DEPLOYMENT OF REEF BALLS

Client: ***PT Newmont Minahasa Raya***
Project: ***Habitat Enhancement Program – Buyat Bay and Adjacent Areas***
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Introduction

The following is a brief report outlining a recommended strategy for the construction, deployment and monitoring of Reef Balls (specifically Pallet Balls and Bay Balls), in the Buyat Bay and surrounding area. This strategy is designed to provide maximum success, safety and benefits from the habitat enhancement program. However, it is important to note that there will need to be a degree of flexibility in the program, and a regular review of all activities should be conducted to allow 'fine tuning' of the program throughout its progress, and as data becomes available. For example, it is not possible to predict exactly the growth and species composition that will be attracted in each area, therefore as observations are made they can be used to guide future deployment configurations.

Additionally, there must be a regular review for quality control purposes to ensure the modules are being made to Reef Ball specifications. This is absolutely essential and a condition of all purchasers and users of the moulds. Quality control is important for many reasons, and includes safety of personnel involved as well as the environment.

A habitat enhancement program such as this incorporates a philosophy of respect for the marine environment and efforts to work with it as well as understand it. It is not to be promoted as a means to continue unsustainable exploitation of the sea by methods such as explosives, cyanide or overfishing. This can not be emphasised enough, and every effort should be made to prevent (or at least discourage) unsustainable fishing, and fishing in general on the Reef Ball reefs should be discouraged for 6-12 months.

Topics covered include:

- Construction issues: materials, concrete mix, methodology, supervision, spare parts;
- Deployment: potential objectives, selection of sites, future deployments, configurations, methods of deployment, and additional sites; and
- Monitoring: suggested monitoring objectives and timing.
- Appendices – checklist and responsible reef creation

Construction of Modules

There are three key aspects to construction – materials, methodology and supervision.

Materials

Materials used must comply with the specifications listed in the Reef Ball manual and most importantly, must not contain any of the materials listed as being not allowed.

*The following are **NOT ALLOWED** in the concrete mix:*

- **Fly ash**;
- **Sand** that may be contaminated, contain salt or organic matter (ie river sand or beach sand that has not been screened and washed);
- **Accelerators**, except for Calcium Chloride;
- **Silicone sprays** - they may damage the balls and prevent colonisation by fouling organisms;
- **Admixtures** that contain toxins or biologically active elements (including iron and nitrogen/phosphates – check with manufacturer);
- **Rebar**, except for fiberglass rebar;
- **Form oil** or release agents/waxes on the inside of the moulds, or anywhere else that may cause them to come into contact with the concrete (sugar water is okay to use); and
- **Any other products** that contain plastics or petroleum products (Phil - make sure you get your toys out!).

Remember, your aim is to promote better respect for the ocean and create balanced reef ecosystems, therefore Reef Balls must be as environmentally friendly as possible.

Several of the required materials or admixtures are made by different manufacturers and consequently are sold under a variety of brand names. The main ones are:

Silica Fume – this may be referred to as silica flour, Micropoz (Australia), microsilica, or WR Grace's Force 10,000. The brand currently being used from Aust/NZ (?) should be fine. Stick to a reputable brandname and supplier.

Super Plasticiser and *Air entrainment mix* – several brands available and the following brought from Australia are ok.
- 'Brickies Own Concentrated Mortar Plasticiser' (Clear), by MELCANN
- 'Clear Bycol' – clear air entraining admixture for smooth working of concrete, by AJAX chemicals.

NOTE: Due to the fact that Newmont has regular shipments from the US, it may be worth ordering admixtures and even silica from the Reef Ball recommended supplier WR Grace – see manual for contact details and ask if they can ship concentrated formula that you simply add water to. This would save on weight and shipping costs.

Concrete Mix

1 cement, 1 sand, 1 gravel Plus silica and admixtures.

Bay Ball = 3-5 kg of silica
Pallet Ball = 8-10 kg of silica

Admixtures – as per manufacturers instructions.

The crucial points to remember are:
- Add at least half the required water first and then the silica. This allows it to mix well before the cement etc is added. The silica will only work if it is mixed thoroughly with the cement!
- Allow the concrete to mix for 10mins before pouring for the same reason as above (concrete testing labs in Australia run the mixer for 30mins before testing silica mixes).

- Too much water weakens the mix, but too little can cause voids to form, especially in the Pallet Ball. Technically the mix should have a 20cm slump, however it is easy to develop a visual gauge of the correct mix, and Harapan and Jumadi are now proficient at gauging by eye. Basically the mix should 'slide' down itself in the mixer rather than 'pour' or 'tumble' in lumps.

The photo below is roughly how the mix should look. It doesn't show it too well, but the mix should not be runnier than this.

Methodology

The following describes the main points to remember and new techniques not covered during training due to short time frame. The checklists cover a step-by-step account of methodology. There isn't anything too complicated about it, but attention to the small things pays off. There is tremendous benefit from following a set 'system'. Time is saved, mistakes eliminated (or at least reduced!), and the modules are produced within specs.

Harapan is very proficient, as you know, and has a good understanding of the methodology. He should maintain a supervisory role until he thinks Jumadi (or someone else) is capable of taking over. Harapan should then continue to check the operation regularly to ensure they continue to follow the system. However, no system is perfect and if they find a way to do the job easier and faster, but still maintain required specs for mix, curing and handling, then let them go for it.

Two checklist s have been produced in English and Indonesian and posted in the container. The most useful is probably the one concerning starting and shutdown steps and are included in Appendix A. At the end of pouring and cleaning equipment, it is important they remember to check supplies of sand, cement, silica, admixtures etc, and refill the admixture and sugar water bottles. Doing so not only sets up the site for immediate start the next morning, but also prevents them from finding out the next day that they have run out of something that takes two days to arrive. It will encourage them to keep an eye on supplies and to order in plenty of time.

Table 1 is an initial Reef Ball construction and deployment calendar that will help plan the program to tie in with barge arrivals and monitoring etc.

Key Points/Issues

- Keep oils away from any areas that may cause them to come into contact with the concrete.
- Make sure they are getting the gravel exposed and removing all the surface layer in order to ensure the pH is as low as it can be.

- Keep reminding the crew to go easy on the plastic screw valves, they are already starting to strip the screw slot. They must get the concrete out of the slot before attempting to unscrew it. You have several spares and more can be ordered easily enough.
- Keep the work area, moulds, balls and container clean. Important to clean the moulds after each use otherwise the concrete will build up quickly forming a thick layer impossible to remove. This makes it difficult for the mould to go together which adds stresses that may break the moulds, and makes repairs hard.
- Keep modules damp under wrap for 3 days.
- Keep track somehow the date each module was made.
- Don't make pointed ridges in the lobster holes as this can be a weak area that could crack on impact. Make them with rounded tops.
- Don't put too much sand in bottom so that there is a crack or gap from the base into bottom holes. This is a weak area and breakage could occur on impact.
- With Pallet Balls it is a good idea to add enough cement to build up the ridge around the top. This creates better strength for resistance to anchor strikes.

Variation of Modules

- Vary the number of holes, ie balls added. This is done for strength and also variety. For stronger modules put less balls, especially in the upper area of the Bay Balls. For example if anchor damage becomes a problem, make thicker walls by putting less air in the bladder and less balls in the upper area. Also, variety is important for marine life, and some fish love caves, so less balls creates a good cave effect. This will give you a more diverse reef.

- Use leftover concrete to throw on modules, outside and inside. The crew has done this, but lately we've let them use it to build a platform by the sea. This creates even more lumps and bumps. Caution: if you are going to do a floating deployment, don't use a module with the concrete on the inside as it may puncture the bladder (assuming you use the bladder for floatation). Also remember that this concrete won't be as old as the module, so put it on modules from the day before so it is almost the same as age as module.

Supervision

I don't need to emphasise the importance of good supervision. Harapan is more than capable but will obviously need to go back to attending to his normal workload. Jumadi is the natural next best person to supervise, but Harapan still needs to check regularly, ie every day for another week, then several times a week, or as needed (knowing Harapan, he will make surprise visits no problem). If they follow the checklists, everything will go a lot better.

The key areas to check for are:

- Top wall thickness of modules (BB = min 50mm, PB = min 150mm) – thicker if anchor damage becomes a problem. Remember thicker is not a problem, but thinner is;
- Correct mix ratios and quantity of silica added;
- Sufficient mixing time, they could be tempted to skimp on this;
- Good exposure of gravel, ie removal of uncured surface cement;
- Correct curing technique and curing time;
- Quality of materials;
- Safety gear, especially safety glasses and decent boots. I understand this is the responsibility of the contractor, but Harapan will need to chase them up on this; and
- All tools still remaining and hung on board.

Spares

The manual provides a list of few spares and repair kits required. The fibreglass panels are very durable but may wear thin after awhile. They can be easily patched or reinforced with standard fibreglass cloth and gel resin.

The balls will last a year or more and you have a spare of the bladders plus ample spare tether and A0 balls. Because they are standard boat buoys, most marine supply houses will have them. The tether balls will have to come from Reef Balls in the US, but they always give you ample extras, so I don't see them being an issue for awhile, unless of course they disappear.

The pins won't break and I don't think they will go walk about. The main spares required will be items such as spray bottles, hammers, and perhaps the plastic screw valve plugs for the bladders and A0 buoys (you already have quite a few spare plugs).

Hard to find spares – we had trouble locating a few things so I've left you with the ones that I brought. They were: air nozzle adapter and hose for scuba regulator – ore testing lab has air nozzles that can be adapted, or Petrosea truck mechanics also use a suitable nozzle. If you have trouble let me know and I can send from Australia. Scale – simple hand held fishing scale for weighing silica – not unique and should be able to be replaced in Manado.

NOTE: I recommend that you remove the regulator and octopus from the reg used for inflating the bladders. They are getting beaten up and don't need to be attached. Make sure the plugs are put back in the first stage.

Safe Keeping
I think it is best if spares are kept with Harapan. This will keep better control of them and if they need them, it is easy for them to request them. Before storing, make a quick inventory of what you have.

Table 1:

REEF BALL
CONSTRUCTION AND DEPLOYMENT CALENDAR

DATE	BB made	PB made	*BB ready	*PB ready	*Deploy/Comments*
24-7	2	-	-	-	
25-7	2	1	-	-	
26-7	2	1	-	-	
27-7	2	1	-	-	
28-7	2	1	-	-	
29-7	2	1	-	-	
30-7	2	1	3 deployed	-	Detailed site surveys/buoy sites/deploy Bay Ball markers
31-7	2	1		-	Barge arrives?
AUGUST					
1-8	1	1	1	1	DAVE LEAVES/set up barge
2-8	1	1	3	2	
3-8	1	1	5	3	
4-8	1	1	7, six deployed	4, 3 deployed	Deploy 1 PB at each site, plus two Bay Balls
5-8	1	1	3	1	
6-8	1	1	5	2	
7-8	1	1	7	3	
8-8	1	1	8	4	
9-8	1	1	9	5	
10-8	1	1	10	6	
11-8	1	1	11	7	
12-8	1	1	12	8	
13-8	1	1	13	9	
14-8	1	1	14	10	
15-8	1	1	15	11	
16-8	1	1	16	12	
17-8	1	1	17	13	
18-8	1	1	18	14	
19-8	1	1	19	15	
20-8	1	1	20	16	
21-8	1	1	21 deployed	17	Deploy seven Bay Balls at each site
22-8	1	1	1	18	
23-8	1	1	2	19	
24-8	1	1	3	20	
25-8	1	1	4	21	
26-8	1	1	5	22	
27-8	1	1	6	23	
28-8	1	1	7	24	
29-8	1	1	8	25	
30-8	1	1	9	26	
31-8	1	1	10	27	
SEPT					
1-9	1	1	11	28	Barge arrives?
2-9	1	1	12	29	
Etc	1	1	13	30	Deploy 10 Pallet Balls at each site, plus Bay Balls available modules
Etc					
Etc					

*NOTE: the modules should be strong enough to deploy after seven days, however, the concrete will NOT be ideal for hard corals, and soft corals will tend to colonise for the first few years. The modules should 'age' for 3-4 wks or longer to reduce the pH more which will benefit hard corals better. It is worth the wait, as once the modules are in, they will not be replaced. So it is better to wait and ensure you are deploying the most beneficial modules.

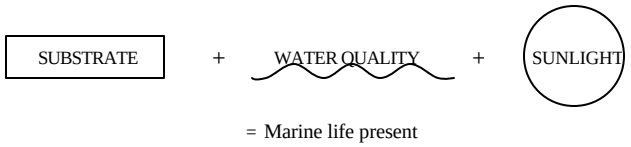
The calendar assumes modules will be made 7 days per week, at least initially to help kick start the program.

Deployment

All programs, (especially community programs) require realistic objectives and goals. Otherwise unreasonable expectations may be created and the programs final outcomes may not meet original objectives/promises, resulting in the community or PTNMR becoming disappointed.

I am concerned this could happen with this program, as it appears as though the Buyat Bay villagers are expecting the Reef Balls to solve, what they perceive as being less fish in Buyat Bay now than there was before PTNMR commenced operations.

Very basically, marine life present in an area is present because of the type and level of three main factors as shown below.



Which ones can PTNMR be accused of changing?

The facts are:

1. From the extensive monitoring undertaken by PT Newmont, the only real change I can see in Buyat Bay is change to the physical and chemical characteristics of the substrate where the tailings are dispersing to. PT Newmont must therefore be careful about promoting that the Reef Balls will replace lost habitat, or will provide a habitat that will function the same as the habitat covered by tailings. The Reef Balls will provide a very different habitat but it will be reef type habitat that can be colonised.

2. From PT Newmont surveys of catches and discussion with Jerry K, target species of the villagers are mainly pelagic fish such as mackerel, trevally, and scads. These are highly mobile species and not closely linked to coral reefs, and no doubt pass through and enter Buyat Bay on an opportunistic/cyclic basis. Deploying Reef Balls is not going to provide a habitat that will appeal to these fish directly, however they may help create eddies that trap plankton that the smaller planktivore scads will feed on. The Reef Balls will attract and provide shelter and food for a lot of fish, but it must be remembered that they may not all be fish that the villagers consider worth catching (eg. see photos of concrete blocks over pipeline).

3. It is highly likely that if there has been a decline in pelagics being caught in Buyat Bay, it is due to overfishing within the Bay and other areas that the pelagics travel. Review of water quality data does not suggest there is a water quality problem that could be held accountable.

4. The project is young in the scheme of things. It is not wise or ethical to promote marine life to an area that could result in bioaccumulation of toxicants.

Potential Objectives

The following are what I feel are realistic potential objectives for the program in your area.

1. Habitat enhancement to add back shelter and structure to reefs suffering bleaching and bomb or cyanide damage, especially branching corals that when dead quickly break down.
2. Increase productivity of 'simple' habitats, ie flat sandy/mud areas or low relief rocky areas including deepwater sites (50m+). NOTE: do not get the impression that sandy/muddy areas are unproductive, they all have their role in nature, so do not aim to cover every square meter of such habitat with modules.
3. General increase in species numbers and diversity.
4. Potential to help support recolonisation of the natural predators to the Crown of Thorns starfish currently infesting many of the monitoring sites.
5. Development of small Reef Ball manufacturing industry for other areas in Indonesia.

Selection of Sites

Considerable thought has gone into this, as well as a review of available impact assessment and monitoring reports. I feel I have a fair understanding of the area, especially after conducting site surveys which is the best way to gain an understanding of the existing water quality and ecosystem health. However, this is still only a basic understanding of the area. It is important the sites are monitored to gain a better understanding of how the Reef Balls are functioning in order to direct future deployments.

I decided three, possibly four sites would be a good starting point for this program. The rationale being that it is better to have more Reef Balls at fewer sites, rather than too many sites with too few Reef Balls. By focusing on three sites, it will be possible to get decent size reefs up and running at each site, which will provide useful feedback for selection of additional sites as well as practice of deployment techniques.

Preference was given to sites where permanent PTNMR transects are located, as this will provide useful baseline data for comparison even though the transects are generally shallower than the Reef Ball reefs.

A site survey was conducted on 29 July, 1999. Sites investigated included:

- Buyat Bay (eastern side);
- Sikod Bay (western side);
- PTNMR permanent transect sites 1 and 2; and
- Sediment trap #12 (the 'straits').

Target depth was 10-20m, and upon finding appropriate depth, the site was buoyed. Divers then checked the bottom for suitability. At each site deemed suitable, a Bay Ball was deployed and buoy (white plastic jerrycan) left in place to help guide future deployments. Comments on each of the sites investigated are provided below.

BUYAT BAY

Only the SE headland was able to be assessed due to poor visibility resulting from recent rains. Target area was the slope adjacent to the existing coral transects (Buyat). A buoy was dropped at 22m (73'). This depth and area has a steep slope, coarse shell grit sand overlayed by 10-30mm of fines. It was not certain whether these fines are tailings or river sediments, or both. Jerry K felt they were most likely of river origin.

Noticeable fauna included sea whips, sea pens and spiral coral. All of these are associated with sandy bottoms, steep reef slopes and occasional strong currents. Judging by the coarse shell grit sand and fauna, it would seem the area experiences strong currents. Therefore it is interesting that there is a thin layer of fines overlaying the sand. Either currents occasionally remove this layer, or there has been a change to sediment input to the bay. Anecdotal evidence suggests that the logging activities that are now ceased did cause a lot of sediment runoff, and the fines may be a legacy of this.

Moving up the slope, well established hard corals and sponges are found on isolated rocky outcrops at 20m, and these have a very thin (1 -3mm) layer of fines on them. It would be worth collecting these fines for analysis to determine their origin, and Jerry K has recommended this to David Sompie.

Conclusion
The site is suitable for future deployment of Reef Balls, however not shallower than 20m due to the corals and steep slope. **Figure 1** helps demonstrate this point, however Reef Balls may be placed is a suitable clear area is found and they can be placed/lowered accurately.

However, Buyat Bay has several disadvantages, namely, river input, high turbidity, and tailings.

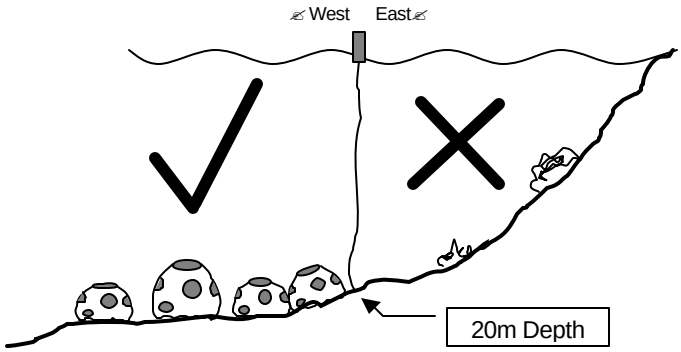
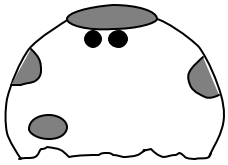


Figure 1: Buyat Bay – preferred location of deployment is in depths more than 20m due to corals and steep slope.

Bay Ball

A Bay Ball was deployed to help mark the site.
Location: 93090 N 689968 E
Depth: 27m (90')
Bay Ball: 'Two lumps' (unique markings aid identification in photos).



'Two Lumps' – SE Buyat Bay

Future Deployment in Buyat Bay

Location: future deployments should always be to the west of the buoy and can either follow the 25-30 depth range, or transverse the slope perpendicular to the shoreline.
Quantity: groups of 10-30 (put PBs in deeper areas), total to equal 50-60.
Configuration: spaced 2-5m apart as per figure.

Note the following:
Make sure no rocky outcrops are present prior to each drop. Keep the modules within monitoring depths for first three months, and check growth for bioaccumulation of toxicants prior to deeper deployment.

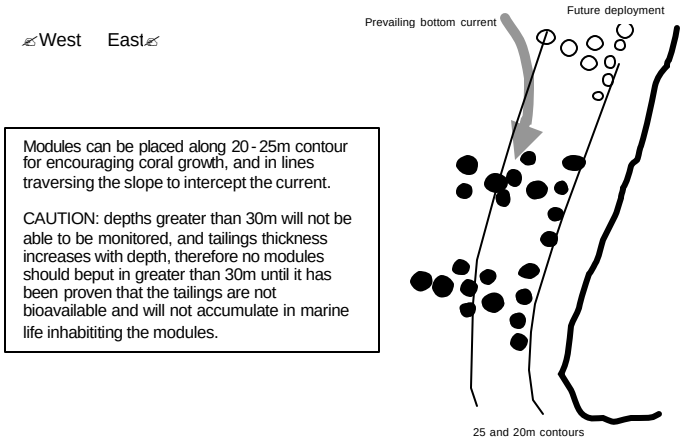


Figure 2: SE Buyat Bay – recommended deployment configuration.

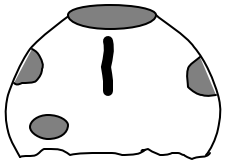
SIKOD BAY

The western area presents an excellent opportunity for enhancement. The bay is edged by mangroves in the northern intertidal area, and corals to about 10m. The bottom quickly becomes flat compact sand with some silty fraction. The bay also has no river inputs to reduce water clarity/quality or salinity. Additionally the mangroves offer a nursery area for many commercial species that may inhabit the Reef Balls.

Conclusion
Excellent site and suitable for Reef Balls.

Bay Ball

A Bay Ball was deployed to help mark the si te.
Location: 91960 N 687962 E (plot of this GPS reading appears too far east)
Depth: 11m (36')
Bay Ball: 'One line' (unique markings aid identification in photos).



'One Line' – Sikod Bay

Future Deployment in Sikod Bay

Location: future deployments should always be to the east of the buoy – check for seagrass meadows, if present, do not place modules within 50m. Seagrass meadows are highly productive habitats and spacial extent can vary significantly throughout the year.
Quantity: groups of 10-20, total to equal 50-100.
Configuration: spaced 2-5m apart as per figure.

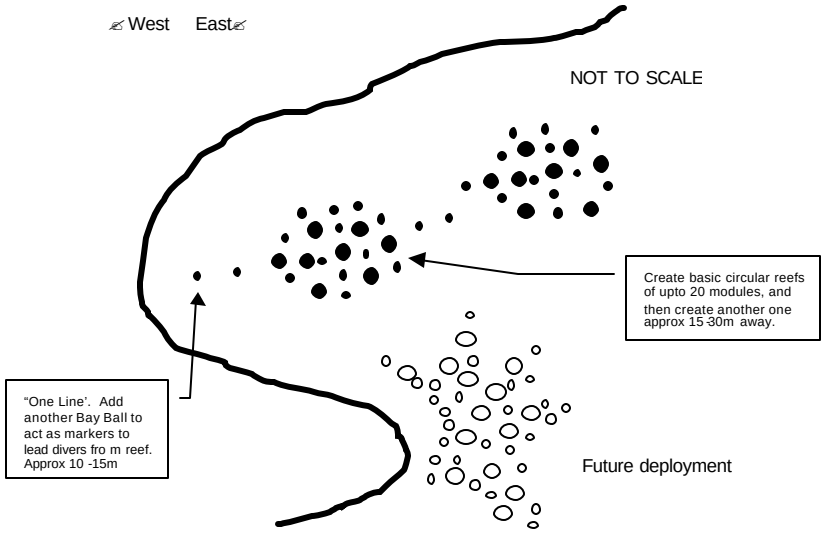


Figure 3: Sikod Bay – recommended deployment configuration.

SITE 1

This is PTNMR's permanent coral transect 'Site 1'. There are generally no clear patches between the corals and it has a very steep slope. Further investigations at 30m may be beneficial. There was one clear sandy area at 4m just east of the transect that would be suitable for 2-3 Bay Balls and perhaps one Pallet Ball. Placement would be tricky though and there is nowhere for the deployment vessel to anchor without damaging coral.

Conclusion
Site not suitable.

SITE 2

Also a PTNMR permanent transect (Site 2), and has less clear patches than Site 1. Large colonies of branching corals (eg Acropora) were dead. Cause not known by Jerry, perhaps Crown of Thorns and/or cyanide. Slope is perhaps even steeper than Site 1. This site has shown reduced fish counts and it would have been good to trial Reef Balls in the area to see if fish numbers could be brought back up. However there are no clear areas for placement. Depths greater than 30m may prove ok.

Conclusion
Site not suitable.

SEDIMENT TRAP #12 (ST12)

This site is located adjacent to a PTNMR sediment trap (ST12) in a strait between Dakakayu Is and Ratatotok Peninsula. Bottom substrate is level compact course sand with isolated rocky/coral outcrops to 2m in height. The sand layer is probably not thick and just overlays the submerged rock platform connecting the peninsula and island. Depth was 8m (26') and fairly uniform all the way across the strait. A noticeable current was running through the strait in a NW direction and is tidally generated, therefore would run in the opposite direction during ebb tides.

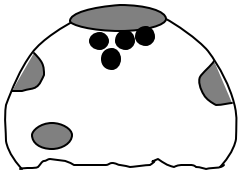
The area had a good variety of fish species inhabiting the rocky outcrops, and several schools of pelagics including two barracudas were sighted. Due to the current, the area is very 'alive' and receiving a good supply of nutrients and plankton. I'm positive a lot of pelagics pass through this area.

A small white jerrycan buoy plus a Bay Ball mark the site.

Conclusion
Excellent site with great potential due to depth (within photic zone), firm substrate, flat, and currents. Should become a very productive area and great dive site to sit and watch pelagics.

Bay Ball

A Bay Ball was deployed to help mark the site.
Location: 94945 N 693237 E
Depth: 8m (26')
Bay Ball: 'Four Lumps' (unique markings aid identification in photos).



'Four Lumps' – ST 12

Future Deployment at ST12

Location: future deployments should be to the east of the buoy and can go across the strait, and up or down the strait if there are sufficient clear patches.
Quantity: lines of 10-20, total to equal 80-100.
Configuration: lines with Pallet Balls at outer edge to create a 'wall' effect to take advantage of the current and subsequent eddies that can be produced, especially towards centre of strait where currents will be strongest. See figure.

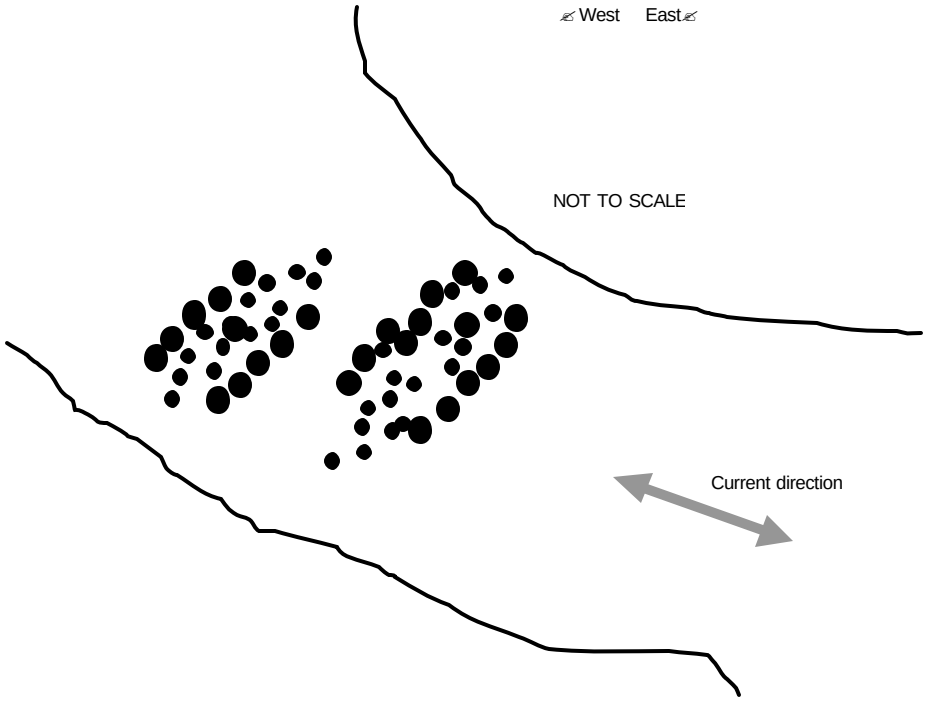


Figure 4: ST12 – 'Straits' – recommended deployment configuration.

Additional Sites
The three initial sites are certainly not the limit to areas that may be enhanced or 'repaired' with Reef Balls. For example I highly recommend placing Pallet Balls in water depths of 50-100 along the SE side of Ratatotok. The best thing to do, is keep me posted of progress and I will help advise on new areas.

Deployment Methodology

Options are numerous and the inventiveness of the locals and PTNMR staff will have no trouble figuring out the best technique to suit the site and equipment available. Naturally remember safety at all times and zero damage to existing corals.

Use the provided configurations as a guide. There is no point in giving exact distances between each module because in reality you will have variations due to barge moving etc. Also, as humans we tend to want to create aesethetically pleasing geometric shapes/forms, whereas nature does not work this way.

Bay Balls

Dropping from Nimera II works well but limited to four Bay Balls. Due to the angle of the module when it hits the water, it tends to flip upside down unless a boat fender or similar size buoy is attached. It is especially important to drop them right side up at ST12 due to the relatively hard bottom.

NOTE: it is not permissiable however to deploy modules and leave the buoy attached. This is adding plastic and unnatural materials to the ocean and not permitted by the Reef Ball Development Group, and does not fit the spirit of this program. If you allow one plastic item, others will see no reason to not add more.

The easiest method is to buoy the target area first as this provides a useful visual reference. Bay Balls can easily be moved by divers underwater. Either tip onto side and roll with one diver either side (but don't roll over corals or other benthic organisms!), or pickup and walk backwards or sideways with it. The buoy or boat fender used for dropping helps reduce the weight, and a small lift bag (30-50 kg, ie 30-50 L) significantly helps. Experienced divers only should move the modules and DO NOT INFLATE BCD TO LIFT ANY OBJECT UNDERWATER.

Safety

The following are not to be considered the limits to safety precautions that should be taken.

- Careful when accelerating in the Nimera II, as the Bay Balls may slide to the back of the boat. Anyone standing to the rear of them could be injured.
- Never drop Bay Balls when divers are on the bottom. Make sure all divers are on the surface and accounted for before dropping.
- Do deeper sites first, then the shallower ones, ie follow standard good diving practices.

Pallet Balls

Several options have been discussed and considered, including floating, rafting and dropping. I believe the best way will be dropping by crane from the supply barges arriving once a month. The added advantage of this is that it ensures the Pallet Balls are aged for at least 3-4 weeks. The alternatives are all possible, however are limited, mainly to the number that can be deployed for the effort spent.

Barge Deployments
Advantages: large number of modules, ease of loading and dropping.
Disadvantages: limited maneuverability, timing once per month

The best method is probably using the Petrosea truck crane – loading the modules on the truck and then driving the truck on to the barge. I strongly recommend practicing in Sikod Bay where there is space, calm waters and a depth that allows divers to easily check the modules.

There will need to be two means of dropping the modues. The most immediate method required for the current sites is the innovative release mechanism developed by the Reef Ball Development Group. This will work well and the crane will allow final positioning of

placement. A second method will be needed for dropping in deeper areas. Petrosea sound as though they have a hydraulic ram that can pull the pi n on the modules, and this will work provided the modules are dropped from below the waterline.

If within diving depth range, two divers can quite easily flip a Pallet Ball back upright, but be careful no one is on the falling side. A buoy can be added to the top of the modules, as with the Bay Balls to help keep them upright during descent.

NOTE: it is not permissiable to deploy modules and leave the buoy attached. This is adding plastic and unnatural materials to the ocean and not permitted by the Reef Ball Development Group, and does not fit the spirit of this program. If you allow one plastic item, others will see no reason to not add more, and you have diminished the value of the program.

Barge deployments may require the barge to anchor, howeve r this should be avoided if possible as this could cause extensive damage to corals. Sikod Bay could probably tolerate anchoring due to the sandy -mud bottom. Buyat Bay would allow anchoring below 40m and the barge could then reverse into shallower water.

Barge deployments will require a good coordinator and the crane operator should only receive signals from one designated individual, otherwise the operation becomes a nightmare.

After Deployment

What happens after deployment is as important, if no t more important as what happens before and during. Hopefully PTNMR will take advantage of this fantastic opportunity to not only create local employment, improve fish stocks and dive sites, but to also promote a new awareness of our role and impact upon the environment. This may sound like typical greenie campaigning, but it makes logical sense. I realise that the locals literally depend upon fish to feed their families and survive, however, if they farm the sea smartly and have a better understanding of how it works, it will serve them better and for longer.

We've gone beyond the saying of *'teach them to fish and they will eat for a year'*. Yes they might, but if you don't teach them how to manage their fishing they definitely will only eat for a year.

The responsible reef creation and utilisation philosophy is given in **Appendix B**, and I encourage you to use it in your newsletters and pass it on to the community. The Reef Balls will attract fish, but there is a real danger of overfishing the stoc k drawn to the modules. Give the modules time to establish.

Ideally the Reef Ball sites should be opened and closed to fishing on a rotating basis. Open one reef and close the other. Hard to do here but it would be a fantastic showcase model for othe r areas and a very valuable lasting gift from PT Newmont Minahasa Raya.

Monitoring

The following is a guide only and you may find it useful to use a survey/monitoring classification system I developed. It significantly helps increase the ease with which people can discuss and appreciate the type of surveys/monitoring that is taking place and where. I developed it because I found myself getting frustrated with circular discussions because everyone had different ideas of what the term 'survey' or 'monitoring' meant.

Basically there are three types of surveys/monitoring, Type 1, 2 and 3.

TYPE 1
Basic survey where species are identified and/or site described, but number of individuals or measurements are not counted or taken. For example the site surveys would be classified as Type 1 surveys.

TYPE 2
Distinguishing feature, is that number of individuals are counted or measurements are taken. This includes counting of individuals from photographs or videotape. However, no permanent transects are established.

TYPE 3
Distinguishing feature is that permanent transects are established. This is the only type that has permanent transects, eg. the PTNMR coral transects.

This classification system is very useful for labelling maps. It makes it very easy to label sites and for people to quickly understand the level of monitoring taking place at each site.

What is the Question?
The first step in establishing any monitoring is knowing what the question is. This can be as simple as 'what is the succession of fish species on the reefs in each site?'.

'What is the succession of fouling communities on the modules?' 'How does the fouling communities on the inside compare to the outside?'

Some suggested studies are:

- Study of fouling communities and variation between sites, depth etc;
- Correlation between fouling community and fish species;
- Fish species over time, especially biomass estimates;
- Commercial species present, numbers, biomass;
- Survey of local fishermen and catch – before and after;
- Fish interaction with the modules – feeding, shelter, passing; and
- Contaminant uptake by fouling organisms or fish.

Students
The reefs will provide an excellent opportunity for university research thesis, and I believe Jerry and David are already discussing this with Manado University.

Water Quality
The modules make ideal structures to house logging sensors such as temperature sensors. These are cheap (<$200) and can be attached to the inside of a module, out of site and protected. They could be used to help determine if the coral bleaching is due to increased water temperatures.

Timing
I recommend that fish surveys commence almost immediately and take place every month for the first three months, and then every 3-4 months for the rest of the year.

The following is a sample monitoring schedule. If conducting fish surveys, it would be preferable to conduct them in the same week that the ongoing PTNMR monitoring is taking place. This will increase the data and ability to compare sites.

Demo only – dates do not have to be these.

DATE	LOCATION	TYPE 1	TYPE 2	TYPE 3
30-7-99	Potential sites	Substrate + fish		
30-8-99	Buyat, Sikod, ST12	-	Fish + fouling communities	?
30-9-99	Buyat, Sikod, ST12	-	Fish + fouling communities	?
30-10-99	Buyat, Sikod, ST12	-	Fish + fouling communities	?
??-1-00	Buyat, Sikod, ST12	-	Fish + fouling communities	?
Every 3-4 months				

PTNMR Environmental staff are more than capable at designing monitoring programs so I leave it up to you guys. Don't hesitate to contact me though if you have questions.

Appendix A - checklist

REEF BALL CHECKLIST

Start of Day

1. Make sure covered Reef Balls are still wet, add water if necessary.
2. Let some air out of balls if hot.
3. Check for all items on complete equipment checklist.

End of Pouring

1. Make more sand.
2. Clean and replace all equipment to proper location.
3. Spray WD-40 on bolts in bucket.
4. Fill sugar bottles.
5. Fill special liquid bottles.
6. Move Reef Balls that are ready off their basses.
7. Check covered Reef Balls are wet, add water if dry.
8. Cement - Is there is enough cement? Order more if necessary.
9. Silica - Is there enough silica? Order more if necessary.
10. Sand and gravel - Is there enough? Order more if necessary.
11. Water for cement - Is there enough? Order more if necessary.
12. Water for drinking - Check / Order
13. Diesel for cement mixer?
14. Put barrier tape around area.

Awal Kerja

1. Pastikan bahwa *Reef Balls* yang tertutup masih basah, tambahkan air jika perlu.
2. Keluarkan sebagian udara dari *ball* jika panas.
3. Cek apakah semua item lengkap pada daftar peralatan.

Akhir Penuangan

1. Tambahkan pasir.
2. Bersihkan dan kembalikan semua peralatan pada tempatnya.
3. Semprotkan WD-40 ke bout-bout di dalam ember.
4. Isi botol-botol gula.
5. Isi botol cairan khusus.
6. Angkat *Reef Ball* yang sudah siap dari landasannya.
7. Cek apakah *Reff Ball* yang tertutup masih basah, tambahkan air jika kering.
8. Semen - Apakah semen cukup? Order jika perlu.
9. Silika - Apaka silika cukup? Order jika perlu.
10. Pasir & Kerikil - Apakah cukup? Order jika perlu.
11. Air untuk semen - Apakah cukup? Order jika perlu.
12. Air minum - Cek / Order
13. Solar untuk pencampur semen.
14. Pasang pita pembatas (tanda) di sekitar daerah kerja.

Appendix B – Responsible Reef Creation and Utilisation

The following is a brief message that was passed on to the construction crew involved in the program in an effort to help them understand how the reef will work. English translation on following page.

Pembuatan dan Penggunaan Terumbu yang Bertanggung Jawab

Reef Ball (terumbu bulat) akan menyediakan makanan dan perlindungan terhadap ikan-ikan dan makhluk laut yang lain. Namun demikian, kita perlu memahami manfaat Reef Ball dan cara yang terbaik dalam menanganinya dan lingkungan.

Membuat Sebuah Terumbu

Membangun sebuah terumbu persis sama dengan membangun sebuah desa. Ketika Anda membangun sebuah desa, banyak orang akan berdatangan di areal sekitar, membangun rumah dan membina keluarga. Ketika Anda membangun sebuah terumbu, ikan-ikan akan berdatangan dari area sekitarnya.

Hal ini akan berarti bahwa ikan akan menjadi lebih banyak, akan tetapi sebenarnya ikan-ikan tersebut baru saja masuk ke lokasi terumbu tadi. Hal ini akan menjadikan ikan-ikan tersebut lebih mudah ditangkap; dan jika Anda menangkapinya, maka populasinya akan berkurang dengan cepat sekali.

Ikan-ikan tersebut perlu dibiarkan membuat "rumahnya" sendiri dan berkembang biak; karena jika tidak, maka ikan-ikan akan habis.

"*Anda tidak akan dapat memanen padi jika Anda tidak menanam dan merawatnya"*

Hal ini juga berlaku terhadap Reef Ball. Anda harus membiarkannya tumbuh. Jika Anda melindunginya. Reef Ball akan memungkinkan ikan berkembang biak dan anak-anaknya akan pindah ke lokasi lain sehingga Anda bisa menangkapnya

Lindungilah Reef Ball selama sekurang-kurangnya enam bulan, dan akan lebih baik lagi jika dilindungi lebih lama, misalnya 12 bulan. Atau bahkan selamanya! Jika Anda melakukan hal ini, maka hasil panen Anda akan berlimpah.

English translation of previous page – ignore the incorrect english used, it was necessary for accurate translation!

Responsible Reef Creation and Utilisation

The Reef Balls will provide food and shelter for many fish and other sea creatures. However it is very important to understand what the Reef Balls will do and how best to work with them and the environment.

Building a Reef

Building a reef is exactly the same as a building a village. When you build a village, many people will move in from the surrounding area, make their home and then raise families. When you build a reef, many fish will move in from the surrounding area.

This means that you will see more fish, but really the fish have just moved into one location. This makes them easier to catch, and if you fish for them, you can destroy the population very quickly.

It is very important that you allow the fish to make their homes and have babies otherwise there will be no more fish.

"You can not harvest your rice until you have planted it, and allowed it to grow!"

The same is true for the Reef Balls. You must give them time to grow. If you protect them, they will allow many fish to have babies which will then move to the other areas so you can catch them.

Please protect the Reef Balls for at least 6 months, and better if you protect them for longer such as 12 months. Or even forever! If you do this, you will continue to have good harvests.

D. Lennon 1999