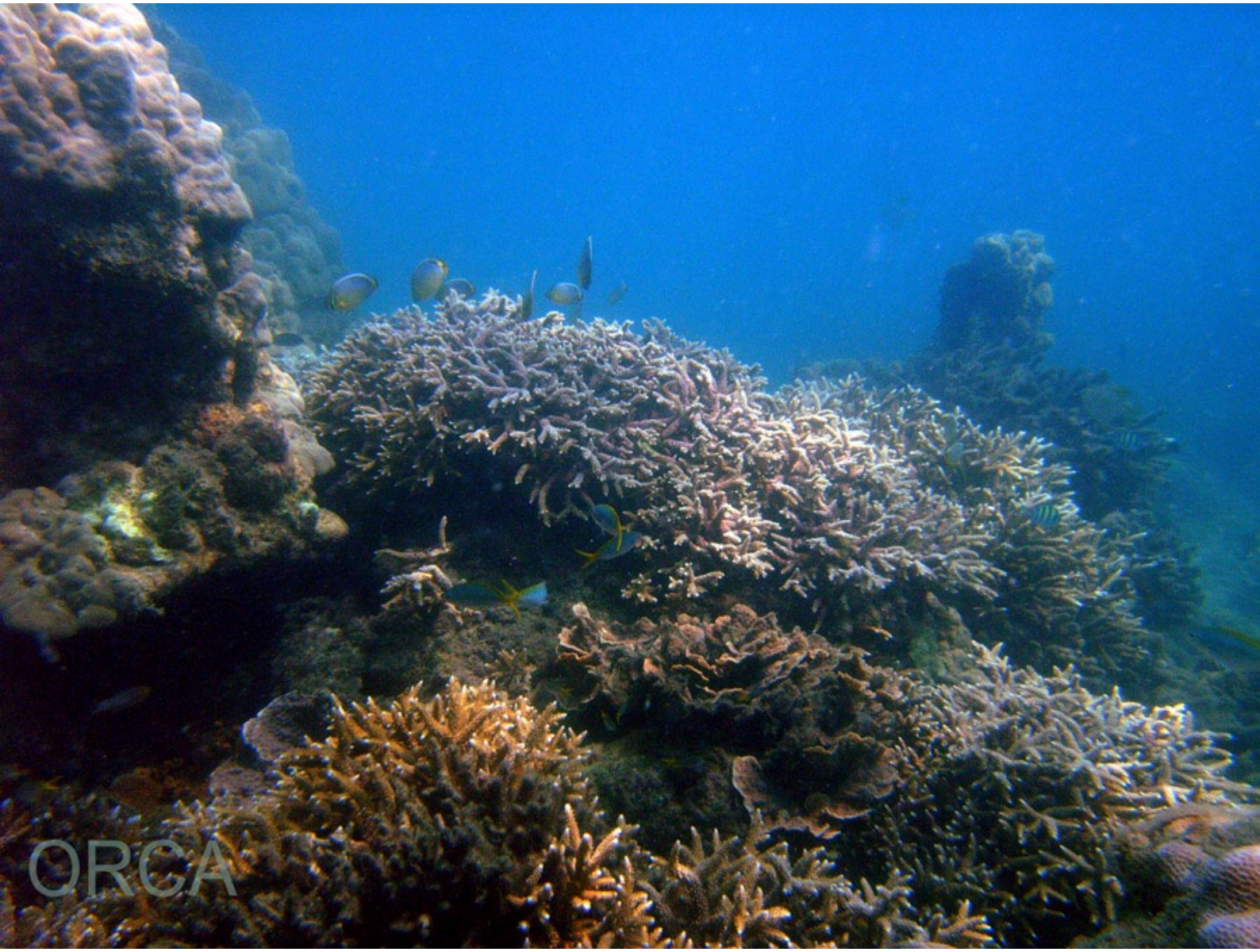
Preliminary Survey of Kayankerni Reef

Prasanna Weerakkody, Sajith Subhashana, K.Lakmal

28-29th June 2011, 25-28 March 2012



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CONTENTS

MAPS AND FIGURES

Map 1: Location of Kayankerni reef icluding Valachchanai Aru and Pasikuda Reef

Preliminary Survey of Kayankerni Reef

Report on surveys carried out on 28-29th June 2011, 25-28 March 2012

Team

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INTRODUCTION

The once prolific and rich coral reefs of the South and the South-west of the country is now nothing more than relics of reefs and veritable coral cemeteries. little of the previous diversity or abundance of life remains and with the continuing human and natural degradational forces they have shown very little recovery in the past 14 years since the 1998 mass coral bleaching/ mortality event. At present few good coral reefs exist in the country all located in areas that were afforded some level of protection from human influences due to war. The Kayankerni reef contains high diversity of coral and allied habitats within the described area and also a high diversity and abundance of marine life. The reef is an extensive system that is not fully explored and documented. The reef compares with important coral reefs as Pigeon Islands and Bar-reef.

The reef is an important Marine habitat based on the status of Coral reefs in Sri Lanka at present. and in need of urgent management initiatives and Protection before the fate of many other coral reefs befall this reef as well.

Location

The Kayankerni reef is a little known reef that was for long worked by the Ornamental Aquarium industry as a major collection site in the Eastern coast of Sri Lanka. The reef is located Between Valachchane and Vakare North of Batticoloa (approx 7o 59.500, N 81o 32.000 E.)

The Eastern coastline of the area include the Pasikuda reef nested within the cove at the Pasikuda headland at the point separating the Kalkuda bay to the south and Vandeloose Bay to the North just below the estuary out fall of the Valachchanei Aru. The Northern end of the Vandeloose bay is formed by the Chengemum munei headland which is surrounded on 3 sides by an extensive reef system known as the Kayankerni reef. which extends though to the Northern shores of the Chengemum munei headland opening in to the Thennadi Bay. The Western end of the Thennadi Bay is composed of the Velikuda Periya munei point which also contain an apron reef along the shore. Another off shore shallow reef patch is found about 1.4 km. off shore at this point. Beyond this point no shoreline coral features are observed till Sallitivu (Challitivu) munei point at Panichchankerni. This headland is composed of a small island with degraded coral reef structures around it. Experienced divers indicate many somewhat deeper reef systems throughout the areas and report good reef areas to be found in the area.

KAYANKERNI REEF

The kyankerni ref is well known to and is a favorite collection site of the Ornamental Aquarium industry collectors who have for years been involved in seasonally migrating to the site to collect fish and reef invertebrates. the operations continued even in the days when the LTTE was controlling the area with them allowing the collection of fishes subject to payment. The site is otherwise not well known and has not had many published references to it.

A preliminary rapid assessment survey was carried out at the site on the 28-29th June 2011 and 25-28 March 2012, The sampling was only visual backed up by photography; no quantitative sampling was carried out. the dives included snorkel swims, SCUBA dives and divers towed by boats (manta survey) to rapidly assess large areas of the reef. The survey provides a guide to the structure of habitats found within the broad reef area and fish diversity. further studies need to be focused to assess the full coral and invertebrate diversity of the reef.

The reef is an extensive complex of reefs and shoals that span the Thennadi bay and extend down along the Northern reaches of the Vanderloos Bay (8° 0'1.86"N, 81°30'44.25"E / 7°59'48.29"N, 81°32'46.27"E / 7°58'50.53"N, 81°33'33.75"E)

 the reefs within the bay are broadly identified in to several sections,

Map 2: Kayankerni reef locations

Figure 1: Groups of fish among Boulder corals

Figure 2: Honeycomb Stingray - *Himntura uarnak*

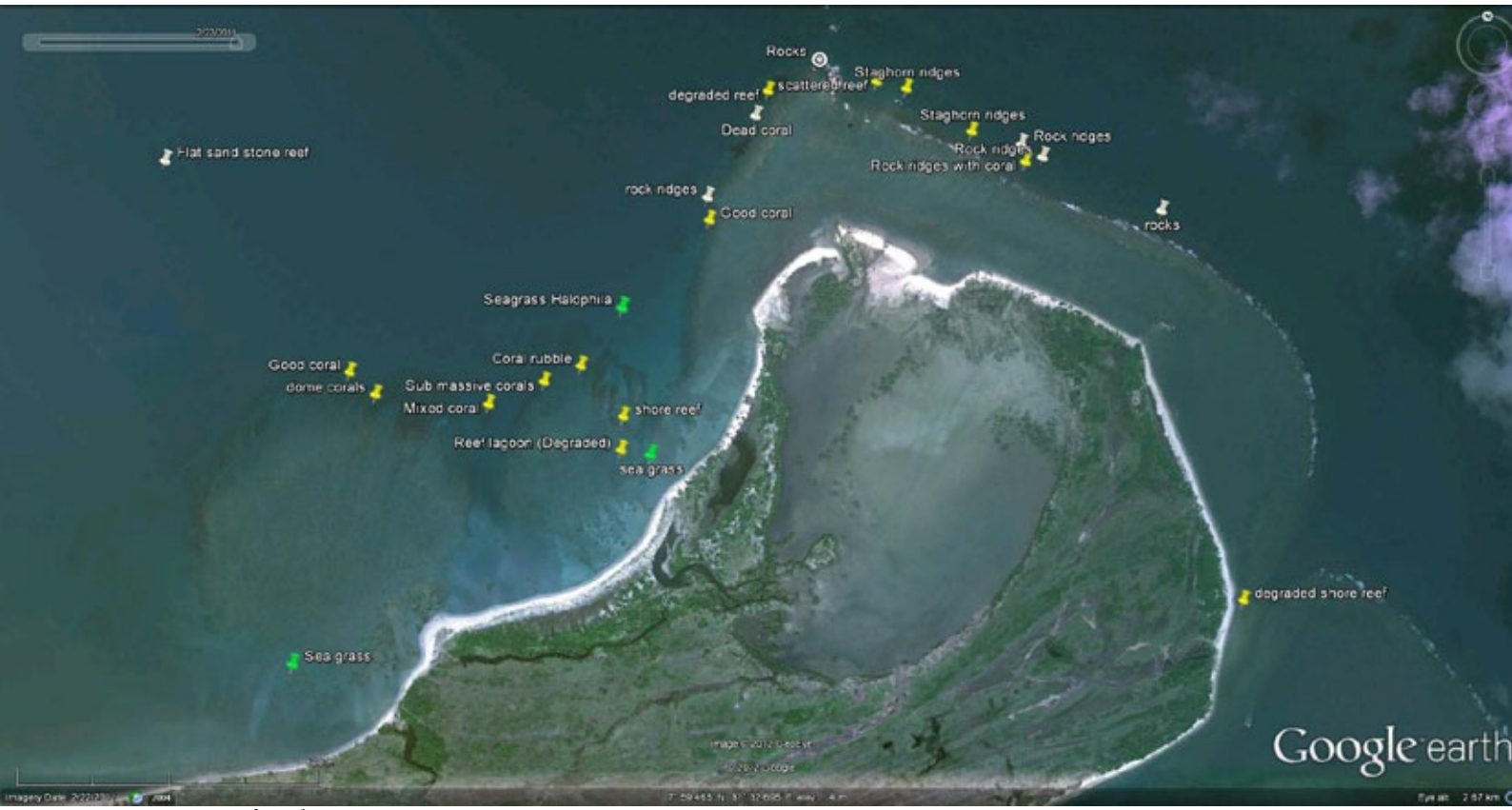
REEF STRUCTURE

Main reef

The primary and the most important reef section is composed of an apron reef in the form of three fans extending to the east of the center of the Thennadi bay along the headland extending to the West. the reef extends up to the rocky outcrops at the far end of the reef; and extends southward surrounding the headland. The apron reefs consist of diverse and abundant assemblages of coral towards the seaward end and grading in to shallow degraded sandy reef flats shoreward. these areas have been previously heavily mined for lime and now partially recovering with scattered colonies of coral. there is a significant area of sea grasses occurring inshore of the reef.

The reef spreads from 250-500m. off shore and stretching up to the large rocky outcrops located about 300m. offshore on the North Western edge of the reef. the main part of the reef is roughly 1.5 km in length along the coast.

The outer sea ward fringes of the reefs showed highly diverse and abundant coral growth in remarkably good health overall. with the inner sections of the reefs forming shallow reef flats with moderate live coral cover the shoreward end of reefs are dominated more by sandy sea bottoms with significant areas of Sea grasses observed, the waters within the inner area of the reef is on average 1-1.5 m. in depth while the outer ends of the reef may fall down to about 4-7m at the base. coral habitats vary from extensive Staghorn beds composed almost exclusively of a few species of Acroporid corals (primarily A. formosa and A. yongei) to Dome coral dominated habitats and other mixed coral habitats. Some reef areas observed recorded very high fish abundance and diversity. Main dominant coral types on the reef included Acropora formosa, A.yongei, Porites solida, P.lutea, P. rus, Montipora spp., Echinopora lamellosa, Pavona, Pocillopora etc. Some sections of the reef show significant damage through previous storm or other heavy wave impact events that seem to be in the process of recovery. Several sections of Coral rubble were noted primarily of Acroporid coral species indicating a significant previous coral degradation event over which the reef is showing significant re-coloni-



Map:3 Main reef- Habitats

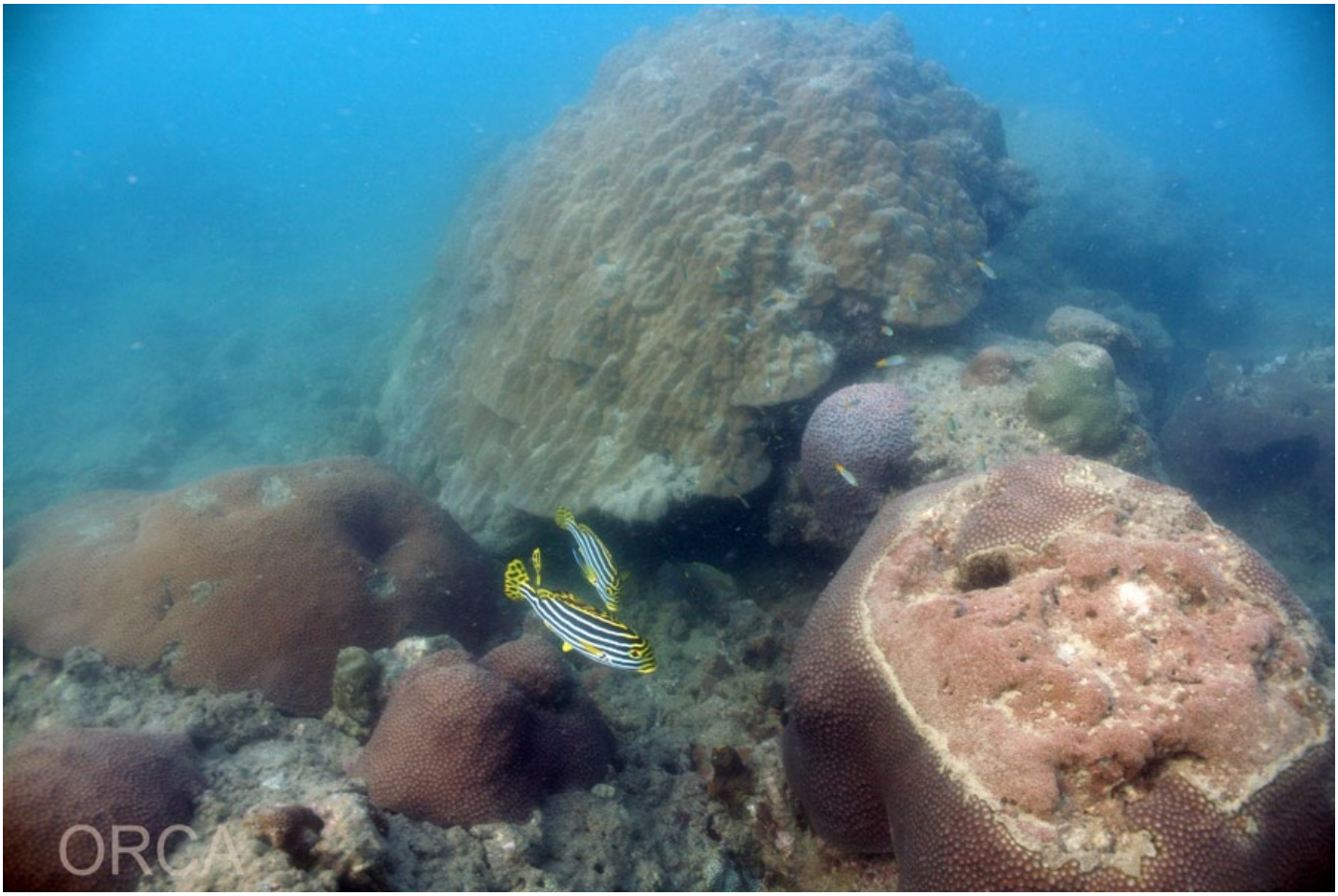


Figure 3: Dome-coral habitats

zation. the low prevalence of invasive organisms on the reef indicate that the reef is in good health, physical pollution on the reef is also low.

The Eastern section of the reef closer to the exposed rock out crop slowly degrade in quality and include steep rock inclines grading to deeper waters; post to which the reef in turn give way to wave exposed reef crest zone with low coral cover and large flats with rock, sandstone and rubble areas interspaced with smaller patches of coral.

The outer reef on the Eastern part of the reef beyond the exposed rock headland is initially composed of rock boulder habitats beyond which the outer slope of the reef is composed of an area of Spur and groove formations leading out to the sea composed of moderate growths of Staghorn coral interspaced with other species. Further to the south the outer reef is dominated by an extensive area of moderate sized rocky boulder based environment with superficial coral cover.

Figure 4: Staghorn corals with Damselfish and Fussiliers

Sand Island

The second most significant area of the reef identified lies about at the site known as the "Sand Island". the extensive isolated patch reef is found about 1.4Km. North of the headland located on the Western end of Thennadi bay. (Approx. 8o 00.5 N, 81o 31.3 E) The reef include many important and healthy reef areas, and also contain a wide diversity of coral and allied habitats and support high associated faunal diversity. The area is exposed to heavy surf and is said to have had an exposed sand island previously which has subsided and is now over grown with coral.

the reef is an off shore elevated rock out crop roughly 500m. x 300m. in extent no exposed sections of the island is visible above water except for breakers when the surf is high. The reef ranges from almost intertidal sections and reaching down steeply to a depth of over 10m. the reef is composed of different habitats including good Staghorn dominated coral, to areas dominated by other coral types and significant large coral dome habitats. The crest section is prone to high surf and is relatively degraded including areas of dead coral and extensive coral rubble zones. The outer sections of the rocky structure is ringed with Staghorn coral habitats on most areas with the Western sections including areas dominated by corals Echinopora lamellosa and Porites rus, On the West and Southern faces the deeper sections of the reef below this coral area is composed of large areas of dome coral dominated habitats. the lower areas on the Northern face of the reef is composed of large submerged rock outcrops and ridge structures that extend into an extensive deeper rock and sandstone reef habitat. The reef at the western end seem to contain higher diversity and abundance of fish and marine life.

Map 4: Sand Island- Habitats.

The reef is used by local artisanal fishermen and several boats were observed engaging in line fishing. Some nets and fish traps may be utilized. no direct evidence of blast fishing or excessive netting was apparent. evidence that ornamental fishing was less at this site than at the Main reef was evident with more species of target species like Chaetodon rafflesi, C. collare, C. melanotus, C. xanthocephalus being observed on the site.

Figure 5: Corals- *Echinopora lammelosa* and *Porites rus*.

West shore reef

There is a small patch reef close to the shore on the Western end of the Thennadi Bay around "Velikuda Periyamunei Point" the area was not adequately surveyed currently but locals indicate that it is highly degraded and of little importance.

Lagoon reef to East and South of headland

The reef on the eastern side of the bay beyond the Main reef spreads around the headland in a continuous reef about 250-300m. off shore with an elevated intertidal reef crest with enclosed reef lagoon. this reef extends beyond the elephant point to reach lower along the opposite side of the headland in to the Vanderloos Bay . fanning out in to a wide arc about 400m to 800m. from the shore separated by a wide reef lagoon. several spot samplings were carried out within the eastern part of reef lagoon and on the outer reef edge which indicate a highly degraded reef system with low coral cover and faunal diversity. The outer areas of the reef beyond the crest at the Northern most point of this section is composed of a series of spur and groove formations of coral in areas dominated by Staghorn corals, the growth

The outer reef on the Eastern part of the reef beyond the exposed rock headland is initially composed of rock boulder habitats beyond which the outer slope of the reef is composed of an area of Spur and groove formations leading out to the sea composed of moderate growths of Staghorn coral interspaced with other species. Further to the south the outer reef is dominated by an extensive area of moderate sized rocky boulder based environment with superficial coral cover.

The reef lagoon was insufficiently explored but seem to be composed of degraded sand areas with interspaced coral colonies.

The Southern section of the reef spreading out on the Southern side of the headland seem large in extent and formations in the satellite imagery may indicate coral formations but the area was not sampled due primarily to low underwater visibility in the area. Local informants indicate that this reef is mostly composed of degraded coral environments.

BIO-DIVERSITY

The reef contain a high diversity of coral and other allied marine habitats within the area making the Kayankerni reef richer in Habitat diversity compared to many similar reefs.

Marine species recorded at the site indicate a highly diverse population Based on the limited sampling carried out the team doumented 9 spp. Algae, 3 spp. Sea grasses, 115 Invertebrate species including 51 coral species and 206 fish species and 1 species of sea turtle within the limited surveys carried out at the Kayankerni reef. Further studies including longer term sampling, and night time surveys will make significant addition to these numbers. The high prevalence of ornamental fishing is significantly limiting the diversity of "Color fish" on the reef; If the reef is provided protected status and ornamental aquarium collection is stopped at the site; species numbers are expected to dramatically increase within 2-3 years. There is a marked increase in occurrence of "Color fish" species between the two parts of the survey which include a sample late in the diving season and one before the diving/collection season is initiated in the East coast.

HABITATS

Coral habitats

The coral areas within the Eastern section of the Thennadi bay is composed of three roughly fan shaped reef areas and at the off shore site at the "Sand Island" The sections are diverse in habitats ranging from large Staghorn coral dominated environments to massive Dome coral dominated habitats to a varied combinations of mixed coral assemblages, in addition Coral rubble zones and Sea grass beds compose a rich diversity of marine habitats within a compact area. The rich diversity of coral species is encountered within the many coral habitats. including Acropora, Porites, Montipora, Echinopora, Pocillopora, Favia, Favites. The coral species list attached is not considered complete as only priliminary visual identifications were carried out (no specimens were collected)

Figure 6: Staghorn Coral *Acropora formosa*

On a general note the condition of the reef seem to be healthier than most comparable reefs with very low incidence of invasive organism activity and physical pollution. recent mechanical damage including human activities though apparent was not significant or recent. coral areas are diverse and range from large Staghorn coral dominates environments with more than 80% coral cover to mixed coral habitats which are usually composed of mixed strands of several different Staghorn Acropora species including A. formosa and A. yongei. Large Dome coral environments with massive coral heads that are commonly over 3m in high and 4m. across are found

in some reef edge areas giving excellent height relief to the reef and supporting large populations of shoaling fish species above the colonies and in the deep crevices at their bases.

In some areas large sections of old dead coral is found interspersed with live coral areas, significant areas of Coral rubble also exist indicating that the reef may have seen a significant mortality event and is now recovering well from it (Bleaching event/Tsunami/Storm). The age of corals vary and most are mature colonies indicating healthy long term survival of corals at the site.

Figure 7: Mixed Coral habitat with boulder coral

Sea Grass

The near shore area of the main reef seem to contain an extensive area of sea grasses, several other smaller sea grass beds were also observed mid reef in the same area. The species included in the preliminary study include Halophila sp., Enhalus acoroides, Halodule uninervis etc. further studies are needed to properly document the extent and composition of the sea grass habitats within the area.

Rocky reef habitats

Many areas of deeper water Rock ridge and boulder habitats are found primarily North of the Sand Island and Along the outer reef beyond the Eastern end of the reef. a further rock habitat is reportedly found in the center area of the bay which was not sampled.

Figure 8: Rocky reef with Parrotfishes

Ship Wrecks

A ship wreck, The Ship now identified as "S.S. Lady McCullum" sunk in 1926 and previously referred to as "Allison &McLeelan" based on an inscription plate recovered from the ship. is reportedly found beyond the eastern part of the reef at 080 00.186N, 0810 .33.387E located about 1.3km North-East of the Rock outcrop at the eastern end of the reef. The team could not dive the site during this study but feel strongly that this site also should provisionally be included within the reef system and managed as an extension of the reef habitat.

**(A description of the Ship wreak is available at www.divesrilanka.com which is attached as an annexed to the report with full credit to the site owners.)*

SPECIES

Fish Populations

The reef contain a rich assemblage of fish species with 207 species observed up to present, The full number of species with more observations is believed to tally well over 300 species. 18 species of Butterflyfish species were documented on the reef. The diversity of smaller fish groups including Gobies, Blennies, Cardinalfishes, Dottybacks, and cryptic groups such as Moray and other Eels, Scorpionfishes, etc. are not adequately covered in the present list.

At first the fish populations seem abundant and diverse on the reef. The reef teems with large shoals of Fusiliers, Damselfishes, Cardinalfishes, Sweepers, Parrots, Snappers and Sweetlips. The initial impression of high abundance and the vibrancy of the fish populations was shadowed by the notable lack of many species of "Color fish" that would normally be expected to be present in a similar situation. This included the Butterfly-fishes the numbers of the high demand species were very rare on the reef and which was only documented on the reef at the dives carried out before the commencement of the collection activities in the East coast. many other species including Genera Pterois , Platax,, Amphiprion, Canthigaster, Ostracion, Chromis, Labroides, Dascyllus etc. were either not observed or found in very small numbers on the reef. While the preliminary nature of the dive is too brief for conclusions the apparent reduction of populations may be attributed to selective collection in the Ornamental aquarium industry.

Figure 9: Firefish -Pterois miles are rare on the reef possibly due to over collection.

Other notable omissions included top end predators including Trevallys (Carangidae),Barrakuda (Sphyraenidae) and Large Groupers (Serranidae). medium to small sized groupers were common on the reef including E. caeruleopunctatus, C.argus, C.formosa.. Angel fishes were abundant with common large species (Pomacanthus semi-circulatus, , P. imparator) observed along with Centropyge multispinis, C. flavissimus and C. eiblii present.

Figure 10: Rare and protecd spacies juvenile P-albovittatus.jpg

Reef Invertebrates

The focus on invertebrates was low as the preliminary nature of the survey did not have scope to look for the more cryptic species. Coral abundance and Diversity was high and is documented in the list. The list only details species that are easily identified in the field without delving in to microscopy. Where it is not possible to go down to species level identification has been carried out to generic level. The survey was strictly a visual survey and no specimens were collected and species needing microscopy or collection of speci-mens; all species were identified to the closed taxonomic group possible visually.

Figure 11: Fish Schooling over Coral

The absence of any large sea anemones (Heteractic, Stichodactyla, Entacmea spp.) was notable and can be directly attributed to the high activity of the ornamental fish collectors in the area

Few crustaceans were observed primarily due to the limitations in the preliminary survey observations. Several Painted Spiny lobsters of medium size was observed along with good numbers of Sea cumbers still populating reef areas. the sea cucumbers observed mostly belonging to the genus Holothuria while it may be possible that a higher diversity would be observed if a night time survey is carried out. The seastars observed included large Pin cushion Sea stars (Culcita spp), Big Blue seastar (Linkia laevigata) the coral predator "Crown-of Thorn Sea stars" (Acanthaster planci) that have reached plague proportions in many other reefs both in the East and North-west coast were not prominent on the reef with only one observation in an outer rocky area of the reef observed during the survey. several other smaller sea stars including the Batik sea star and the small red sea stars were also recorded. Feather Stars(Crinoidea) populations were very Abundant and Diverse.

The Big Blue Octopus, Reef Squids, Pharaoh cuttlefish, Large Spider conch shells (Lambis spp.), large ear-shells (Pinna sp.) were notable among the mollusks. No Giant clam (Tridachna) shells were observed. an omission which may be directly attributed to the Marine Aquarium trade collection.

A good diversity of sponges were observed with medium sized Barrel sponges being common. along with many other common reef invertebrate groups

The species of reef invertebrates becoming invasive on many other reefs in Sri Lanka and causing significant damage to the reefs were remarkably found in very low numbers and with no significant invasive events observed on the reef.

REEF CONDITION AND HEALTH

It can be noted that the reef is in a comparably better state of health than most other surviving coral reefs in the East and North-West of Sri Lanka. The reef is composed of a complex of reef patches and shoals interspaced with areas of sand, coral rubble and Sea grass. There are several large dead coral areas as well as intermittent dead coral spaces within coral areas which indicate a past wide scale coral mortality event. It is difficult to date the event based on the dead coral and rubble available except that it is at least 5 or more years old and possibly attributable to either the 1998 coral bleaching event or the 2004 Tsunami. But the reef seem to show good restoration of coral habitats and the mature state of most coral colonies indicate that the reef has been stable for 5 or more years in the minimum. The live coral cover varies between different sections of the reef from 5-10% low areas to areas with 80-90% live coral cover. the species composition and coral habitat diversity varies from massive coral dome (mainly Porites spp.) dominated environments to large strands of Staghorn corals, though most Staghorn areas involve more species diversity within the "Staghorn" group of Acroporid corals with less mono-specific strands than at e.g. Pigeon Is. The significant height relief of coral structures and of the shoals on which coral grown rising on general 1.5 -4m. or more above the sand floor provide good opportunity for additional habitat and good reef structural relief.

The Indications of physical damage and solid debris pollution is at a lower scale on the reef and the non-incidence and occurrence of invasive Reef organisms in any alarming numbers indicated that the reef is in better health than most other reef observed currently. Though the Brown Corallimorphs, Black sponge and Algae Halimeda were recorded on the reef the numbers are low and indicate natural levels for a healthy reef. no significant invasive event was observed on the reef.

On one of the satellite images inspected in Google Earth two areas of the reef appear as black patches close to the rocks on the eastern end of the reef. the team engaged in a survey of these sites but found no predominantly black habitat that would reflect the cause of the satellite imagery. The area contain some slightly higher than normal occurrence of the dark colored algae (*Avrainvillea erecta*?) which may indicate a previous invasive event that has receded and naturalized now. the reef area show low live coral cover possibly due to the effects of an invasive event.

HUMAN IMPACTS

The reef is a long term and prominent location used by the collectors working for the Ornamental Aquarium Export Industry. the collectors used to pay toll to the LTTE and operate even while the war was on. The evidence of collection pressure is clearly evident on the reef with marked reduction in target species notable among both fish and invertebrate populations. the series of dives carried out at the beginning of the season before the arrival of the fish collectors confirmed this assumption as much higher diversity and abundance of "ornamental' species were observed on the reef.

The most striking indications of this is apparent in the lack or rarity of all species of large sea anemones and associated clown fishes (commonly observed at many other east coast reefs) Butterflyfish species, Lionfishes, Batfishes and the high demand varieties of all other fish groups including morays, hawkfish, damsels, etc. on the reef.

The Ornamental target species that were observed in the month of March before the commencement of the collection activities that were not recorded from the June reports late in to the collection season include Butterflyfishes -*Chaetodon collaris, Chaetodon cittrinellus, Chaetodon melanotus, Chaetodon xanthocephalus, Chaetodon falcula, Chaetodon lineolatus, Chaetodon meyeri, Chaetodon rafflesi, Chaetodon triangulum, Heniochus acuminatus, Heniochus singularis*, Sailfin tang-*Zebrasoma desjardini*, Lionfish- *Pterois miles,* Striped eel-catfish *Plotosus lineatus,* Puffer *Canthigaster valentini* etc.

The absance of the large sea anemones and accompanying Clown fishes are assumed to be a direct result of collection for export. The faunal group is still found in good numbers in the allied reefs in the East coast including Pasikuda and Pidgeon Islands. These sea anemones are known to live over a hundred years and have low reproductive rates. The high demand for these in the aquarium export sector has totally exterminated the group from the entire Southern and Western coasts except in areas closed for long due to the war and in very few deepwater sites deeper than 25m. Once depleted this group of invertebrates have not shown natural recovery over a period of 25 years in the west and south coasts. Urgent measures need to be brought in to provide a ban on export of these species.

Figure 12: Coral with signs of recovered physical damage.

The homogeneity of coral beds of fragile types of coral are significantly disrupted showing high incidence of smaller scale physical damage that has been since recovered. This may be caused by activities of fish collectors of the reef and incidental coral breakage in the process of capturing the target groups of fish.

Figure13: Lost fishing nets entangled on coral

The reef was also notable for the omission or very low abundance of many larger shoaling fish species including jacks and Trevallys (Paraw), Barracuda (Jeelawa), Gray mullets (Godaya) makeral? (Bolla), Garfishes and Halfbeaks (Moralla, Theliya, Habaraliya) etc. Large groupers were also rare on the reef. No sharks were observed and no rays except for one large Stingray at a reef outside the main reef complex in deeper waters. This is certainly due to some form of excessive fisheries pressure such as reef netting, Blast fishing and on some instances Spear fishing. None of the above groups were recorded on the reef during the survey with the exception of a single shoal of Jacks in the outer reef area. With the exception of sharks these species are expected to occur in high numbers on a healthy reef environment. and the cause of the phenomena need to be investigated and remedied.

Figure 14: Invasive Algae *Halimeda sp.*

Fishing activity is low on the reef except the large Ma-dal operation in the center area of the bay away from the reef. this is not expected to have a significant impact on the reefs.

Several small boats and canoes were operating angling, gill nets and fish traps in different areas including the area surrounding the Sand Island reef. Several lost nets were observed entangled on coral and causing smothering of corals in different sections of the reef.

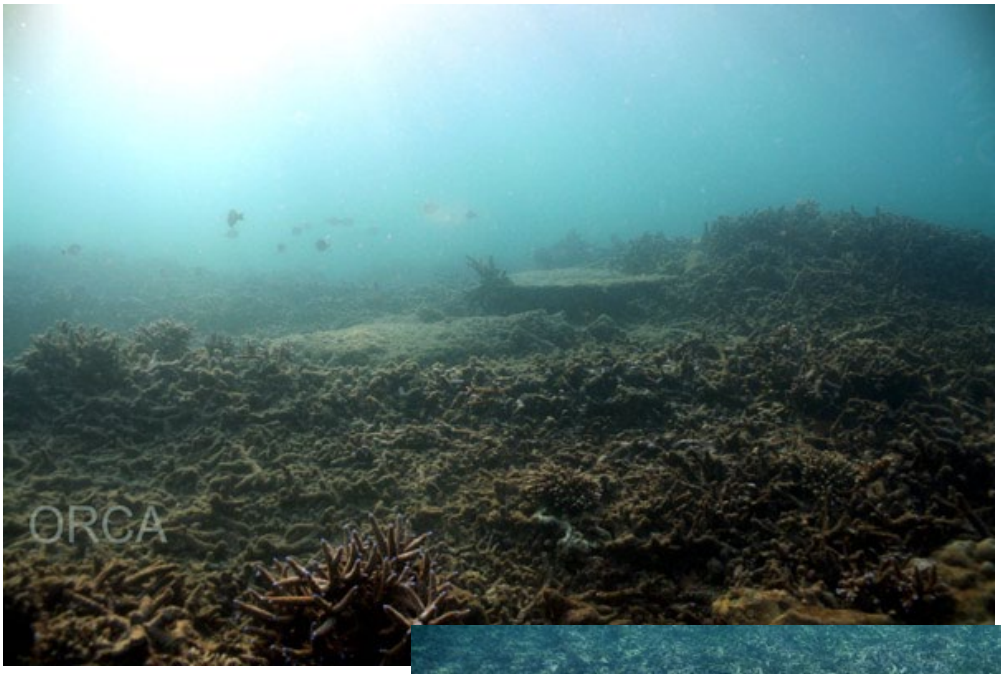


Figure15: Dead-Coral.

The area has been subject to severe coral mining for the lime industry in the pre-tsunami time. most of the shallow inner reef flat areas show indication of mining. The activity has ceased post to the Tsunami and the reef is showing notable recovery in areas.

Figure 16: Coral Rubble

RECOMENDATONS

The reef is an extensive reef system and contain a rich diversity of habitats and species within a coral based ecosystem along with allied habitats that make this reef an important reef system in Sri Lanka. Especially in view with the highly degraded state of all coral reefs in the Southern and Western shores the with the only good coral areas remaining in the North western shores at Kalpitiya and North of it to Mannar and in the East coast specially at the Pigeon Islands and Pasikuda and few other sites. In comparison the present reef at Kayankerni compares with the best of Sri Lankan reefs and must rank high on the conservation priority list for Sri Lanka

It is apparent that this reef is a very important coral reef environment surviving in Sri Lanka. while most of the other reefs in similar survival state and Bio-diversity richness is currently under protection by DWLC this reef has not received any protection despite surveys carried out by the relevant government agencies.
While additional studied are needed to document the full extent, bio-diversity and conservation status of the reef. We are confident to strongly propose that this reef must protected under the F&FPO and taken under the management of the relevant agencies at the earliest possible to prevent the degradation of this reef. conservation measures need to be brought in place to preserve the reef along the same lines with the protection provided for Bar-reef and the Pigeon Islands reef.

THE PROPOSED PROTECTION ZONE

Two core areas of reef were identified that are in need of protection at the sites identified as the "Main reef" and the "Sand Island reef" The extent of the remaining reefs within the Thennadi bay and the apron reef that extend south along the eastern and Southern faces of the headland may be included in to the buffer zone area of the reef. It is recommended that the shipwreck site located North East of the reef be included in the management activity. further studies are needed to ascertain the value of the reef system in the Southern part of the Headland.

METHODOLOGY AND CONSTRAINTS

The survey was carried out using Snorkel and SCUBA dives and extensive use of Tandem diver tows to sample large reef areas fast and efficiently. Sampling was carried out using visual sampling backed up by underwater photo and video documentation. No specimens were collected and No night dives were carried out during present survey.

The Survey is limited in the extent of sampling carried out. The work carried out focused on identifying the reef habitats and status and health of the reef and documenting non-cryptic Diurnal macro fauna of the reef. The species numbers documented does not include a complete indication of reefs diversity. More work need to be carried out to cover annual variations, nocturnal populations and cryptic and smaller sized fauna of the reef. No specimens were collected and all Coral and other species were identified to a level limited to strict visual identification.

Few allied areas remain to be sampled to complete the survey of the area.

ANNEX:1 lIST OF FISHES RECORDED

Dasyatidae **Stingrays**
Himantura uarnak

Muraenidae **Moray Eels**
Gymnothorax javanicus
Gymnomuraena zebra

Plotocidae **Eel Catfish**
Plotosus lineatus

Synodontidae **Lizardfish**
Synodus variegatus
Saurida sp.

Clupeidae **Sardines**
?.sp

Belonidae **Garfishes**
Tylosus sp.

Holocentridae **Squirrelfishes**
Myripristis murdjan
Myripristis adusta
Myripristis vittata
Neoniphon samarra
Neoniphon opercularis
Sargocentron spiniferum
Sargocentron caudimaculatum
Sargocentron cornutum
Sargocentron rubrum

Fistularidae **Flutemouths**
Fistularia commersoni

Scorpaenidae **Scorpionfishes**
Pterois milesi

Serranidae **Groupers**
Cephalopholis argus
Cephalopholis formosa
Cephalopholis sonarati
Epinephelus tauvina
Epinephelus merra
Epinephelus caeruleopunctatus
Epinephelus longispinnis
Plectropomus aereolatus
Aethaloperca rogaa
Grammistes sexlineatus

Diploprionidae **Soapfishes**
Diploprion bifasciatum

Cirrhitidae **Hawkfishes**
Paracirrhitus forsteri
Paracirrhitus arcatus
Cirrhitus pinnulatus

Apogonidae **Cardinalfishes**
Apogon kalopterus
Apogon spp.
Cheilodipterus macrodon
Cheilodipterus quinquelineatus
Archaemia fucata

Teraponidae **Targetfish**
Terapon jarbua

Gerridae
Gerres acinacea

Leiognathidae **Ponyfishes**
Leiognathus daura

Carangidae *Jacks and trevallys*
Caranx sexfasciatus

Lutjanidae **Snappers**
Lutjanus decussatus
Lutjanus rivulatus
Lutjanus fulvus
Lutjanus fulviflamma
Lutjanus monostigma
Lutjanus kasmira
Lutjanus vittata
Lutjanus biguttatus
Lutjanus lutjanus
Lutjanus argentimaculatus
Lutjanus bohar
Lutjanus lunulata

Caesionidae **Fussiliers**
Pterecaesio chrysozona
Casio cuning

Haemulidae **Sweetlips**
Plectorhynchus vittatus
Pletorhynchus picus
Plectorhynchus schotaf
Plectorhynchus albolineatus
Diagramma pictum

Nemipteridae **Monocle Breams**

Scolopsis vosmeri
Scolopsis bilineatus
Scolopsis affinis
Scolopsis bimaculatus
Monotaxis grandoculis

Lethrinidae **Emperors**

Lethrinus ornatus
Lethrinus nebulosus
Lethrinus harak

Mullidae **Goatfishes**

Mulloidichthys flavolineatus
Mulloidichthys vanicolensis
Mulloidichthys mimicus
Parupaneus barbarinus
Parupaneus indicus
Parupeneus forskali
Parupeneus macronema
Parupaneus bifasciatus
Upenius sp.

Kyphosidae **Rudderfish**

Kyphosus sp.

Monodactylidae **Mono**

Monodactylus argenteus

Pempheridae **Sweepers**

Parapriacanthus sp.
Pempheris oualensis

Chaetodontidae **Butterflyfishes**

Chaetodon decussatus
Chaetodon vagabundus
Chaetodon collaris
Chaetodon auriga
Chaetodon cittrinellus
Chaetodon melanotus
Chaetodon trifasciatus
Chaetodon trifascialis
Chaetodon plebeius
Chaetodon xanthocephalus
Chaetodon falcula
Chaetodon lineolatus
Chaetodon meyeri
Chaetodon rafflesi
Chaetodon triangulum
Heniochus acuminatus
Heniochus singularis
Heniochus pleurotaenia

Pomacanthidae **Angelfishes**

Pomacanthus semicirculatus
Pomacanthus imperator
Centropyge flavipectoralis
Centropyge multispinis
Centropyge elblii
Aplomichthys xanthurus

Pomacentridae **Damselfishes**

Abudefduf vaigiensis
Abudefduf sordidus
Abudefduf septemfasciatus
Plectroglyphidodon dickii
Chromis ternatensis
Chromis dimidiatus
Chrysiptera leucopoma
Pomacentrus similis
Pomacentrus phillipinus
Pomacentrus indicus
Pomacentrus chrysurus
Dascyllus trimaculatus
Dascyllus aruanus
Neopomacentrus azysron
Neoglyphidodon bonang

Labridae **Wrasses**

Chelinus undulatus
Chelinus chlorurus
Chelinus trilobatum
Cheilio innermis
Coris caudimaculatus
Coris batuensis
Bodianus axillaris
Anampses sp.
Halichoerus hortulanus
Halichoerus marginatus
Halichoerus nebulosus
Halichoerus margaritaceus
Halichoerus timorensis
Hemigymnus fasciatus
Hemigymnus melapterus
Gomphosus caeruleus
Macropharyngodon ornatus
Macropharyngodon meleagris
Stethojulis trilineata
Thalassoma lunare
Thalassoma hardwickii
Thalassoma janseni
Thalassoma trilobatus
Labroides dimidiata
Diproctacanthus xanthurus

Scaridae **Parrotfishes**

Calotomus carolinus
Scarus rubroviolaceus
Sarus caudofasciatus
Scarus niger
Scarus ghobban
Chlorurus rhacoura
Leptoscarus vaigiensis

Tripterigiidae **Triplefins**

Helcogramma striata
Helcogramma sp.
Enneapterigius sp.

Blenniidae **Blennies**

Plagiotremus rhinorhynchos
Plagiotremus tapeinosoma
Petroscritus sp.
Cirripectus
Escanias nalolo
Ecsenias sp.
Escanias bicolor
Exalias brevis
Entomacrodus sp.
Istiblennius

Gobiidae **Gobies**

Cryptocentrus /Amblyeleotris sp.
Amblygobius phalaena
Valencienna spp.
Gobiodon citrinus
Gnatholepis sp.
Istigobius decoratus

Zanclidae **Moorish Idol**

Zanclus cornutus

Acanthuridae **Surgeonfishes**

Zebrasoma desjardinii
Acanthurus lineatus
Acanthurus leucosternon
Acanthurus triostegus
Acanthurus pyroferus
Acanthurus tristis
Acanthurus mata
Acanthurus dussumieri
Ctenochaetus striatus
Ctenochaetus strigosus
Naso annulatus

Siganidae **Rabbitfishes**

Siganus javus
Siganus lineatus
Siganus canaliculatus
Siganus virgatus

Balistidae **Triggerfishes**

Balistapus undulatus
Balistoides viridescens
Psudobalistes flavimarginatus
Rhinecanthus aculeatus
Rhinecanthus rectangulatus
Melichthys vidua
Melichthys indicus
Suffleman albicaudatus
Suffleman frenatus

Monacanthidae **Filefishes**

Amanses scopas
Alutera scripta
Pervagor tomentosum

Ostraciidae **Boxfishes**

Ostracion cubicus
Ostracion meleagris

Tetaodontidae **Pufferfishes**

Arothron nigropunctatus
Canthigaster valentini
Canthigaster solandri

Diodontidae **Porcupinefishes**

Diodon hystrix
Diodon liturosus

** 207 Species in 42 Families*
*** The List is considered incomplete -See text.*

ANNEX: 2 LIST OF INVERTEBRATES RECORDED (INCLUDING CORAL)

Marine Plants

Algae

Halimeda gracillis	
Caulerpa racemosa	
Caulerpa taxifolia	
Padina sp.	
? sp.	*Turf Algae*
Ulva sp.	*Sea lettuce*
Asperagopsis taxiformis	
Velonia? sp.	
Avranvillia errecta?	

Sea grasses

Halophila sp.	*Sea grass*
Enhalus acoroides	*Sea grass*
Halodule uninervis	*Sea grass*

Invetertebrate Fauna

Porifera

Sponges

Xestospongia testudinaria	*Barrel sponge*
? sp.	*Stone sponge*
? sp.	*Yellow ball sponge*
? spp.	*Sponges*
Terpios hoshinota?	*Black cyanobacterial-sponge*

Cnidaria

Ctenophores

? sp.	*Ctneophores*

Jellyfish

Rhizostmeae sp.	*Jellyfish*
? sp.	*Hydroids*

Soft Coral

Sarcophyton spp.	*Leather coral*
Sinularia spp.	*Leather coral*
Lobophytum spp.	*Leather coral*

Sea Whips

Juncella spp.	*Sea Whips*

Corals

Acropora formosa	*Staghorn Coral*
Acropora yongei ?	*Staghorn Coral*
Acropora microphthalma ?	
Acropora hyacinthus	*Table Coral*
Acropora lamarkii ?	*Table Coral*
Acropora cytheria?	
Acropora tenuis?	
Acropora spp.	
Montipora aequituberculata	*Rose coral*
Montipora tuberulosa?	
Montipora spp.	
Pocillopora damicornis	

Pocillopora verrucosa
Pocillopora eydouxi
Pocillopora meandrina
Echinopora lamellosa
Porites solida — *Dome coral*
Porites rus
Porites lobata — *Dome coral*
Porites desilveri
Porites sp.
Favia favus
Favia speciosa
Favites complanata
Favites abdita
Favites pentagona
Favites sp.
Pavona spp.
Galaxia fascicularis
Hydnopora exesa
Hydnopora microconus
Leptoria phrygia
Platygyra daedalea
Platygyra lamelliana
Platygyra pini
Symphyllia recta
Symphyllia agaricia
Lobophyllia sp.
Goniastrea sp.
Goniopora sp.
Diploastrea heliopora
Montastrea sp.
Plerogyra sinuosa
Turbinaria peltata
Psammocora contigua
Psammocora digitata
Pavona sp.
Leptoseris sp.
Podabacea sp.
Pachyseris sp.
Distichopora violacea
Dendrophyllia sp.

Gorgonians
? sp. — *Gorgonians*

Corallimorphs
Rhodactis sp.? — *Corallimorph*

Zooanthids
Palithoa sp. — *Zooanthid*

Echiurida

Ehiurid worms
? sp. — *Echiurid Worm*

Annelida

Tube Worms

Spirobranchus sp.	*Feather duster worms*
Sabellastarte sp.	*Christmas tree worms*
Sabella sp.	*Feather duster worms*

Crustacea

Barnacles

Chthamalus? sp	*Barnacles*

Shrimps

Alpheus sp.	*Snapping shrims*

Spiny Lobster

Panulirus versicolor	*painted Spiny Lobster*

Hermit Crabs

Coenobita sp	*Hermit crab*
Dardanus guttatus	*Hermit crab*

Crabs

Grapsus tenuicristatus	*Swift-foot crab*
Charybdis miles	*Soldier Crab*
Thalmita sp.	
Matuta lunaris	*Moon Crab*
Carpilius sp.	*Egg Crab*

Mollusca

Shells

Heliotis sp.	*Abalone*
Trochus sp.	*Topshell*
Oliva sp.	*Olive shell*
Strombus sp.	*Strombus shell*
Lambis chiragra	*Arthritic Spider Conch*
Lambis lambis	*Common Spider Conch*
Lambis truncata	*Giant Spider Conch*
Lambis scorpio	*Scorpion Conch*
Cypraea tigris	*Tiger Cowrie*
Cypraea talpa	*Talpa Cowrie*
Cypraea spp.	*Cowrie shells*
Drupa sp.	*Coral snail*
Conus spp.	*Cone shell*
Terebra sp.	*Auger shell*

Nudibranch

Phyllidia varicosa	*Phyllidid Nudibranch*

Bivalve shells

Pinna sp.	*Ear shell*
Crassostrea sp.	*Rock Oyster*

Cephalopods

Sepia pharaonis	*Pharao Cuttlefish*
Sepiotheuthis lessoniana	*Reef Squid*
Octopus cyaneus	*Big Blue Octopus*

Echinodermata

Sea-urchins

Diadema setosum	*Black sea urchin*
Echinothrix calamaris	*Sea urchin*
Echinostrephus molaris	*Boring Sea urchin*

Sea-cucumbers

Holothuria atra	*Sea cucumber*
Holothuria edulis	*Sea cucumber*
Stichopus horrens	*Sea cucumber*

Sea-stars

Acanthaster planci	*Crown of Thorn Seastar*
Culcita novaeguineae	*Pin cushion Sea star*
? sp.	*White sea star*
Nardoa sp.	*Green sea star*
Linkia multifora?	*Batik sea star*
Linkia laevigata	*Big Blue sea star*
Fromia indica	*Indian Seastar*

Brittle-star

Macrophiothrix longipeda	*Long legged Brittle star*
Ophiocoma sp.	*Brittle star*

Feather-star

Stephanometra sp.	*Feather star*
Comanthina sp.	*Feather star*
Comanthus sp.	*Feather star*
Himerometra sp.	*Feather star*

Ascidacea

Ascidian

Didemnum sp.	*Green Ascidian*
? spp.	*Ascidians*

Vertebrates Reptilia

CHELONIIDAE

Eretomochelys imbricata	*Hawks-bill Turtle*

** The List is considered incomplete -See text.*

ANNEX: 2 S.S. LADY MCCULLUM SHIP WRECK SITE

Due to the time restrictions of the present study the team was unable to sample this site as part of the survey but never the less believe that any management plans for the site must take in to account the importance of this site as well.

The Images of this section courtasy of Dharshana Jayawardena, The explanatory notes are extracted from the website: www.divelanka.com all credit due to the Authors and Site owners.

S.S. LADY MCCULLUM SHIP WRECK SITE

8/03/2012: Based on historical records, last known location, size of the ship we have now ascertained this to be the Lady McCullum SS which ran aground in 1926 en route to Trincomalee from Kalkudah. This is a British transport (passenger/cargo ship) with steam propulsion built in 1908 and belonged to the Ceylon Steamship Co at the time of the sinking.

09/09/2011: This is a relatively small ship and it stands up right. At a leisurely pace, one could swim from the bow to the stern in about 15 minutes if there is no current . The ship is badly broken up and the only conceivable shapes are the large boilers that are scattered in two areas of the ship. Rest seems a jumble of broken metal and pipes. The propeller shafts are clearly visible yet for some reasons the fan blades are missing.

There is also a small rocky reef on the right side of the bow-stern axis. The combined area of the ship and the reef provides a haven for various fish. While the visibility here may not be that great it provides a great dive.

The identify of the ship is not known. However it is referred to as "Allison & McLeelan" which was inscribed on a piece of metal recovered. This may not necessarily be the name of the ship.

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