INTERIM REPORT ON THE ARTIFICIAL REEF CONSTRUCTED IN THE LONG BAY-OKURA MARINE RESERVE, AUCKLAND

29th July 2002

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Preamble:

The aim of the research was to construct two small patterns of artificial reef comprising different sizes of pierced concrete hemispherical shells. These were constructed utilising the American system called "Reefballs". Colonisation of these is now being monitored. It is hoped to extend the study to include work on sedimentation rates and the impact on the benthic population. It is anticipated that this activity will fulfil a range of positive outcomes:

(i) increase conservation awareness from the use of the Reserve as an educational resource and recreational dive site.
(ii) permit future informed decisions to be made on artificial reef construction in New Zealand.
(iii) monitor the problems of run off which are faced by the reserve.

Reef 1 – Zig Zag Reef:

The reef is located at 36^0 40' 52" S, 174^0 45' 14.8" E in 5.5 m at minimum spring low tides. It comprises twelve concrete hemispherical shells made of 60 MPa concrete with microsilca added. There are nine Bay Balls [mass approximately 300 kg, height 0.7 m, base diameter 1.0 m with about 10 piercings] in a N – S line. At the Northern end, there is a Pallet Ball [mass approximately 1200 kg height 0.9 m; base diameter 1.2m with about 15 piercings].]. At the Southern end, there are two further Pallet Balls; one with a 30x30 cm slate plate attached to a vertical surface and the other with a plate attached to close the top hole of the unit; i.e. in a horizontal position. These slates are the same as the ones utilised by current E. O. S. intertidal studies. Placement took approximately 6 weeks because of tide/weather/logistical constraints. All 12 units lie on a N – S line parallel to the beach with an angle of approximately 45^0 between this line and the zigzags and about 1.0 metre between each.

Reef 2 – Octagon Reef.

The reef is located at 36^0 40' 51.1" S, 174^0 45' 19.6" E in 6.2 m at minimum spring low tides. This also comprises twelve units with four of the smaller Bay Ball units planted as the central core. There are four Bay Balls around the perimeter; a Pallet Ball at the Eastern point of the octagon; and one further Pallet Ball on the Southern margin. There are slate plates attached to a vertical surface of both these Pallet Balls. Another Pallet

Ball is placed on the western side. The last Pallet Ball forms a tail to the south since inclement weather prevented it being placed in geometrical perfection. All the spacings are again about 1.0 metre.

Colonisation sequence:

November 2001

Hard surfaces were colonised firstly by planktonic organisms, e.g. pelagic phytoplankton. The first settlement to be observed (after a period of about 6-7 days) was a microfilamentous brown algae (unidentified, but common in the Gulf). The next colonising organisms were vagrant (and opportunistic) benthos, such as the cushion star: *Patiriella regularis*, and the hermit crab: *Pagurus* sp. c.f. *P. novaezelandiae* and herbivorous gastropods like the whelk: *Cominella adspersa* (egg cases of the latter were recorded on a number of the reefballs). Concurrent with this, nektonic organisms like the spotty: *Notolabrus celidotus* and triplefins: *Fosterygium varium* and *Fosterygium* sp. feed on small invertebrates and graze on the algae. The next wave of colonisation observed was that of sciaphilic invertebrates such as barnacles and polychaete worms. Two settlements of the rapidly colonising barnacle *Austrominius modestus* were recorded; the first occurring about ten days after the placement of the reefballs. A second, more numerous settlement event of *A. modestus* occurred about four weeks later. Of the annelids, the first was the spiny tubeworm: *Spirobranchus cariniferus* which settled about two-three weeks after reefball placement. After a month, these reached lengths of up to 12 mm.

February 2002

Both artificial reefs are close to being fully colonised. Biodiversity on the two reefs is still somewhat low but new species continue to colonise the reef. Most noticeable was the new settlement of the ascidian (Sea squirt) *Asterocarpa coerulea* around the sides of numerous of the Reef Balls. Larger macro-algae, brown seaweed *Carpophyllum maschalocarpum* (still at early stage approximately 5cm long) is establishing itself around the top of some of the Reef Balls. Also identified on the zigzag reef were two Large Trophon (*Xymene ambiguus*), these are typically sandy shore species and are probably resident in the area. A new fish species, a juvenile Sweep (*Scorpis lineolatus*) was present at the Octagon Reef. Juvenile sweep are often found on shallow reefs, close to shelter (provided by the Reef Balls?).

The unidentified filamentous brown algae still dominates coverage on the reef balls, however the barnacle *A.modestus* are now densely populated particularly on the zigzag reef, with several settlements of barnacles evident (small and large live shells, and older empty shells). *A.modestus* is also dominating percentage coverage on the slate tiles over the spiny tubeworm *Spirobranchus cariniferus* (which was formally dominant). Numbers of *Cominella adspersa* and the starfish *Patiriella regularis* appear down. What appeared to be snapper divots were observed around the surrounding reefs. There appears to be an abnormally high sedimentation rate on the two Artificial Reefs, which

may contribute to the absence of some organisms. Further studies on sedimentation rates will hopefully follow.

May - June 2002

Zigzag Reef:
The zigzag reef is now entirely colonised. The make up of organisms on the reef has markedly changed over the past few months. Both biodiversity and biomass of organisms on and immediately around the reefballs has increased, with the appearance of a host of new organisms and an increase in numbers of some already existing organisms (personal observations). Most noticeable was the number of fish, a few new species of which may now be resident. The zigzag reef has seen the arrival of a number of juvenile fish from the summer spawning season, seeking shelter and food, swimming in and around the reef. Schools of small Snapper (less than 90mm long in schools >50), Trevally (less than 100mm long in schools >50), Blue Maomao, and Sweep (less than 70mm), were observed swimming around the reef, with dozens of juvenile Goatfish (*Upeneichthys lineatus*), (less than 90mm in length), pale in colour swimming along the bottom feeding on small invertebrates in and amongst the reefballs. There were also numerous adult Parore (*Girella tricuspidata*) swimming in amongst the reefballs, some large up to 300-350mm long, some adult Red Pig Fish. The Spotties, Triplefins, and adult Sweep are still present in similar numbers. The triple fins have increased in size. There were many snapper divots around the reef, and a few larger snapper (up to around 250mm) were seen on the outskirts of the reef, at the edge of our level of visibility.

The once dominant filamentous algae has been greatly reduced in percent coverage to a few percent only. It has been replaced with a dense covering of barnacles (*A.modestus*), tube worms (including *Spirobranchus cariniferus*), and rock oysters (*Saccostrea glomerata*). These are already creating second and third layers in places colonising on top of dead and empty shells already attached to the reefballs.
There are now at least three different tubeworms including *Chaetopteros sp*, and *Spirobranchus cariniferus*. The third species (unidentified) has a large surface coverage on the outside of the reefballs (approx 20%). There have been at least two different settlements of *S.glomerata* with an older smaller settlement of oysters up to 40mm long (1-2% coverage) and a more numerous recent settlement of oysters up to 20mm long (approx 10% coverage). The oysters are more prominent on the inside cavity walls and hole walls of the reefballs than the outside.
There is a small number of juvenile green-lipped mussels (*Perna caniculus*), approximately 2 cm long, establishing themselves in the base of the side hole walls. New gastropods to the zigzag reef include the Siphon Whelk (*Penion sulcatus*), the Spotted Whelk (*Cominella maculosa*), and the Oyster Borer (*Lepsiella scobina*) which are all carnivorous and were located on the outside of the reefballs.
Brown macro-algae up to 10cm long (possibly *Halopteris novae-zelandiae*) is establishing itself within the holes of the reefballs with at least two species of sponges also are colonising the outside of reefballs. Dozens of small shrimps are to be seen seeking shelter in small cracks underneath the reefballs.

The population of cushion stars is noticeably down from previous dives, with an increase of a larger starfish, *Coscinasterias calamaria* (up to 200mm) resting in the holes of the reefballs and on inside cavity walls.

The Octagon Reef:
Colonisation on the octagon reef is not yet complete at around 80-90%. The colonisation makeup is very similar to that of the zigzag reef with a few differences, most notably the difference in coverage of barnacles and oysters. Very few oysters and barnacles have colonised the octagon reef in comparison to the zigzag reef. The filamentous algae is still present though in increasingly smaller coverage but the tubeworms have a much greater dominance (*S,cariniferis*, and the unidentified species). There are similar numbers and species of juvenile fish present, with various schools sheltering within the octagon.

Overall change in biota:

New organisms are present in the area. These have either migrated from other parts of the marine reserve, or have settled from the moving water body. (A combination of both is likely). The latter group probably would not have colonised the area if the reefballs had not been present. It is very encouraging to observe such large numbers of juveniles present.

Comparison of surfaces:
No significant differences in the colonisation of the smooth areas of concrete surface, rough aggregate surfaces nor the slate plates have been noted.

Bottom Conditions:

Sediment: The sites selected have bottom sediments classified as grey-brown shelly muddy fine sand. Sediments around the reefballs contain a larger amount of fine silt than could be expected in this environment. The origin of this is probably urban run-off. There are large numbers of empty bivalve shells on/near the surface.
Two trial sedimentation collectors (made from a PVC pipe 100mm in diameter and 700mm long, staked to the seafloor) have been tested around the octagon reef in attempt to study the rates of sedimentation.

Settlement: The reefballs still show no appreciable settlement into the sediment. The holes in the base of the units were left open and no additional thickening measures taken in manufacture. There have been many storms over the period with onshore winds gusting up to 100 kmh^{-1} however the site selected appears to be well protected, with the artificial reef remaining stable with no significant scouring even after storm periods.

Concrete pH Tests

Tests of the surface pH of the well-weathered units stored at Gibbons Crib Walls show that the surface pH lies in the range 8 – 9. Technical difficulties with the AUT Datasonde have prevented any meaningful results being taken from the reefballs in the water as yet. The lack of difference in colonisation between the available surfaces tends to indicate that the pH range of the concrete substrate is satisfactory.

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