kinds of data about the population biology of your corals would help inform you choice, and why?

name

relevant to:
shape, habitat requirements (light, space, wave energy, depth range)

?colony status (unitary, fragmented or in clumps)

relevant to:
approx. number of genotypes in population

?size (living & dead areas)

relevant to:
reproductive ability, approx. maximum age?

?condition (pale or bleaching, disease, predators, compeditors, etc.)

relevant to:
health,life expectancy

Benthos: Crustose Coralline Algae (CCA)

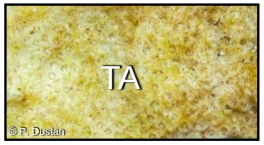
CCA also get diseases.

Benthos: Cyanobacteria and Algae

Cyanobacteria

Turf Algae/Turf Algal Sediment Mats:

Relationships when Herbivores are Absent



short/sparse Turf Algae

herbivores are cropping

- herbivores

TA proliferate

tall/dense Turf Algal Mat

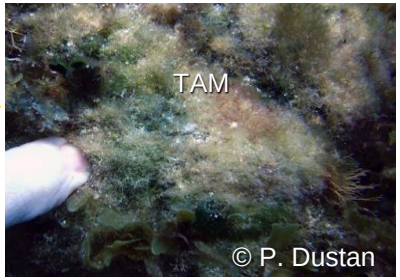
+ sediment

prevent coral larval settlement; overgrow corals and CCA; may be reservoirs for coral pathogens

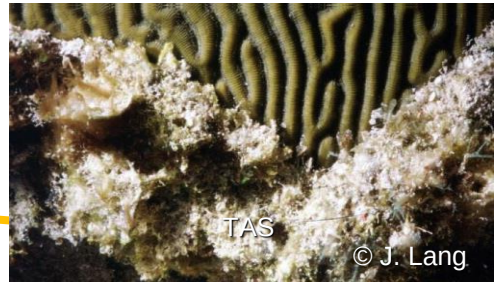
TA Sediment Mat

avoided by many herbivorous fishes

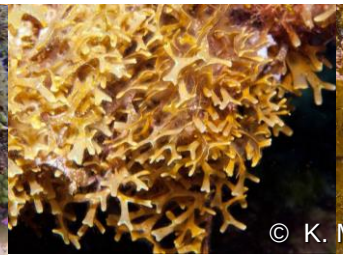
Turf Algal Mat



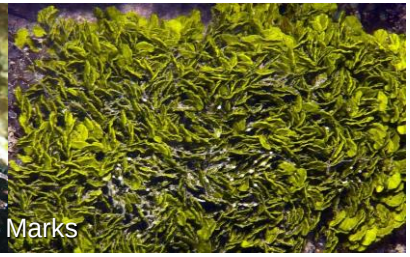
Turf Algal Sedimdent Mat



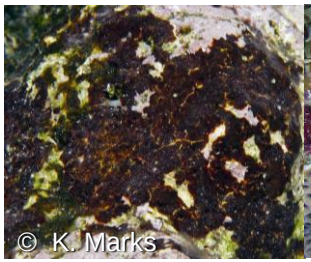
Fleshy Macroalgae

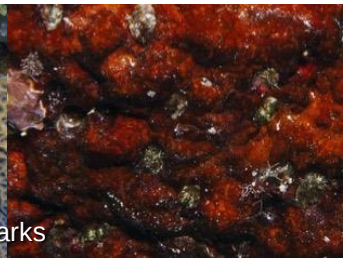


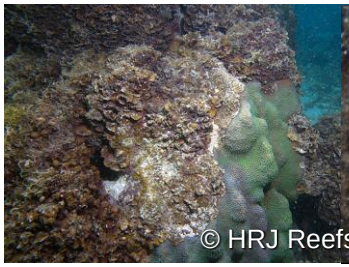
Calcareous Macroalgae

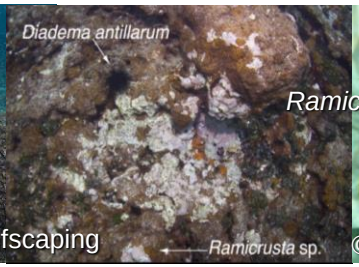


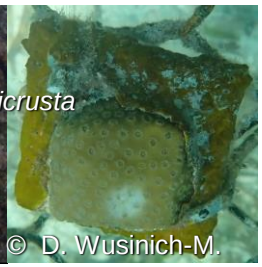
Peyssonnelids











Benthos: Aggressive Sessile Invertebrates

© S. Zea

© B. Kakuk

© K. Marks

© B. Kakuk

+ Invasive xeniid soft corals

© E.Villamizar

Benthos: Other Sessile Invertebrates

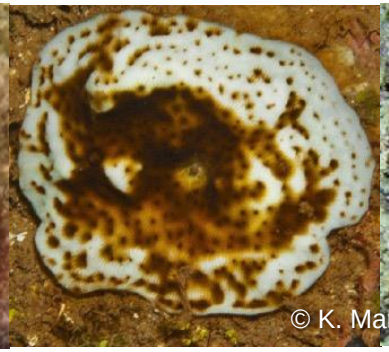
© K. Marks

© K. Marks

© D. Toledo

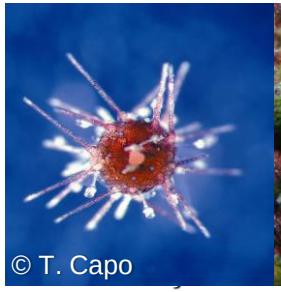
Other Important Benthos

Juvenile Corals



Herbivorous King Crabs

Herbivorous Urchins



Predatory Spiny Lobsters

Scavengerous Sea Cucumbers

Herbivorous Queen Conch

* Given what you know about the ecological condition of your reefs in 2024, which sites are more suitable for long-term rebuilding (rehabilitation) and why?

You may include > 1 reason:

+	? coral cover	essential constructors of coral reefs
	? benthic "algal" cover as	
+*	crustose corallines	cement coral skeletons, coral larval settlement is possible
+	sparse turf algae	coral larval settlement is possible
- *	turf algae mats & sediment mats	can outcompete corals, including outplants
-	conspicuous cyanobacteria	can outcompete corals, including outplants
-	fleshy macroalgae	can outcompete corals, including outplants
-	crustose macroalgae	can outcompete corals, including outplants
-	peyssonnelids (esp. *Ramicrusta)*	can outcompete corals, including outplants
-	? aggressive non-coral invertebrate cover	can outcompete corals, including outplants

Benthic index: summaries net effect of all +ve promoters and all –ve detractors on benthic cover.

	? non-aggressive non-coral invertebrate cover	do occupy abundant space on some reefs
+	? coral recruit density	reflects success of natural coral larval recruitment
+	? urchin density (*Diadema* or *Echimometra viridis)*	reflects invertebrate herbivory level
+	? herbivorous crab density	reflects invertebrate herbivory level
+	? functionally important fish names, approx. sizes, density	have many ecosystem functions

* + = Coral and coral reef promoters; - = coral and coral reef detractors

MONITORING: Categories, Goals, Objectives, Metrics

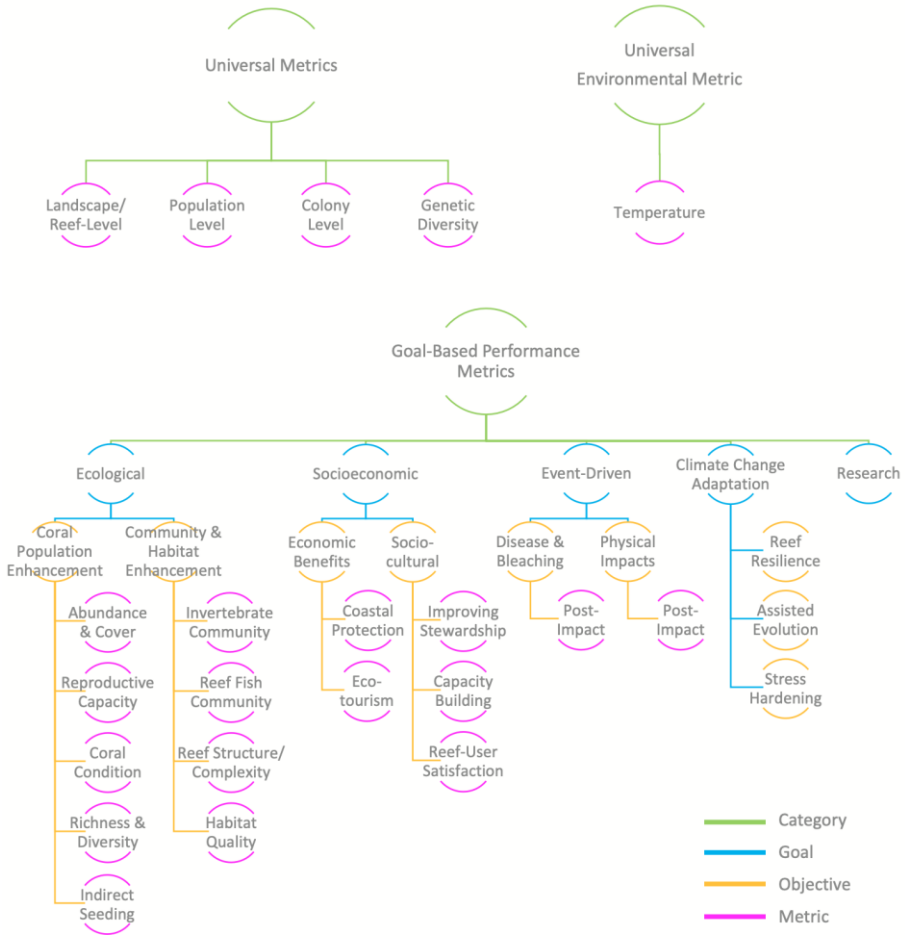


Figure 7. Summary of recommended approaches for monitoring coral reef restoration.

From: Coral Reef Restoration Monitoring Guide, **p. 16.**

MONITORING CONSIDERATIONS

Reference & Control Sites

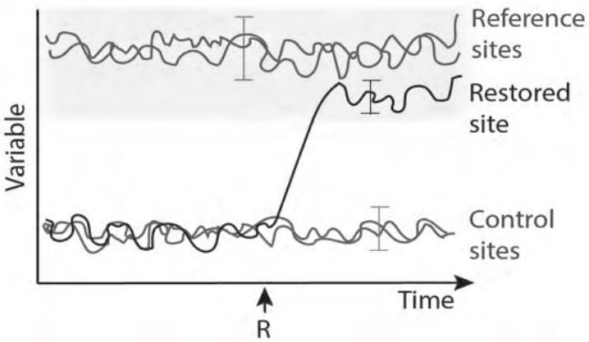


Figure 2. Control and reference sites are needed to assess the success of restoration. *R* indicates when restoration began. Measures in the restored and multiple control sites before and after the time of the impact should be compared to measures in reference sites which provide measures of expected conditions for restoration to be considered successful. Figure and caption adapted from Chapman (1999).

a control site survey could be used as a proxy. Control sites may also be used in addition to baseline surveys. Control sites are sites in similar condition to the restoration site prior to restoration, but are left undisturbed in order to measure changes in the restored site. Control sites alone, however, are not sufficient to assess restoration success, for they merely provide a comparison to show whether the restored sites have changed. Reference

der Valk, 1996; Simenstad and Thom, 1996). The reference site should resemble what the project is striving to achieve through restoration, this may not always be restoring to historical levels (i.e., a lush *Acropora* thickets found in the 1960s in the Caribbean), but to an intermediate or more modern day reefscape (i.e., clusters of large *Acropora* colonies). It is important that a restoration

Random *vs.* Stratified Random

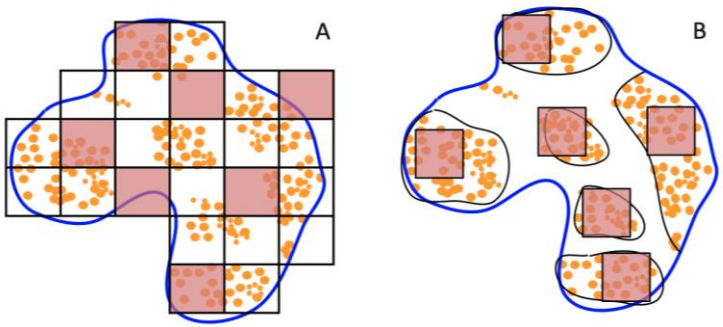


Figure 4. Example designs of (A) simple randomized sampling and (B) restricted random sampling. Random sampling, due to the outplanting design, does not adequately capture the restored corals, therefore the areas for sampling can be restricted to the outplanted areas and then random sampling plots can be chosen within these restricted areas.

project monitoring plan. The simplest methods may be a haphazard or simple random sampling approach (Figure 4). However, for a restoration project, it may be necessary to deploy a more systematic approach (e.g., systematic, cluster, two-stage, restricted random or stratified sampling) to ensure that restored corals are being monitored in numbers that are sufficient enough for data analyses to be both statistically and ecologically meaningful. This concept is illustrated in Figure 4, where a simple random sampling design misses a majority of the corals used for restoration; however, a change in survey design to a restricted random sampling includes delineated outplanted areas where random sampling is deployed only in those outplanted areas. This would be an appropriate method to survey colony demographics; however, if studying a different metric, such as change in coral cover, the simple random design or others may be more appropriate to capture change inside and outside of an outplanted plot, especially for transient species (e.g., *Acropora* species). Therefore, it is best to

From: Coral Reef Restoration Monitoring Guide. **pp. 9-11.**

MONITORING PREREQUISITES

1. **Know your own reefs–and, in a changing world, when intervention is necessary.**
   (e.g., **disease, bleaching, storms, invasive organisms, dredging, coastal construction, ship groundings)**

2. **Create good community relationships as others often see changes before you.**
   (e.g., **fishers, industry and recreational divers, conservationists, researchers, citizen scientists, general public).**

3. **Train others to help conduct surveys** ***(e.g.*****, see 2 above).**

3. **Try to have dedicated, stable (long-term) funding for planned and unplanned surveys.**
   (e.g., **French ministry of environment has emergency funding of €50,000 available each year to territories,**
   but only re leased if one of the monitoring methods described in its bleaching monitoring guide is followed).

4. **Timeline–create a plan and expect changes** ***(e.g.,*** **see 1 above).**
3. **.**

Figure 5. Timeline for monitoring restoration after outplanting. Additional monitoring is recommended in response to specific events such as disease, bleaching, and cyclones.

From: Coral Reef Restoration Monitoring Guide **p. 12.**