Introduction:

This document is not intended to be scientific in nature or detailed in an engineering sense. It is provided purely as a record of events and observations related to the building of an artificial structure intended to enhance the marine environment and provide shelter for marine life.

The Leven Scuba Club inc. (hereafter the Club) is a relatively small group of divers (less than 40) with an interest in the environment from which we derive our pleasure. It has been seen and proven over time that fish life in general had declined on the North West Coast of Tasmania. Rather than enter too much into the politics of why this might be the case, it was decided by the Club to try and do something positive towards reversing the trend.

From the experience of Members, documented reports, photographic evidence of Reefs constructed elsewhere in the world, it has been established that fish would congregate around underwater structures, breed and populate adjoining areas. Of course this varies with the type of fish, but the Club thought it a worthwhile venture to invest time and funds into building some type of Artificial Reef structure in an area relatively barren of vertebrate marine life. This was considered a valuable experiment in increasing fish numbers and as a useful project for the Club to undertake which would provide an additional dive location.

In 1996 the Club purchased a 66 ft. long wooden vessel which sat derelict in the Mersey River Devonport. It was reputed to have been a diving tender named HMAS Seal during the second world war and was later renamed Morati. In the period from 1970 to 1980 the vessel worked as a fishing trawler.

Members from the Leven Scuba Club prepared the vessel for sinking which included removal of hatch covers and environmentally cleaning the bilge's, then towed it to it's present location in 30 metres of water some 5 kilometres to sea off Don Heads, and scuttled the ship. This was completed in October 1996. Position: 41º 07.272' S 146º 19.716' E.

By the 4th of November 1996 the sunken hull had attracted a huge population of Red Cod, Bearded Cod and Bulls-eyes. This was quite amazing given they are common reef fish and the wreck was well away from the vicinity of any known reef structure and the area around the hull is essentially sand. The dive on the 4th November 1996 was recorded photographically by the writer and the intention was to continue recording the hull wreck as a growing reef with parts of the hull used as common reference points.

Over the following summer many very heavy storms hit the location and to our dismay a subsequent dive some 6 months later revealed that the hull had completely broken up and there was very little evidence left of the shape of the vessel. The fish life was still abundant and Boarfish, Leatherjackets, Cod and many other species were observed.

It was obvious that even at 30 metres depth, wave action had broken up the structure we hoped would form the basis of the reef, and it was decided by the Club to build on it with other structures to provide the shelter needed for a successful artificial reef.

Approval process:

As with the sinking of the 'Seal' a rigorous approval process is required by Government Departments, which includes Marine and Safety and Sea Dumping through the Dept. of Environment. The Port of Devonport Corporation also must approve as the location is within their bounds of responsibility.

All the necessary documents were submitted as required in order to be able to build on the existing reef using a technology developed in the USA and tried also in Queensland. This was the use of 'Reef Balls'. These are concrete hemispheres, hollow inside and are honeycombed with side and top openings and have proven to provide a very stable and ideal habitat for fish. They are placed in numbers in close proximity to each other and a reef is born.

There were some concerns raised as to the positioning of 'Seal Reef'. The original intention was to have it in slightly shallower water around 21 metres in depth. The fact that it sank in 30 metres was due to Port Corporation instructions and grid positions given to the tow vessel skipper.

The actual position of the vessel still fulfilled all requirements with respect to the type of bottom and proximity to other known reef structures so this in itself presented no problems. However when the Port Corporation insisted that any further "dumping" be carried out further West due to an expanded safety zone around the entrance to the Mersey River, the location of the proposed reef came under Club scrutiny.

An approval was received on the 15th November 1999 from the Dept. of the Environment (Sea Dumping), to place 50 Reef Balls at 41º07.1' S by 146º17.21' E. This was the revised position suggested by and approved by the Port of Devonport Corporation.

Safety issues were raised with respect of the Club being able to dive the area on a regular basis. The 'Seal', being 5 kilometres to sea, and having no shelter close handy was already becoming an issue as winds over the summer following the scuttling made it impossible to operate with acceptable safety measures in place for recreational divers and small boats.

The Club had much debate on the subject and finally decided that the approved area was unsuitable and unsafe and moved to leave the 'wreck' of the Seal as a stand alone deep dive site for advanced and experienced divers. A search for a new artificial reef site was proposed.

Given the extended safety zone around the mouth of the Mersey River, the options available to the Club limited the search area to East of Horseshoe Reef, and waters adjacent to Bakers Beach. The basic criteria the Club maintained was that of a sparse sandy bottom away from established and known reef structures.

A series of dives were carried out in early 2000 to survey the bottom East of Horshoe Reef in depths varying from 15 to 25 metres. A depth not more than 25 metres was preferred by Club Members.

After many potential sites were surveyed and discarded due to shingle bottom or existing reef, a site west of Point Sorell (Wilson's Point) was selected. The site is 1.5 kilometres from the low tide mark on Moorlands Beach in 18 to 21 metres of water, with a sandy bottom and close handy to the Port Sorell estuary should the need for shelter arise.

Position: 41º07.264' S 146º30.845' E.

An approval process started all over again, with all six bodies contacted and the new proposals and positions listed. Thankfully approval arrived from all parties and the Leven Scuba Club's second artificial reef had a potential home.

Natural Heritage Trust funding:

After the scuttling of the 'Seal' in October 1996 Club finances were pretty low. Many incidental expenses related to the preparation and sinking of the wreck were covered by the Club's general account, not least of which was a $900 insurance premium paid to AMP to cover the Club against accidental sinking before the vessel left the confines of the Mersey River.

With encouragement and assistance by Avril Brown from the department of Primary Industry Water and the Environment, and support from Marine Environmental Consultant Peter Waterman, the Club applied for a grant from the Natural Heritage Trust under the objective: **Fish Life Restoration through Reef Habitat Development.**

$5795 was the amount estimated for the project, the majority of which was for the purchase of fibreglass Reef Ball moulds from the USA and some materials associated with the construction. It was conditional on the Club contributing an equal amount towards the project and this was seen as reasonable and affordable and could be accounted for by Members time as well as cash.

In December 1999 a cheque for that amount was received, and the Club immediately moved to purchase moulds and other materials from 'The Reef Ball Development Group'. $4349.54 bought the Club two sets of 'Bay Ball' moulds complete with detailed instructions as to mounting the moulds, details on materials recommended for ball construction and a video which gave examples of how to deploy the Reef Balls by floating them individually to the site.

Bay Balls galore:

Reef Ball technology is patented by The Reef Ball Development Group and therefore it's not intended to detail in this document the construction as described in the 'training literature' supplied with the moulds. However,

while following the basic principles in the training manual, the methods used by the Club varied somewhat to the norm and they will be dealt with in construction descriptions in following chapters.
Reef Balls are available in various sizes according to the type of mould purchased.

Refer: reefball@reefball.com for more details.

The Bay Ball moulds purchased by the Club were the smallest available and for our purposes the most practical size. They produce balls approximately 1.5 metres in diameter and around 1 metre tall. The balls are hollow, with holes top and bottom and 'Swiss Cheese' style holes all around the sides. They can be arranged as individual modules, stacked into 'apartment complexes' or put together in any combination their shape allows.

Having stated the possible structures available, it must be pointed out at this stage that the difficulty in achieving the preferred reef layout was not foreseen by the Club.

The weight of balls produced from the moulds varied from between 250 kg to 300 kg per unit. This presented a considerable challenge for handling the reef balls safely on land, but even more so in moving the balls from where they were dropped from the transport vessel into the preferred pattern which we hoped would be an effective reef structure.

Through the winter of 2000 and into the summer, Club members worked on Saturday mornings and Wednesday evenings pouring concrete into moulds and producing two reef balls per working bee.

The construction took place at a Member's private residence and the Club is very grateful to Darren and Karen Lawson for their generous contribution to the project. It must be remembered that all work carried out was voluntary and done by members not necessarily experienced in concrete construction or with any previous skills in producing components from moulds.

42 Bay Balls were made and 'cured' prior to the first balls being taken to the reef site. It was a requirement of the Department of the Environment that the concrete be allowed to stand for at least three months after mixing to allow the ph levels to approximate that of the surrounding sea. By the end of January 2001 we had reached our target of 50 balls.

Construction:

As mentioned the basic principles of mould assembly described in the training manual were followed. Two wooden pallets were purchased and were given a waterproof plywood surface, onto which the moulds could be assembled. They were marked as one and two to match the slight variations found between the two moulds. The moulds were similarly marked.

The Club at the outset wanted to keep construction as simple as possible. Given that the moulds we were using were relatively small and the base and lower wall thickness of the balls looked to be reasonably thick and strong, it was decided to use a standard concrete 'driveway' mix and see how a couple of balls turned out. 5 parts gravel and one of cement with enough water to give a thick but flowing consistency was used. With a couple of Members on the mixer, a couple on the barrow and bucket, and one with a poker on the moulds we produced our first 2 Bay Balls.

It was evident from the outset that we would have to make some improvements to the procedure of 'poking' the mixture into the moulds as it was laborious and messy and not at all certain in filling the lower areas of the moulds. It got the job done, but was ineffective in making balls without construction flaws

The instructions prescribed additives such as plant grade plastisizers to aid flow and microsilica for flow and strength. However, the gravel mix the Club used was part microsilica, so the options open were to either use a plastisizer or use another method to get the concrete to flow into the moulds. A Member was able to acquire two electric vibrating actuators. They were fixed to the pallet bases and an adjustable frequency control unit was used to drive them.

The next pours went extremely well with the mixture flowing in as quickly as it could be bucketed from the barrow. Club Members were well pleased with the modification. The moulds were removed the following day and the inflatable centres removed prior to the next pour being organised. This was one of the more awkward parts of the whole operation of producing reef balls.

The inflatable bladder, which was necessary to make the balls hollow, had to be removed by deflating it and retrieved through the access hole at the top of the mould. If a little more than just enough concrete was used in the pour, the access became too small and some of the concrete had to be chipped away to provide access to the air plug and to make the hole large enough to draw out the bladder. The bladder itself was made of heavy duty, pliable plastic and was in fact a marine buoy similar to that used on boat moorings. It wasn't easy to get out but after a little 'mining' we established the right level of concrete, then it was accomplished without too much drama.

The balls were turning out very smooth from the moulds with little aeration or potential weakness below the midpoint. We were able to handle the balls from the pallet bases with the assistance of a loaned tractor, which had a three point linkage crane. A 4 x 2 beam was inserted through two of the lower holes and a sling used between that and the crane to lift each module. The modules were then stored on the Lawson's property for the concrete to cure.

The finished articles were smooth and looking good, but it was pointed out that we were trying to promote marine growth on the balls and it might not be desirable to make them to a smooth finish as the potential growth had little to hang onto. We were getting some micro cracking occurring in the thinner upper regions of the balls as they dried and this was considered acceptable and perhaps desirable in aiding organisms to attach themselves.

The mix prescription in the training manual suggested the addition of microfibre to increase strength. We also reasoned that this might also give the surface a 'fluffiness' which would be an advantage to marine growth.

From approximately ball 8, all our mixes included a cupful of microfibre. (chopped fibreglass wool). The modules turned out well and the surface finish had a hairy feel to it. We hoped that strength had also increased. It was found previously that the occasional ball broke away around thinner regions prior to the addition of fibres. This was considerably reduced.

Prior to each assembly the moulds and bladders were cleaned of sticking concrete with wire brushes and scrapers, and treated with a mixture of sugar and water to act as a release agent.

The effectiveness of this treatment was questionable because at most times there was little drying time allowed during each working bee prior to the pour being made. Over time the moulds became impregnated with concrete and it was found necessary to pressure clean them and repair sections of the moulds where scraping had broken the surface of the fibreglass. We tried coating the inner surfaces of the moulds with Gel-Coat, which also proved to be of doubtful value and we returned to the application of a release agent. It worked reasonably well provided adequate drying time was provided for.

Balls in transit:

On the 12th of January 2001 the Leven Scuba Club was ready to load a 'shipment' of Reef Balls onto a truck and deliver them to the wharf on the western shore of the Mersey River.

The truck was an Aurora Energy work vehicle, kindly loaned, and fitted with an extendable overhead crane and flat tray capable of carrying 20 plus Bay Balls. It was an ideal combination for the exercise and it's great to have members with the right contacts!

Possibly the most challenging task in the Artificial Reef project was finding a method of moving the balls from land to the selected position approximately 13 kilometres east of the Mersey River. Some brainstorming sessions were held and quite a few proposals put forward.

Techniques described in the training documents included individual balls being deployed by towing them one by one to the site by a jet ski or similar. The internal bladder was then deflated to sink them. This would not have been possible with the size of ball we had produced.

The weight of the concrete modules was much greater than the amount of potential lift from the internal float. The balls were just too thick and too small in overall size for this method.

We toyed with the idea of buying a catamaran then removing the trampoline and fitting an overhead crane in its place. The vessel could be operated from the beach at Moorlands and all that was necessary was to deliver the modules to the high tide mark and we could do the transfer one ball at a time to the location 1.5 kilometres from the beach.

When the proposal of transferring the balls one at a time was properly analysed, it was clear that the operation would take many hours of very heavy labour to complete.

Carrying out the operation in safety was extremely unlikely so all proposals of individual ball deployment were scrapped. An offer of assistance from the fishing boat skipper who was instrumental in getting the wreck of the 'Seal' in place was the preferred option for the Club.

Grant Taylor is a part time fisherman, a real rough diamond and 'Jack of all Trades'. He is one of the most obliging gentlemen one could ever hope to meet. Not only did Grant give a considerable amount of his time and fuel for the 'Seal' reef project, he asked nothing in return for the 3 trips completed in placing the 40 balls to date. Members voted a donation to Grant to at least cover his fuel costs. The Leven Scuba Club is extremely grateful for his assistance, and it's doubtful whether either of our Artificial Reefs would be in place without the use of his vessel and his expertise.

So on the 12th of January 2001, 21 Bay Balls were loaded and delivered wharfside for transfer to Grant's boat. The work area forward of the cabin was cleared of the normal fishing paraphernalia, covered with felt matting obtained by another Member with useful work contacts, and 8 modules were lowered to the deck. It was not known at that stage how many could be transferred safely and a conservative approach was taken. In addition, it had been decided to place a marker on the site as a reference point so a buoy and anchor weight was carried as well. This was to be placed first on arrival and the balls dropped around it.

The weather on the 13th of January looked promising so it was 'all systems go'.

We had discussed the approach we would take in getting the balls to the bottom in safety and it involved the use of another boat to work in tandem with the 'mother' vessel. The hydraulic winch valves on the boom of the fishing boat were modified to give greater control in lowering. A 'pin' was constructed from strong pipe and for each lift, this was placed through the lower holes of each ball. The balls were to be slung from this pin and the pin attached to twin lines for retrieval. (Ropes) One line went to the second boat and one stayed back with the 'mother' craft.

As each ball touched bottom and the weight was relieved from the sling, the crew on the second boat would pull the pin from the ball by standing off a distance and drawing it out. The pin was then to be retrieved by the crew of the mother vessel ready for the next deployment.

It was important that no divers be in the water at the time the balls were being lowered. The risk of entanglement or crush injuries from the boats in close proximity was too great.

Both crews left early on Saturday the 13th. The fishing boat Lillian G, with its cargo left from its western wharf berth in the river, and the runabout from the Mersey Yacht Club boat ramp.

The birth of a Reef:

As expected the runabout arrived on station well before the Lillian G, so the three Club Members aboard settled back to wait. The sea was calm and clear and ideal for the operation at hand.

Some time later the Lillian G arrived and proceeded to motor around the anchored runabout preparing to weigh anchor and the process of lowering Reef Balls. At first it appeared they would stop further north in 25 metres of water, but some prompting from the crew of the runabout coached the work boat back to the original position planned. The runabout moved away from the mark and the Lillian G settled over 18 metres of water.

By this time the wind had increased a little to around 8 knots and there was a little chop on the surface. The crew of the Lillian G set to work and lowered the mooring marker without incident. The boats were lurching around a bit, which didn't make the handling of the balls any easier. The pin line was passed across to the runabout crew and the Lillian G was tethered to the mooring marker.

With the runabout working 'live' and standing off around 20 metres to starboard, the first ball was hoisted over the gunnels of the fishing vessel and let drop to the bottom of the sea.

The original 'plan' was to place several close clusters of Bay Balls within sight of each other in reasonable underwater visibility. eg: 10 to 15 metres. In practice this proved very difficult.

Even the light breeze and the low chop caused the Lillian G to swing around on the mooring quite a bit. It wasn't immediately obvious to us, but the pull of the second crew may have had some bearing on the final position of the balls as well.

The first few drops were completed with much chaffing to the hands of the runabout crew until a system fell in place where the pin was aligned for extraction prior to the drop. The ball was dropped, and then only a light pressure on the pin line applied until all the weight was released from the supporting sling. The pin then came out relatively easily with that method. It was a very steep learning curve for all of us involved.

All 8 Bay balls were unloaded and the Lillian G returned to port for another load. The runabout crew geared up eagerly for the first dive on 'The Reef Balls'.

First dive on the Balls:

It was important for us to know how the modules had settled on the sand and whether or not the drop to the floor of the ocean did any damage to them. Underwater visibility was around 10 metres and the first balls were seen from about half way down the mooring line. I must say that it was quite an exciting feeling having our own reef in sight, even though it was only 8 balls, and they weren't really placed as we had hoped they might be.

All were south of the mooring as expected, because the breeze came in from the north. The first four modules 'landed' close to each other and the divers were able to roll two of them so they made up a cluster of four. The other four were scattered more so they were left to sit as individuals. It appeared that no damage occurred during the deployment process. With their positions accepted for the time being, the divers were still well pleased with the placement and they returned to the surface and the runabout for some lunch. The breeze had increased to 10 to 12 knots.

One of the three crew members had some type of rendezvous organised with a lady friend back in Devonport and had organised to be picked up from Pardoe Beach approximately a 5 kilometre run away from the reef position. This had some affect on the fuel budget for the day but was completed ok.

This left a crew of two to handle the afternoon shift of ball drops. We relaxed back on the mooring awaiting the return of the Lillian G in reasonably lumpy conditions.

After what seemed like an eternity the mother ship arrived back and took over the mooring position. It was bucking and lurching considerably this time due to the swell and Grant decided to use the engine to supplement the mooring as it appeared the larger vessel might drag the block.

It was agreed that this drop of 13 would be as close as we could get them to the mooring block itself, and despite the lurching of the deck, the crew aboard the Lillian G set to work swinging the balls over the side. Grant's strategy was to power the boat forward against the oncoming swell until he considered the vessel to be adjacent to the mooring block. It was a hazardous business but was handled with sufficient care that the operation was completed without a major incident. 21 Bay balls were sitting on sand in 18 to 20 metres of water around vicinity of our planned co-ordinates.

Both boats returned to the Mersey with both crews feeling pretty weary from the day's effort. This was not helped when the runabout broached in large following waves near Horseshoe Reef. After recovering, the boat's ballast was positioned differently for the rest of the trip. A fuel top up was also necessary on reaching the river, as the unplanned detour to the beach ensured the runabout would not have made it back to the Yacht Club.

The evening drop:

A week of unsettled weather past and no dives, or further trips to the reef site were possible. On the week starting Monday the 22nd of January the weather forecast looked promising and arrangements were again put in place to load more balls on the Lillian G during the evenings after the normal workday. This time we believed we could transport more in the one trip and stacked the modules two high on the truck and subsequently, a similar arrangement on the deck of the boat. The Lillian G sat low in the water with almost five tonnes of Bay Balls on board.

Thursday the 25th of January 2001 welcomed flat seas and all was in place for an evening trip to the site. The tender vessel for this trip was an Alloy runabout with a crew of two and this left from Port Sorell to meet up at the mooring.

The Lillian G left port around 6 p.m. and chugged slowly out towards the mouth of the river. All was not well with the engine. It appeared to be misfiring and not answering to the throttle. Grant shut the engine down and the vessel drifted while skipper and crew went head down in the engine room. After much muttering and technical discussion a fuel filter was replaced, the system bled and the engine fired on all cylinders. We were away again, somewhat delayed with the sun sinking slowly in the west. Daylight saving is great!

As expected the runabout had arrived well before the Lillian G, but the sea conditions were comfortable and they were keen to get the drop completed. As were everyone aboard the fishing boat.

Grant decided to drop anchor around 50 metres north of the mooring and lay back on the breeze until he was around 20 metres from the buoy. The unloading was completed without too many problems. There was the odd stuck pin, but by hoisting back and re-dropping that was easily overcome. Our 'system' seemed to be working ok. We had a total of 40 Reef Balls in the water and both boats were on the way back home before dark.

Diving the reef:

Dives planned for the following weekend were carried out, and Club Members dived to start a survey of the positions the modules took up on the bottom. It was found that most were scattered a little distance from each other but some had 'landed' as planned and would form the basis for clusters if a way could be devised to easily move the balls together underwater.

Small marker buoys were placed at the two extremes reached in the survey. Not all modules were accounted for at this stage.

A follow up survey dive was completed on the 4th of February and found that one of the previously placed markers had been taken or lost from the site. Another was fitted at the largest grouping of balls and much of the area was covered as was practical in the time allowed. A total of 31 balls were counted and the remainder were suspected to be in the north-eastern quadrant not yet covered due to down current conditions.

The most interesting thing noted was the extraordinary amount of growth and marine life attracted in such a short period of time.
In the three weeks since the first Balls were dropped, brown and red algae had established itself on the modules and was around three and four centimetres long in places. A large school of juvenile silver trevally worked the area, picking up titbits from the growth on the balls and the surrounding bottom. The school extended all the way to the surface in the region of the mooring line and the marker buoys.

In addition, several of the Reef Balls housed small Boarfish and there were other reef fish such as baby leather jackets (several species) and cowfish sighted. Hermit crabs not previously noticed in the area were also using the balls as shelter. All the signs were good and we were very encouraged by the dive.

In the following weeks the weather allowed only one opportunity to dive the site. On that occasion it was decided to try and move some of the modules in the north-western group to test the viability of the equipment the Club had on hand. A tank with regulator was sent down on a line. Two divers followed with a 60 litre drum and attachments for slinging one ball at a time on an aluminium beam. A crew member stayed aboard the boat to assist.

The drum acted as an air bag and provided approximately 60 kilograms of lift. While this was of some assistance, it proved not nearly enough. Several modules were moved a short distance, but the work was very heavy and time consuming. The air consumption of the working divers was also an issue, and the spare tank served as an auxiliary air supply for them on ascent.

With a cluster of seven balls achieved, we learned that we required more lifting power, and more divers on hand for any further movement of the modules.

On the 4th of March 2001 the small marker buoys were again replaced and some video footage taken of the life around and in the reef balls. More Boar fish were evident, and again the silver trevally were prolific. A short survey swim to the north-eastern quarter confirmed the presence of more reef balls 20 or so metres east of the cluster of seven.

On the 11th of March, some navigational ropes were placed along the bottom between the main mooring block and the two main northern groupings to assist quick location on subsequent dives.

Again storms and heavy seas prevented any further work on the reef for several weeks. Towards the end of April 2001 the Club dived the site to confirm the position of the north-eastern group and to plan a further work party to move that group closer together.

The divers were surprised to note that much of the weed growth had been removed from the reef balls by the heavy seas and there were fewer fish in and around the balls than on the previous two dives. It was disappointing to see but not totally discouraging. It's clear that individual balls do not get shelter from the other modules and are open to the full effects of the swell. The importance of clusters and 'apartment' style designs was emphasised and this should prove more effective in retaining weed growth and be attractive as a permanent home for reef fish.

The main mooring line was cleaned top to bottom and a plan was devised to take several groups of divers, with surface air supply and double the lifting capacity, to the site at the next opportunity.

Lost Balls:

May, June and July were very rough months and the water visibility was reduced to a level considered unsuitable for a dive on the reef. The site was visited by boat on one occasion in July 2001 to check that the markers were still in place. Unfortunately they weren't. Even the main mooring line had gone. It was thought that with GPS positions, there would be no problem in finding it again and re-attaching the float. That wasn't the case.

Two Club members owned small hand held 8 channel GPS units and these had proven quite adequate to get us into the vicinity of the reef and while the buoy was in place a visual fix normally took us to the mooring. On most occasions the GPS indication took us to within 50 metres of the exact position.

With no visual reference on the surface, and poor underwater visibility, the Club carried out several dives without finding the reef.

More windy weather prevented further attempts at locating the reef balls and a dive on the 4th of November using 50 metres of builder's line to swim a circle around the anchored position still failed to pick them up.

The sea conditions improved considerably during December 2001 and finally on the 23d of the month a dive on the GPS bearing was 'spot on'. 14 Bay Balls could be seen from half way down the anchor line. A quick swim around refreshed the divers of the balls relative positions and the main mooring line was replaced with a new rope and buoy. The original had been cut. No evidence remained as to what happened to the smaller marker buoys.

It's not known at the time of writing, who or what cut the main mooring line. The length of rope left indicated that it was severed at surface level on a low tide.

The Club was left to speculate on the reasons for this occurring. The buoy itself was of little value as it consisted of an empty 20 litre plastic container. Maybe a professional fisherman has taken a dislike to the idea, or more likely a representative from the Marine Police decided to remove an unregistered buoy. Just another little problem to overcome!

For obvious reasons bearings were taken on landmarks to give additional reference points to aid location if markers again disappeared.

Working divers:

Three work groups attended the reef site on the 13 of January 2002. The plan was to place a safety tank on the bottom where the modules were to be clustered, have navigation lines in place with one marker buoy on the north-eastern grouping. Two lifting drums were to be used in conjunction with the alloy beam, and a surface air supply to fill the drums.

The first pair of divers placed the safety tank, navigation lines and marker buoy then returned to stand the surface watch. The second divers worked as a threesome to carry out the lift and re-deployment of the balls.

Safety was uppermost so bottom times were planned to be very conservative and no minimum objectives set. The third group of three divers would carry on where the second group left off.

It was found that the surface air supply was quite a bit slower in filling the 60 litre drums than the previously tried scuba tank. The unit was an 8 cfm hookah compressor but would have been delivering considerably less at the depth we were working. The work went ahead and two balls were relocated to make up a cluster where the safety tank was placed. That task used up the air limit for the first group of divers.

The second shift moved in and on the first move attempted, had a very nasty experience. The holes chosen for the lifting beam were not in the strongest section of reef ball. When the lift drums were filled with air and applied pressure to the beam. The ball exploded sending the drums and beam rapidly to the surface in a flurry of bubbles. Luckily none of the divers were directly over the beam at the time so the worst effect was a broken ball and a hell of a fright for all involved. It does not take much vision to imagine what might have happened if divers had been manhandling the beam at the time and had part of their equipment or bodies entangled with it. It could well have been a disaster.

When the divers re-grouped and gathered back the equipment, they were able to move one more of the modules to the previous cluster. A very solid mornings work, but only three reef balls repositioned.

The De-Briefing:

The dives on the 13th of January were the Club's first major attempt to gain the reef structure we believed would be successful in retaining growth and fish life of the long term. As it turned out, we were less than satisfied with what was achieved on that day.

It was evident that our equipment was not up to the task, and all of our operatives needed to be briefed on the most suitable placement and use of the lifting gear.

During the February meeting of the Club a resolution was passed to purchase a quality lift bag system capable of supporting a minimum of 200 kg.

Other problems discussed included the continual loss of markers from the site. On a previous occasion we spoke about the possible purchase of a GPS with much greater accuracy for relocating the reef when no surface buoys are in place. Research was carried out with that in mind. The Club resolved to go ahead with a GPS purchase when the WAAS system became available in Australia. Our information is that it will be in the very near future and offers a high degree of accuracy at a very moderate cost.

Conclusions:

It has been proved to us that Reef building is not an easy task. That accepted, the Leven Scuba Club is still committed to our objective of **Restoring fish life through Habitat Development.** At the time of writing, no further efforts have been made to move modules or improve reef structure. The Club is in the process of obtaining commercial grade lift bags to assist in module movement and will in the near future purchase navigation equipment capable of putting us within 3 metres of the reef.

The Club has the balance of 50 Bay Balls ready to be deployed, and it is our intention have them placed together between the two clusters of balls making up the major structures north of the mooring block. This in itself should build on and reduce the need to carry out further shifting of modules on the bottom. It will be necessary to pick ideal weather to allow accurate positioning of the vessel lowering the balls, and to mark clearly where the modules are required on the bottom.

Having stated the required tasks ahead, it must be remembered that the Leven Scuba Club is a small group of people made up of members with a need to make a living doing things other than diving.

A project such as this was probably underestimated with regard to the workload and problems encountered. As with most voluntary organisations, much of the work is carried out by an even smaller core of active members and actually getting the workers available on the same day, when the weather is suitable is not always practical.

Weekends, particularly when daylight saving finishes, are generally the only time available to work on such projects. Most members also have family commitments and like to do the odd pleasure dive as well when the weather is favourable.

The Leven Scuba Club also intends to continue the support offered to the Devonport Port Corporation with respect to monitoring introduced marine pests and sampling of river sediment. This must be programmed in as required by the Consultant (Peter Waterman) and will reduce the amount of available weekends for work on the reef site.

It's believed by Club Members that the project is well in hand, but will take more time to complete than originally hoped for. That accepted, it is expected to be finished to the satisfaction of all involved.

Recommendations:

1. With respect to the construction of the Reef balls themselves, it may be an advantage to work with two different sized moulds which produce a mix of small and larger sized modules.

2. The tried and proven construction materials as listed in the Reef Ball construction manual should be followed as closely as possible. However, the writer would be interested to carry out some experimentation with the addition of a material, such as polystyrene in the form of 'Bean Bag' marbles in the concrete mix. This would reduce weight while handling and over time would crater the surface of the ball to assist weed growth. It may only be practical to add it to the lower sections of each mould, as upper ball strength would be an issue.

3. For the purposes of open water Reef Ball deployment, individual module deployment from the shore would appear impractical.

4. While the system used by the Club for lowering the modules to the bottom was effective. A purpose built grab, which could be released by the crew on the winch, would have been a better option.

5. The actual structure of the reef itself is still a subject under discussion. It is plain that large groups of modules put together and stacked are more effective than smaller clusters and individual balls. Suggested plans and patterns for ball placement are included with the construction literature but they may not be any better in attracting fish life than a bulk dumping of modules in one heap. Naturally it would be neater, but from experience,

some of the best fish life exists around reefs of fallen down rocks with plenty of holes.

6. Monitoring of reef progress should be carried out as time and weather permits and not by specific dates on a calendar set out in advance. It was intended to have a photographic record (stills) from day one, but to date the Club has only video footage of the underwater development. Only two members owned underwater still cameras during the construction phase, and both have moved elsewhere in their employment during the reef placement. The Club is discussing the purchase of a camera for this specific purpose.

7. Some accurate equipment such as differential/WAAS GPS is recommended for locating open water reefs. Marker buoys cannot be relied on to remain in place.

8. As diver safety is of paramount importance, an ultra conservative approach to dive tables is recommended while working with heavy modules. Exertion level and consequent air consumption is high.

9. It is believed that the effectiveness of the reef in attracting a large population of permanent fish life is directly proportional to the number of modules placed together in the one spot.

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