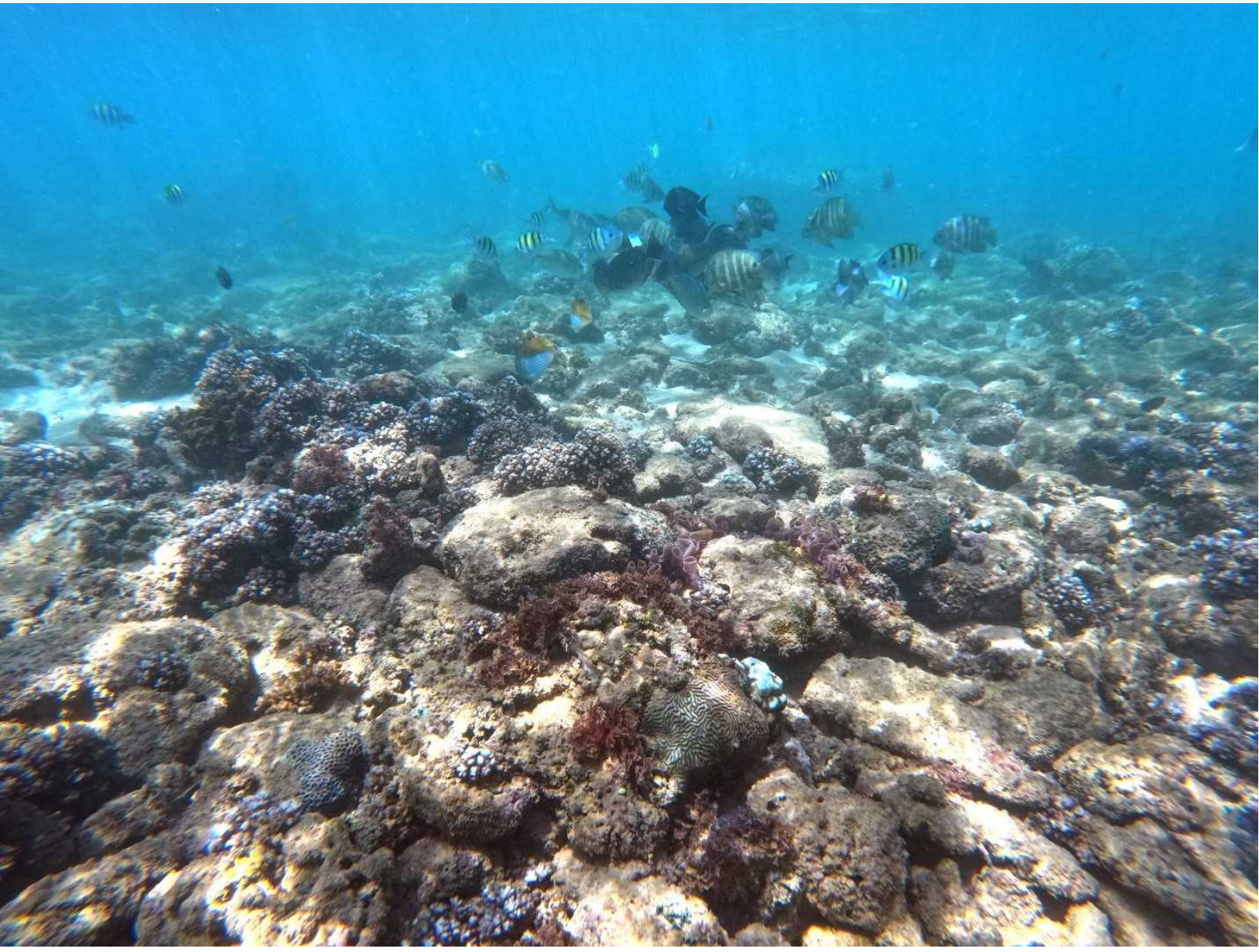
The Status and trends in Hikkaduwa Coral reef 2022

Results of a Rapid assessment survey of the Hikkaduwa coral reef- status, Threats and Proposed interventions including reef restoration activities



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ORCA with the partnership of Tokyo Cement Group and DWLC (Hikkaduwa MPA)

ORCA
OCEAN RESOURCES CONSERVATION ASSOCIATION

Hikkaduwa Marine National Park

Introduction and status of reef.

Located on the South Western Coast of Sri Lanka. The Hikkaduwa Coral reef is a coastal fringing reef with a reef crest running parallel to the shore about 100m off the shore and extending for about 700 m. forming an enclosed reef lagoon inside. The full reef extends about 1km. from the fishery harbor to the North and to the Turtle point headland in the South, The Southern end of the reef a deeper open section is tipped off by a series of large rocky outcrops known as the “Wal-Duuwa” Rocks located about 500m. off shore.

The Hikkaduwa Marine National Park includes an area of 101.58 Hectares in extent and a coastal length of 4.8km.

Figure 1 Map of Hikkaduwa MPA

Once a vibrant and thriving coral ecosystem the reef was severely impacted by a series of wide scale Natural threats. In 1996 a massive infestation of Green Algae Halimeda and Caulerpa overran the reef reducing the …. algal bloom o in 1996 to the Indian Ocean wide Coral Bleaching and mass mortality event of 1998 which decimated the live coral cover of all southern coast reefs. The Live coral substrate cover at Hikkaduwa reef dropped from around 60-70% in 1996 to around 35% due to the massive infestation of *Halimeda* algae and down to around 5% post to the 1998 Mass Coral bleaching event. The event also exterminated the Staghorn coral *Acropora Formosa* a keystone specie of coral in most shallow southern reefs which in general which composed 40-50% of reef corals. The series of subsequent bleaching events of 2010 and 2016 along with continued human pressure from tourist

damage, boat strikes and pollution and the sand filling of the lagoon due to the construction of a breakwater on the northern boundary of the reef under the Hikkaduwa fishery harbor development caused further degradation of the reef and prevented recovery of the reef. The depth of the reef reduced from the deeper zones within the reef that ranges over 10ft before to an average depth of 3-5 feet post the sand filling event. This killed off the lower parts of the corals by being coverd by sand and increased the risk of siltation and suspended sand damage to the corals that were previously located high above the substrates as the sand level rose up. This also caused a significant loss of reef relief and habitat loss.

The reef has lost most of its structure and habitat creating corals like the Staghorn corals, the high digitate, larger foliaceus and table corals. Though a significant coral diversity is still present on the reef most of it is composed of encrusting, submassive types. Though foliaceous, digitate, tabulate coral species are still present on the reef they are scatterd and found in low abundance. The large floor areas dominated by coral rubble deny stable viable substrates for survival of new recruitments of coral larvae settling in to the reef. The reef surfaces contain a highlevel of silt deposits and the low relief of reef structures expose the surviving corals to high levels of siltation and suspended sand during storm surges.

The Survey

A general survey was carried out to document the Coral, Fish and Invertebrates observed visually on the reef to create a baseline of the Bio-diversity of the reef. A general visual assessment was carried out to document status and trends on the reef including availability of habitats, stability of reef structures, presence and threats from invasive species, threats from Natural and Man-made sources etc.

The primary survey was conducted during 4 field days in March and April 2022. Quantitative data of reef substrates and fauna were carried out on transect surveys using snorkeling and SCUBA diving equipment. General Biodiversity Species lists for the reef were compiled based on observations during the field days supplemented by records collected from general surveys carried out on the reef from November 2021 to April 2022.

Methodology

A series of 15 Line and 14 Belt transects were carried out based on Reef-check /AIMs guidelines (modified) to document substrate composition and assess abundance of key reef fish groups and non-cryptic invertebrates.

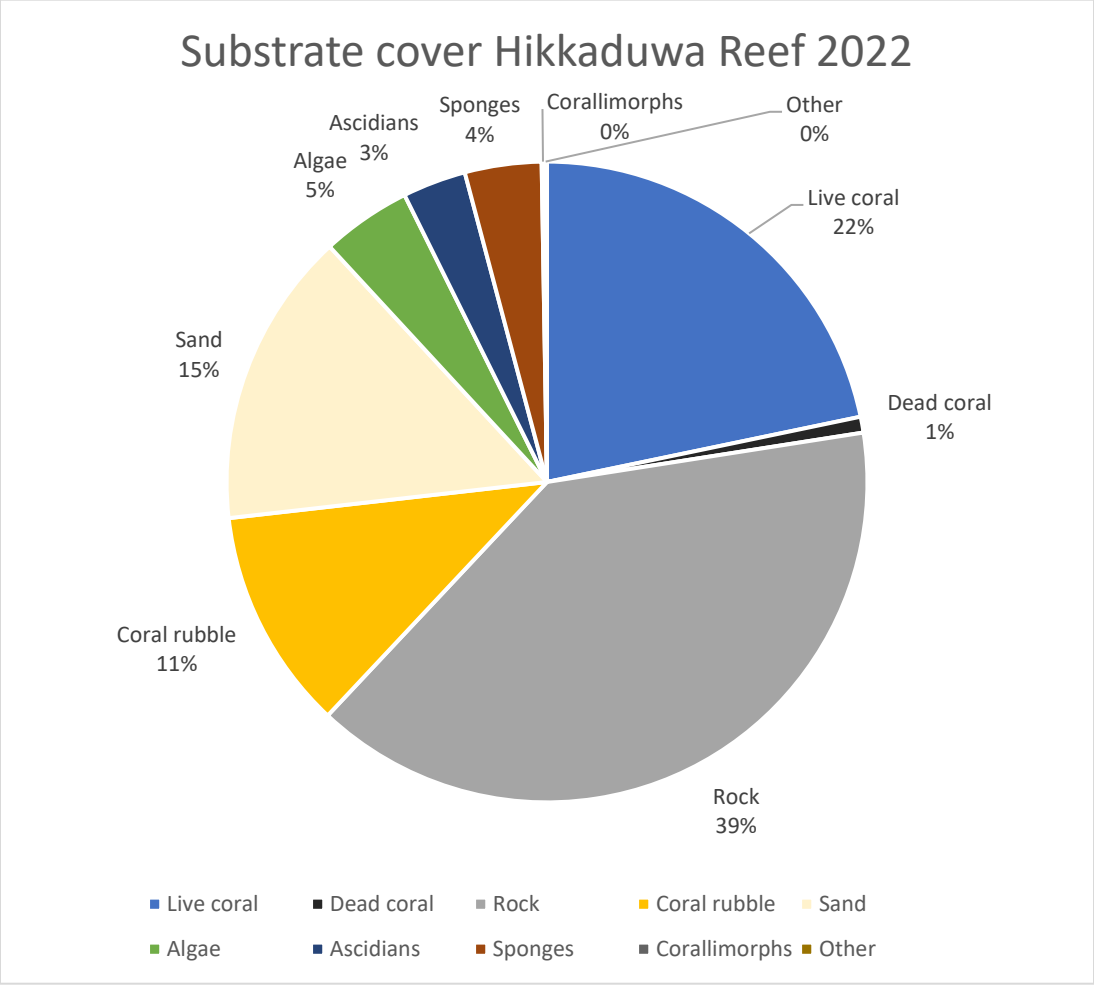
A series of 15 replicates of 25m. long point transects were carried out and sampled every 0.5m. giving a total of 50 substrate type sample points per transect. A set of 14 Belt transect 5m.x 25m. were carried out on the same transects to sample the abundance of key categories for Fish and non-sessile Invertebrates that were selected as indicators of reef health and human pressure.

The sampling was focused on the main reef areas generally used by tourists and allied areas of the main reef structure. These areas would comprise the primary areas that would need management

interventions in the short term. Additional sampling would needed to be carried out under a wider survey program to sample all areas of the reef including the outer reef slope areas. The transects were deployed as random transects within the identified survey zones.

The scope of the survey did not allow sampling of all areas of the reef and several areas that are currently not used for tourist activity and generally less impacted by human presence and was omitted from the survey.

Out of the 15 Transects surveyed 8 Transects were deployed within the Reef lagoon area that is used primarily used for tourism, 4 Transects were deployed at “Wal-Duuwa” rocky Islets which is the second most important tourist location of the Hikkaduwa reef. The other transects were deployed in allied areas that included mostly degraded reef areas.



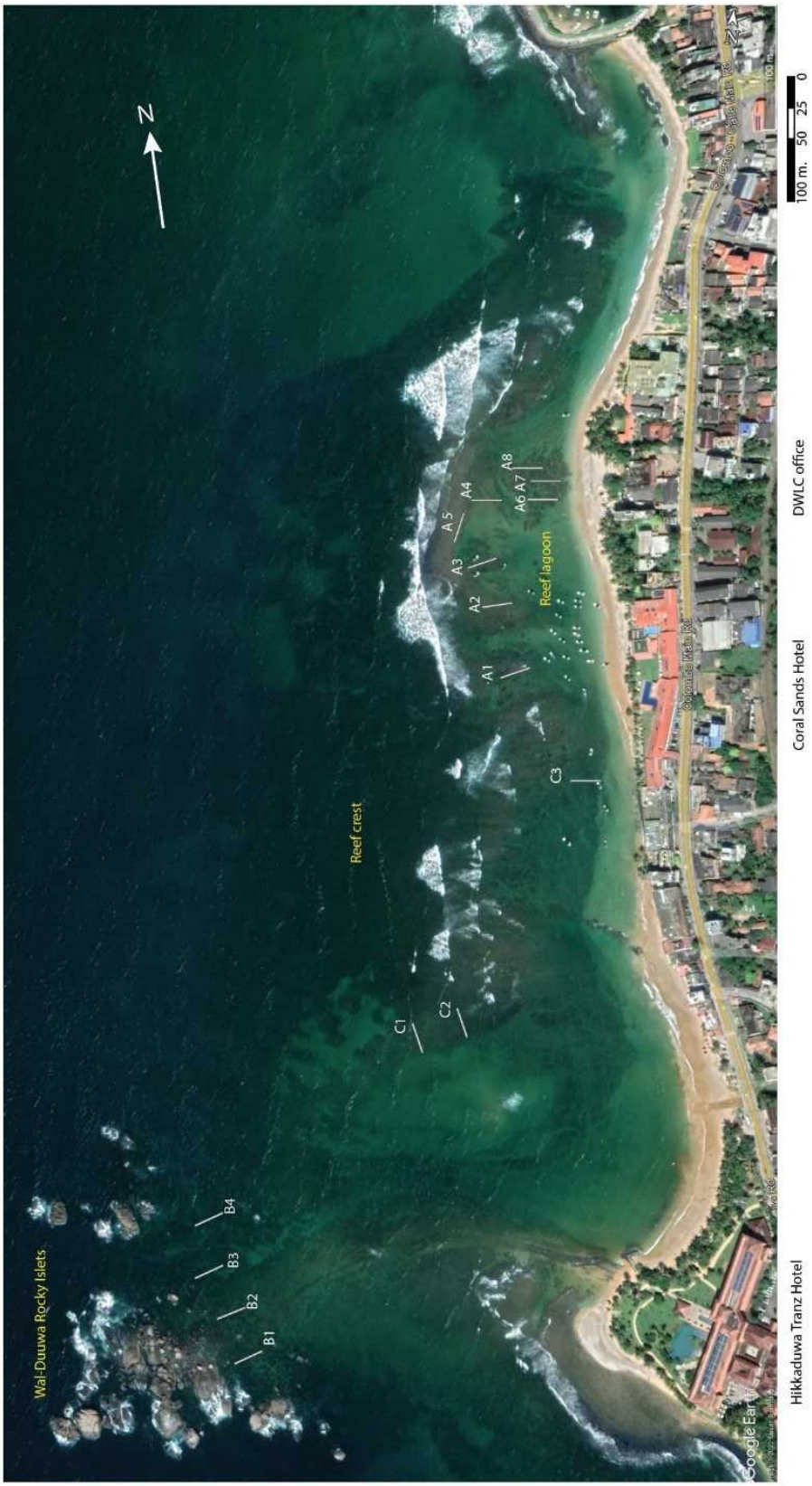


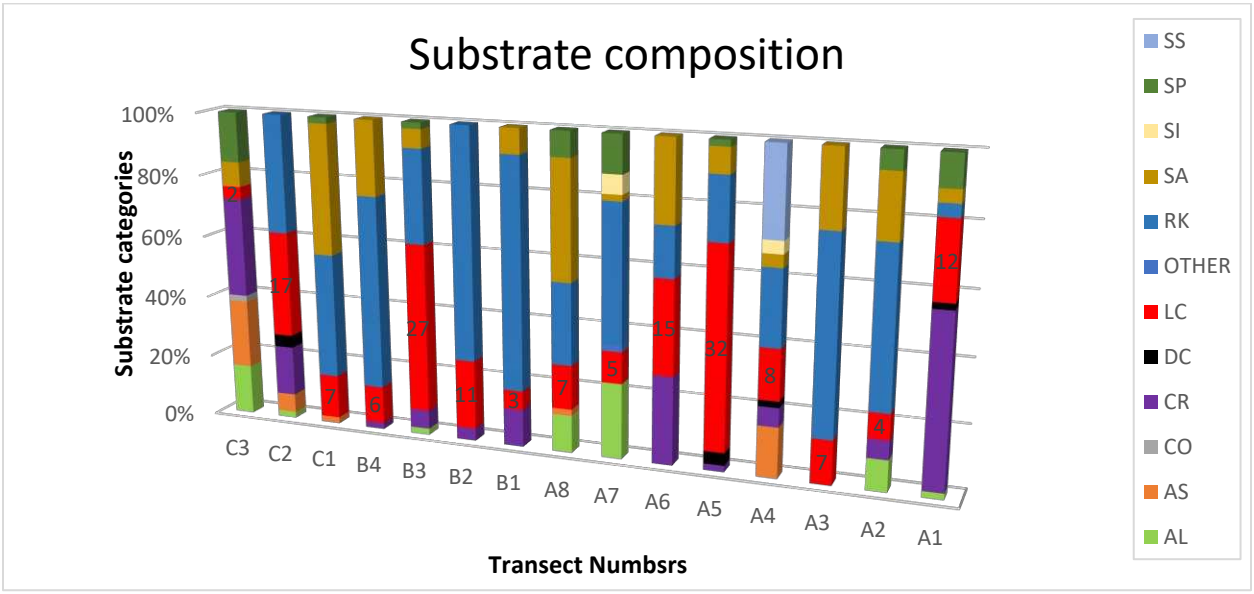
Figure 2 Transect Locations at Hikkaduwa reef

Status of reef

The substrate cover survey

The live coral cover of the reef was recorded as 22% on the transects with the dead coral at 1% which indicated that the reef is not under any significant causes of coral death. Over the reef areas the other substrates were composed of 39% categorized as Rock. This category indicates old dead coral and other solid substrates which are not covered by any significant overgrowths. These substrates are considered as reef areas that may be available for natural coral recruitment. The coral rubble cover shows a decrease with the current cover at 11% among the transects which is encouraging as Coral rubble zones seem to be degrading in to sand or accreting in to more stable rocky surfaces. The Highest coral rubble cover was documented in the large reef patch to the southern end of the reef lagoon (Transects A1,C3) while the coral rubble present in the center zones of the reef lagoon had mostly migrated to the southern patch or degraded to sand and no longer was considered a major threat to coral recruitment in the core area of the reef.

Algae(5%), Sponges (4%) Ascidians (3%) and corallimorphs (<1%) indicated low numbers of potential invasive species.



Belt transects

5m.x 25m. Belt transects were carried out over the same transect lines deployed for substate cover to monitor Reef fishes and sessile marine invertebrate abundance.

Categories of Fishes and Invertebrates were selected as indicators of different aspects of reef health and degradation

Belt Transect Sample Categories

Predators

The predator count represents the health of the reef and in particular the fishing pressure on the reef. In the present scenario the reduced abundance of some species were due to the reduction of suitable habitats rather than fishing pressure.

Large Groupers

Indicates fishery pressure and habitat availability. Several medium-large individuals of Peacock Groupers were observed on the reef. Excepet for this species no other large groupers were observed.

Small Groupers

Indicates fishery pressure and habitat availability. Small groupers were common on the reef where crevice habitats were available through diversity was limited to a few species.

Jacks

Indicates fishery pressure. Large groups of Jacks were observed within the lagoon *(Caranx sexfasciata)* only a few other species were observed on the reef and No very large carangid species were observed.

Snappers

Firefish/Scorpionfish

Indicates ornamental fishery pressure and habitat availability. Very few individuals were observed restricted to areas where some cave structures remain.

Other predators

No Sharks, Barracuda or other significant predatory species were observed.

Indicator species

Butterflyfishes

The Butterflyfishes form a group of fishes with diverse food and habitat requirements ranging from reef generalists to highly specialized corallivores and species that are very selective of types of coral and habitats they inhabit. The numbers of Butterfly fish species within a reef is considered a good indication of the habitat diversity of the reef.

Herbivores

Large Surgeonfish / Small Surgeonfish

Rabbitfish
Large Parrotfish / Small Parrotfish

These groups of herbivores fishes indicate reef health as the herbivores are critical to maintain the balance of algae over reef habitats. The reduction of Herbivore species may indicate high fishing pressure. In particular the lack of large parrotfish may indicate illegal fishing activities including spearfishing in the area.

Invertebrates

Urchin
Sea Urchins are important reef grazers and helps in clearing and maintenance of reef surfaces available for coral recruitment.

Sea Cucumbers
Sea Cucumbers serve an Important function in maintenance of reef substrates as scavengers and in their ability to clean reef sands. Indicates fishery pressure.

Spider Conches
Indicates fishery pressure and habitat health. (Though not recorded in the transects few specimens were observed on the reef)

Giant Clams

Indicates fishery pressure and habitat health. (Though not recorded in the transects few specimens were observed on the reef)

Octopus
Indicates fishery pressure and habitat health. (Though not recorded in the transects few specimens were observed on the reef)

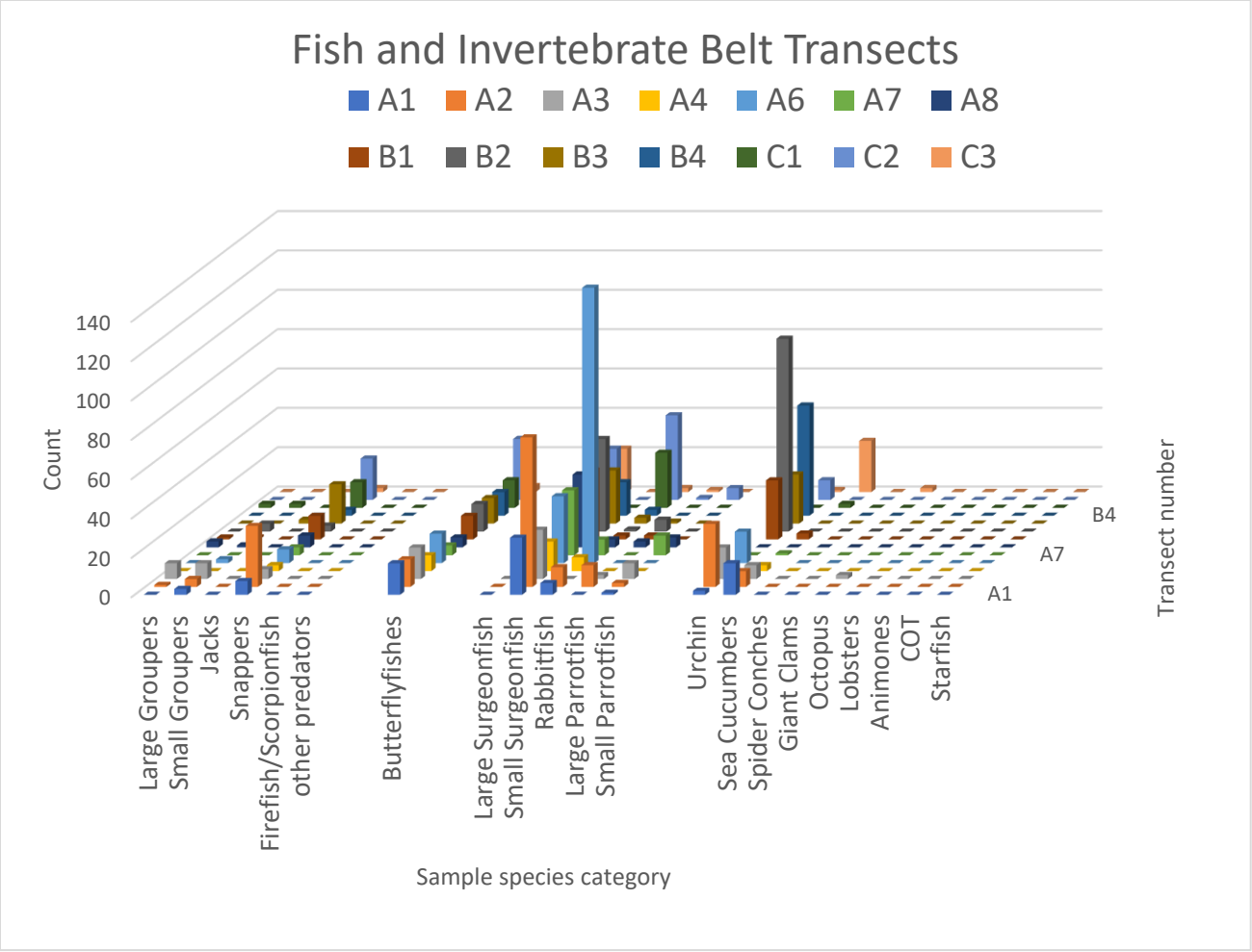
Lobsters
Indicates fishery pressure and habitat health.

Anemones

Indicates fishery pressure and habitat health.

COT
Potential Invasive species. Indicator for reef health

Starfish
Indicates fishery pressure and habitat health.


Fish and Invertebrate Belt Transects
A1
A2
A3
A4
A6
A7
A8
B1
B2
B3
B4
C1
C2
C3
Count
0
20
40
60
80
100
120
140
Large Groupers
Small Groupers
Jacks
Snappers
Firefish/Scorpionfish
other predators
Butterflyfishes
Large Surgeonfish
Small Surgeonfish
Rabbitfish
Large Parrotfish
Small Parrotfish
Urchin
Sea Cucumbers
Spider Conches
Giant Clams
Octopus
Lobsters
Animones
COT
Starfish
Sample species category
A1
A7
B4
Transect number

Observations

Corals

63 species of corals were documented in 31 Genera and 13 Families during the surveys. The Live coral cover of the reef was recorded at 22% of reef substrates. Though relatively good coral diversity was observed the abundance of corals are still low over the reef and health of the corals not ideal due to continued threats both from human interventions and through natural impacts.

Siltation is considered one of the primary threats to corals growing on the lover part of the reef and survival potential is considered low in coral colonies recruited on to coral rubble areas and other unstable substrates.

Threats from Reef invasive species was not considered significant except on the coral rubble dominated zones close to the southern exit channel areas (transect C3).

Fishes

As the Hikkaduwa reef if protected and very low extractive fishery practices are carried out on the reef some fish populations seem to be thriving at a level hardly seen in any other coastal reef in the South coast of Sri Lanka. The lack of ornamental fish collection also has contributed to the occurrence of a higher diversity and abundance of color fish on the reef that positively contribute to the aesthetics of the reef and tourism potential in addition to the biodiversity of the reef.

Large shoals of Big eye trevally (*Caranx sexfasciatus*), Striped mackerel (*Rastrelliger kanagurta*) Rabbit fishes (*Siganus lineatus*,)and Mono (*Monodactylus argenteus*) are found resident within the reef lagoon.

Though relatively higher numbers of larger groupers were encountered at Hikkaduwa than in any other comparable coastal reefs In the South coast these were limited to a few areas of the reef where reef cave structures were still available. The moderately large groupers observed on the reef was restricted to a few species such as *Cepalopholis argus*. The larger species of groupers such as the *Epinepelus tauvina, E.malabaricus, E. caeruleopunctatus* was absent in the reef.

The large moray eel population has been reduced significantly and the moray eel diversity is also observed to be low.

No large predatory species except Carangids and Groupers were observed. Lionfishes and Scorpion fish numbers were low, No Sharks, or Barracuda were documented during the survey.

Butterfly fish diversity was relatively good with 13 species of Butterflyfishes documented. 6 of the species were generalists and not indicative of good coral reef conditions. Of the species documented the only two coral obligate species were documented near the Wal-duuwa rocky Islets only.

The herbivore populations seem to be healthy and well represented indicating low fishing pressure the presence of healthy herbivore populations are apparent on the reef as the algal cover is in low density throughout the reef and not posing a significant threat to corals.

There seem to be some marked areas where the fish populations seem to be lacking or is showing inadequate numbers. These are primarily among the cave dwellers and cryptic species which seem to be significantly affected by the marked reduction of reef relief and reef internal-space habitats within reef areas which provide homes for these species. Restoration of these habitats would contribute significantly to increasing Fish biodiversity of the reef.

Invertebrates

The observed Invertebrate diversity was relatively low. This was especially evident in the Night dives carried out on the reef lagoon areas. The populations of sea stars, crinoids, Urchins, sea shells, Sea slugs, Crabs, Shrimps, Hermit crabs and Lobster were all observed to be in low numbers. Additional surveys may be needed to better sample Invertebrate species as most are cryptic in nature.

Sea cucumber populations were seen to be in moderate numbers with about 10 species recorded within the survey. The Urchin populations were low within the reef lagoon areas though high numbers were documented in the Wal duwa rocky islet area. There is a trend that tour guides would actively remove the long spined Urchin varieties that are normally common on the reef as they can cause injury to tourists. This practice needs to be checked as the Urchin populations contribute to maintaining reef health in many ways including setting back population outbreaks of Corallimorphs.

The numbers of Hermit crabs observed was low both in abundance and diversity. Even the numbers of the common shore hermits Coenobita was observed to be low. This may be due to the low availability of Dead Sea shells as shells would be regularly collected and removed by tourists as souvenirs. If regulation or awareness is increases to control this trend the Hermit crab population may recover.

The populations of reef crabs and shrimps are very low compared to dives carried out on the reef pre-degradation. None of the once abundant shrimp species such as *Saron, Hipplysmata, Rhincochinetus species* were recorded even during the Night dives carried out. A few pairs of Boxing shrimps *Stenopus hispidus* was observed on the reef. The Reef crab and lobster populations were observed to be low.

Giant clam (*Tridachna sp*.) population seem to be increasing within the reef lagoon. Other sea shells seen regularly included Cock's Comb Oyster (*Lopha cristigalli*) Spider conches (*Lambis chiragra*) and some Cowries were regularly observed.

The population of sea stars were low and the rubble dwelling Brittle star diversity and abundance was observably low compared to previous years. Populations of feather stars were also observed to be low. The Potential Invasive species "Crown of Thorns Sea star" was not observed on the reef.

The Primary contributing factor for the low abundance and diversity of the Invertebrate populations may also be due to the loss of micro habitats on the reef and loss of cave structures and high elevation substrates on the reef.

Degradation.

The once lush Coral reefs of Hikkaduwa has been severely degraded post to a series of events which caused massive loss of live coral cover.

The first mega event on record in recent past was the Massive invasive Algal bloom that occurred in the years 1996-1997. Due to an unidentified environmental trigger extensive Algal growth were observed on several South coast reefs including Hikkaduwa, Polhena and Unawatuna reefs. These infestations mainly involved a growth burst of algae dominated by *Halimeda* and *Caulerpa* species The Algal infestation caused significant loss of coral cover at Hikkaduwa reef.

This was followed by the Largest Coral Bleaching/Mortality event recorded in the Indian Ocean which occurred in 1998. These two degradation events which struck the Hikkaduwa reef consecutively drove the live coral cover down to less about 5% of total reef substrates from a live coral cover that was over 80% before the mortality events.

The Tsunami of 2004 did not cause significant damage to the reef the Coral Bleaching events of 2010 and 2016 caused additional loss of coral cover.

Due to continued stress from human/tourism related pressures continued to degrade the reef and prevent natural coral cover recovery.

The progressive degradation of the dead coral structures has resulted in massive loads of broken coral fragments turning in to coral rubble which in the interim dominated most reef areas. The increase of coral rubble on the reef affects the natural re-colonization of the reef as the loose mobile substrate created by the rubble fields do not provide a suitable viable substrate for larval recruited corals to survive on the longer term. The high abundance of coral rubble also increases the risk of suspension of coral rubble pieces during high wave energy events like Storms where the suspended coral rubble pieces can become high velocity projectiles that can cause significant damage to established coral colonies.

The construction of a large rock groyne as part of the Fishery Harbor development project on the Northern end of the reef constructed around 1993-4 caused a significant blocking of the natural sand transport system of the reef causing major sand filling of the reef lagoon. This has caused additional problems to the reef as the general depth regime of the reef was reduced by 1-3ft. over most areas. The sand filling caused habitat loss as the water depth on the reef reduced and the sand accumulations would fill in most cave and crevasse habitats that was available at the base of coral structures, the higher level of sand causes an additional threat from siltation over living corals as the sand is easily suspended due to low water depth and the low separation of sand and living coral areas on the reef.

The sand filling of the reef lagoon still is a problem and most of the reef areas documented less than 1m. of depth within the reef lagoon areas. Only in the deeper pool at the edge of the reef edge in front of the DWLC office the reef shows about 1-8m. of depth. The filling of the reef areas with sand causes 2 key problems to the reef.

1. Reduced water column depth resulting in reducing reef relief for habitats, higher currents, more exposure of corals to sediment and damage from suspended sand during storms.

2. Filling in of most cave environments on the underside of reef outcrops which causes significant habitat loss for cave dwelling fauna and results in loss of species diversity in the reef.
3.

In addition to the Natural causes of reef degradation continued Human threats contribute significantly to the reduction of Natural recovery potential of the reef.

The main human impacts affecting the Hikkaduwa reef Include.

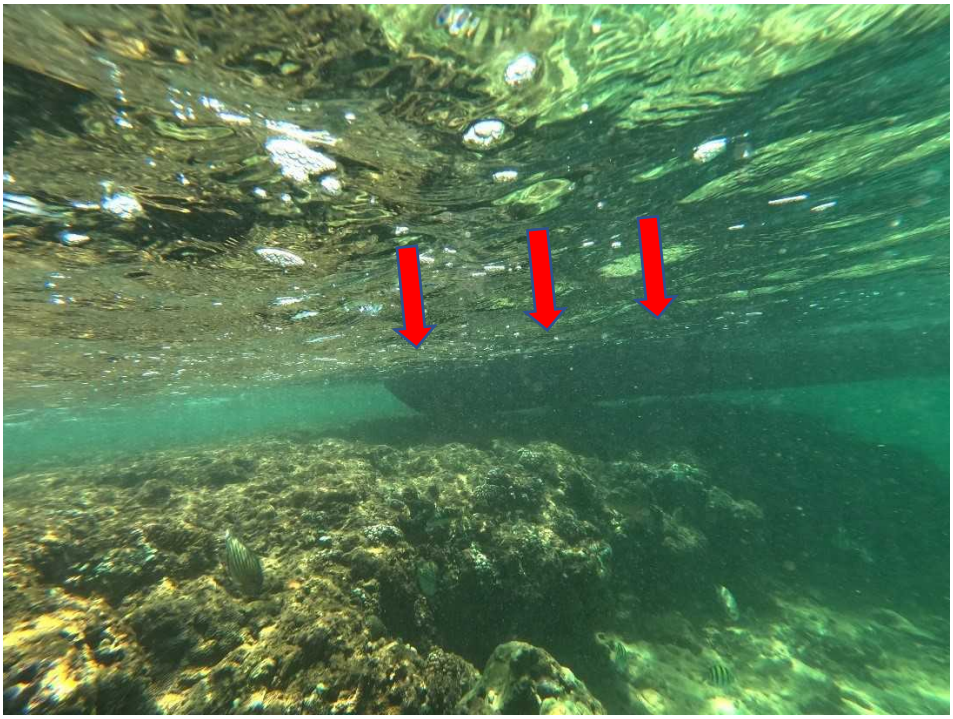
1. Collision damage from Glass bottom boats
2. Pollution from Glass bottom boat exhaust
3. Physical damage from tourists touching, walking and standing on corals and reef areas.
4. Pollution from Hotels
5. Pollution from canals and freshwater input.

The Effects of Tourism on the reef contribute to reducing the natural potential of the reef to recover as physical damage and Pollution from Tourists, Glass bottom boats and Hotels continue to contribute negatively to the survival of the reef corals. While physical damage retards growth or causes coral mortality the added pollution from hotels and Boat engine exhaust contributes to presence and growth of Invasive reef organisms which take a significant toll on Reef Corals.

The Glass bottom boat operation in deeper sections of the reef including “Wal duuwa” Rocky Islets is relatively sustainable as the area has sufficient depth for the boats to operate without causing significant physical damage to the reef corals. The area being situated off shore and being open to currents and wave action tend to flush and dilute Boat engine emissions reducing the localized pollution risk to some degree.

The operation of boats within the lagoon poses a different set of problems as the shallow water and the depth at which the corals grow does not give sufficient clearance between boat hull and the reef and frequently cause physical damage to the coral from boat hull and engine impact. Most boats engage in driving the bow of the boat on to the reef crest deliberately mounting the boat on top of the reef edge to get access for the glass bottom window to be placed on coral areas. This is a major problem as it is actively contributing to prevent restoration of a potentially high growth area of the reef.

The pollution from the exhaust of the out-board motor (OBM) engines of the boats is diverted through the middle of the propeller in to the water and is mixed with the water in the propeller stream. This causes High levels of hydrocarbon pollution of the water bodies and where larger densities of tourist boats operate in areas of good coral growth it can significantly affect the health of corals and could contribute towards population out breaks of Invasive species which can also negatively affect reef health and coral survival.



3 Glass bottom boats ramming on reef crest with coral

4 Coral growth on reef crest rammed by boats

Challenges and opportunities

Hikkaduwa Marine Protected Area is the only Marine Protected area in the South coast of Sri Lanka manned by a full-time DWLC staff. This gives the site an advantage over other reef sites that the site can be easily monitored and managed with a better control of Human impacts. The Hikkaduwa is possibly the only reef that has zero pressure from artisanal fishing and exploitation for Ornamental aquarium trade. Currently the reef fish populations are in a healthier state at Hikkaduwa than any other southern coastal reef. This gives a unique advantage over other reefs that the coral cover restoration activities would be supported by other ecosystem functions and services which are healthier than most other southern coastal reefs.

The high abundance and diversity of reef fish are not reflected across the whole range of species that naturally inhabit reefs. There are significant fish groups that are not present or present in low abundance on the reef. The cause of which can generally be attributed to reduced habitat diversity on the site including lack of branching/table coral species and smothering of most cave structures of the reef due to sand filling.

The Invertebrate diversity of the reef is low. This was very evident in the Night dives that were carried out on the reef. This is also primarily attributed to the general low habitat diversity available on the reef.

The reef contains a good diversity of coral species present on the reef naturally though the abundance and total live coral cover on the reef is still low. The natural recovery and survival of corals seem to be low and often challenged due to many natural and manmade causes that affect the survival of corals. The reduced reef relief has caused lack of high elevated environments that are preferred by the corals and provide safer healthier environments for growth.

Proposed Interventions to Restore Reef

1 Create a base plan for conducting assisted reef restoration activities and a zonation plan for the reef.

A zonation plan should be developed and implemented based on the findings of the surveys. It is proposed to set aside two restoration zones within the reef. One within the Reef Lagoon preferably in the Northern end of the deep pool near the reef crest and another zone close to the wal-duwa Rocky Islets. To assist restoration of coral cover and reef habitats is proposed.

2 Carry out demarcation of main reef user zones.

The identified restoration zones would be clearly demarcated using securely anchored buoys and floater lines. The design of Anchors and Buoys need to be "reef safe" that would not cause damage to corals by entanglement or abrasion during strong storm action.

3 Establish one or two sites within the reef as restoration zones

Within the demarcated Restoration areas conduct a series of activities including restoration of reef structure using artificial reef substrates -replanting of reef areas using coral fragments rescued from coral broken by natural or human activity, or from corals growing in un-suitable environments.

4. Establishment of coral nurseries for use with restoration zones.
Two mesh panel coral nurseries should be set up close to the two restoration sites to facilitate temporary holding of rescued coral prior to replanting.

5 Reef Structural enhancement through use of Artificial reef substrates.

Strategic use of artificial reef structures in identified restoration zones within the reef can be used to enhance both the habitat diversity of the reef and to provide high relief substrates on which coral can be replanted which will be safe from sand smothering and impact from coral rubble during storms.

A well designed Artificial reef structure can replicate lost cave habitats and provide home to additional reef species of fish and invertebrates to re-colonize the reef.

6 Translocation of lost Keystone coral species
Re-introduction of fast-growing coral species that directly contribute to increased habitat availability on the reef can make a major difference in reef restoration (e.g., *Acropora Formosa, A. hyacinthus/ lamarki* group, *Montipora aequituberculata*). These corals which were naturally present in High abundance before the reef mortality events are either extinct or are in very low numbers in the Hikkaduwa and in the south coast reefs at present - A Translocation/ reintroduction and establishment of a viable breeding cluster of these coral species can help regenerate not only Hikkaduwa reef but coral reefs in the South coast in general through the establishment of a mother colony though which larval dispersal to other reefs can be facilitated which would benefit reef recovery over a very large area of southern coast line.

7. Site monitoring and maintenance (Reef Keeping).
A program of regular monitoring and maintenance activities would be carried out within the restoration

zone to remove pollutants, manage reef invasive species continue coral replanting and maintain demarcation buoy systems.

8 Training.

A team of DWC marine park staff should be engaged with the expert team and an in depth-on site training will be carried out in reef restoration activities at the site on reef restoration theory and best practices.

9 Possible Re-introduction of lost reef Bio-diversity

An activity could be carried out to restore lost reef biodiversity of allied non-coral species that was lost on the reef. (eg. Sea Anemones and clown fishes, Urchin species, Fire fishes etc.)

Acknowledgements

The survey was initiated at the request of Mr. Uthpala Adaranga- Warden, Hikkaduwa Marine Park and was carried out as a joint activity with the ORCA team and DWLC park staff and with the financial support of Tokyo Cement Group.

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Checklist of Fishes recorded During the Survey

Muraenidae

Gymnothorax javanicus
Echidna zebra
Sideria grisea

Synodontidae

Synodus variegatus

Engraulidae

Stolephorus c.f. sp.

Belonidae

Tylosus crocodilius

Hemiramphidae

Hemiramphus sp.

Holocentridae

Myripristis murdjan
Myripristis violaceum
Myripristis hexagona
Neoniphon samarra
Sargocentron spiniferum
Sargocentron caudimaculatum
Sargocentron rubrum ?

Fistularidae

Fistularia commersoni

Scorpaenidae

Pterois milesi
Scorpaenopsis sp.

Serranidae

Cephalopholis argus
Cephalopholis formosa
Epinephelus longispinis
Epinephelus merra
Grammistes sexlineatus

Cirrhitidae

Paracirrhitus forsteri
Cirrhitichthys sp.
Cirrhitus pinnulatus

Apogonidae
Apogon nigrofasciatus
Apogon taeniophorus
Cheilodipterus macrodon

Teraponidae
Terapon jarbua

Sillaginidae
Sillago sihama

Gerridae
Gerres sp.

Carangidae
Caranx melampygus
Caranx sexfasciata
Trachinotus bailloni

Lutjanidae
Lutjanus decussatus
Lutjanus rivulatus
Lutjanus fulvus
Lutjanus fulviflamma
Lutjanus monostigma
Lutjanus kasmira
Lutjanus vittata
Lutjanus bohar
Lutjanus argentimaculatus
Lutjanus lunulata

Caesionidae
Pterecaesio sp.

Haemulidae
Plectorhynchus vittatus
Plectorhynchus schotaf

Scolopsidae
Scolopsis vosmeri

Scolopsis bimaculatus

Lethrinidae

Lethrinus ornatus
Lethrinus nebulosus
Lethrinus harak
Lethrinus obsoletus ?
Pomadasys sp. (fulvus)

Mullidae

Mulloidichthys flavolineatus
Parupaneus barbarinus
Parupaneus indicus
Parupeneus forskali
Parupeneus macronema
Parupaneus bifasciatus

Pempheridae

Parapriacanthus sp.
Pempheris oualensis
Pempheris vanicolensis

Kyphosidae

Kyphosus cinerascens

Chaetodontidae

Chaetodon decussatus
Chaetodon vagabundus
Chaetodon collaris
Chaetodon auriga
Chaetodon cittrinellus
Chaetodon trifasciatus ?
Chaetodon trifascialis ?
Chaetodon andamensis (plebeius)
Chaetodon xanthocephalus
Chaetodon lineolatus
Chaetodon meyeri
Chaetodon lunula
Heniochus singularis

Pomacanthidae

Pomacanthus semicirculatus
Apolemychthys xanthurus
Centropyge multispinis

Pomacentridae

Abudefduf vaigiensis
Abudefduf sordidus
Abudefduf septemfasciatus
Plectroglyphidodon dickii
Plectroglyphidodon lacrymatus
Chromis viridis
Chromis ternatensis
Chromis dimidiatus
Chrysiptera leucopoma
Chrysiptera glauca
Chrysiptera biocellata
Pomacentrus similis
Pomacentrus phillipinus
Pomacentrus indicus
Pomacentrus chrysurus
Dascylus trimaculatus
Neopomacentrus azysron
Stegastes nigricans

Labridae

Chelinus undulatus
Chelinus chlorurus
Coris frerei
Anampses caeruleopunctatus
Halichoerus hortulanus
Halichoerus marginatus
Halichoerus nebulosus
Halichoerus margaritaceus
Halichoerus scapularis
Halichoerus timorensis
Halichoerus zeylanica
Novaculichthys taeniourus
Hemigymnus fasciatus
Hemigymnus melapterus
Gomphosus caeruleus
Macropharyngodon ornatus
Stethojulis trilineata
Stethojules albovittata
Thalassoma lunare
Thalassoma hardwickii
Thalassoma janseni
Thalassoma purpureum

Thalassoma amblycephalum
Labroides dimidiata
Diproctacanthus xanthurus
Leptojules sp.

Scaridae
Calotomus carolinus
Scarus rubroviolaceus
Scarus ghobban
Leptoscarus vaigiensis

Sphyraenidae
Sphyrna obtusata (?)

Mugilidae
Liza sp. (c.f)

Pinguipididae
Parapercis clathrata

Tripterigiidae
Helcogramma sp.

Blenniedae
Plagiotremus rhinorhynchos
Cirripectus sp.
Istiblennius sp.
Escanias nalolo
Escanias bicolor
Entomacrodus sp. ?

Microdesmidae
Ptereleotris sp.

Gobiidae
Cryptocentrus /Amblyeleotris spp.
Valencienna sexguttata
Valencienna strigata
Gobiodon citrinus
Gnatholepis sp.
Istigobius sp.

Zanclidae

Zanclus cornutus

Acanthuridae

Acanthurus lineatus
Acanthurus leucosternon
Acanthurus triostegus
Acanthurus bariene
Acanthurus mata
Acanthurus dussumieri
Acanthurus nigricauda
Acanthurus xanthopterus
Ctenochaetus striatus
Ctenochaetus strigosus
Naso elegans (litturatus)
Naso uniconis

Siganidae

Siganus javus
Siganus lineatus
Siganus canaliculatus
Siganus virgatus

Scombridae

Rastrelliger kanagurta

Balistidae

Balistapus undulatus
Balistoides viridescens
Rhinecanthus aculeatus
Rhinecanthus rectangulatus

Monacanthidae

Amanses scopas
Cantherinus pardalis

Ostraciidae

Ostracion cubicus
Ostracion meleagris

Tetaodontidae

Arothron nigropunctatus
Canthigaster solandri

Diodontidae

Diodon hystrix

Diodon liturosus

NUMBER OF SPECIES	174	150

Checklist of corals recorded During the Survey

63 species 31 Genera 13 Families

Family: Acroporidae

Acropora aculeus

Acropora cytherea cf.

Acropora gemmifera cf.

Acropora hemprichii

Acropora hyacinthus cf.

Acropora lianae

Acropora natalensis cf.

Acropora pinguis

Acropora palmarae

Acropora robusta

Acropora scherzeriana cf.

Montipora aequituberculata

Montipora monasteriata

Montipora sp. C.f turgescens

Montipora sp. 2 green

Family: Agariciidae

Gardineroseris planulata

Pavona clavus

Pavona explanulata

Leptoseris explanata

Leptoseris mycetoseroides

Family: Dendrophylliidae

Tubastrea aurea

Turbinaria peltata

Family: Faviidae

Favia danae

Favia favus

Favia matthaii

Favia speciosa cf.

Favites abdita cf.

Favites pentagona cf.

Montastrea valenciennesi cf.

Montastrea curta cf.

Diploastrea heliopora

Plesiastrea versipora cf

Goniastrea edwardsi

Goniastrea retiformis

Platygyra lamellina

Platygyra daedalea

Platygyra pini

Leptoria phrygia

Echinopora lamellosa

Family: Fungiidae

Podabacia crustacea

Podabacia lankaensis ?

Family: Merulinidae

Hydnophora exesa

Family: Mussidae

Acanthastrea echinata

Lobophyllia hemprichii

Symphyllia agaricia

Symphyllia radians

Symphyllia recta

Family: Oculinidae

Galaxea fascicularis

Family: Pectiniidae

Mycedium elephantosus

Echinophyllia aspera

Family: Pocilloporidae

Pocillopora damicornis

Pocillopora eydouxi

Pocillopora verrucosa

Stylophora pistillata

Family: Poritidae

Porites lobata cf

Porites rus

Porites solida cf

Goniopora stokesi

Family: Siderastreidae

Coscinaraea columna

Pseudosiderastrea tayamai

Psammacora contigua

Psammacora digitata cf.

Family: Stylasteridae

Distichopora violacea

Checklist of Invertebrates recorded During the Survey

Mollusca

Gastropoda

Lambis chiragra

Lambis lambis

Lambis truncatus

Cypraea caputserpentis

Cypraea tigris

Cypraea sp.

Chicoreus ramosa

Terebra sp.

Conus sp.

Oliva spp.

Cellina? sp.

Trochus maculata1

Bivalvia

Tridachna squamosa1

Pinna sp.

Lopha cristigali 1

Hyotissa hyotis 1

Cephalopoda

Octopus cyanea 1

Octopus sp.

Sepiothiuthis lessoniana 1

Echinodermata

Asteroidea

Culcita novaeguiniae

Ophiuroidea

Ophiocoma erinaceus

Ophiocoma brevipes

Ophiomastix annulosa

Macrophiothrix longipeda

Crinoidea

Crinoids..

Echinoidea

Diadema setosum

Diadema savigniae

Echinothrix sp.

Echinostrephus molaris

Tripnuestes gratilla

Holothuroidea

Holothuria atra

Holothuria edulis

Stichopus sp.

Stichopus hermanni

Stichopus horrens

Thelanota anax

pearsonothuria graffei

Actinopyga muritiana

Actinopyga echinites

Crustacea

Natantia

Stenopus hispidus

Alpheus spp.

Decapoda

Ocepode sp.

Grapsus tenuicristatus

Grapsus albolineatus

Pecnon planissimum

matuta planipes

Trapezia sp.

Thalamita /Charybdis sp.

Calcinus sp.

Dardanus sp.

Panulirus versicolor

Annelida / polychaeta

Sabella sp.

Spirobranchus sp.

Sabellastarte sp.

Ascidians

Didemnid (green)

Didemnid (Orange)

Brown Ascidian

Platyhelminthes

Pseudobiceros sp.

Sponges

**The survery did not cover sponge species diversity adequately.*

Brown Sponge
Yellow Ball sponge

Terpios hoshinata

Soft coral

Sarcophyton sp.

Lobophytum sp.

Algae

Caulerpa racemosa

Halimeda opuntia

Halimeda macroloba

Padina sp.

Ulva lactuca

velonia sp.

Codium sp.

Dictyota sp.

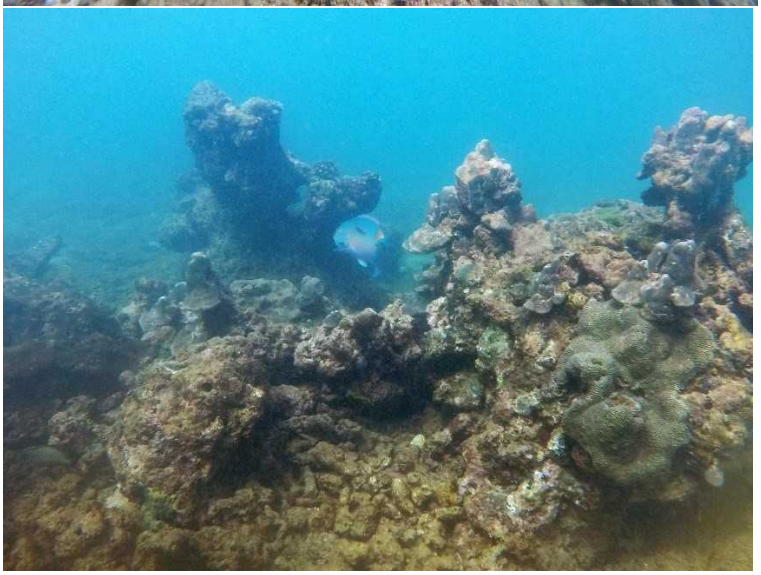
Sargassum sp.

Halymenia sp.

Hypnea pannosa

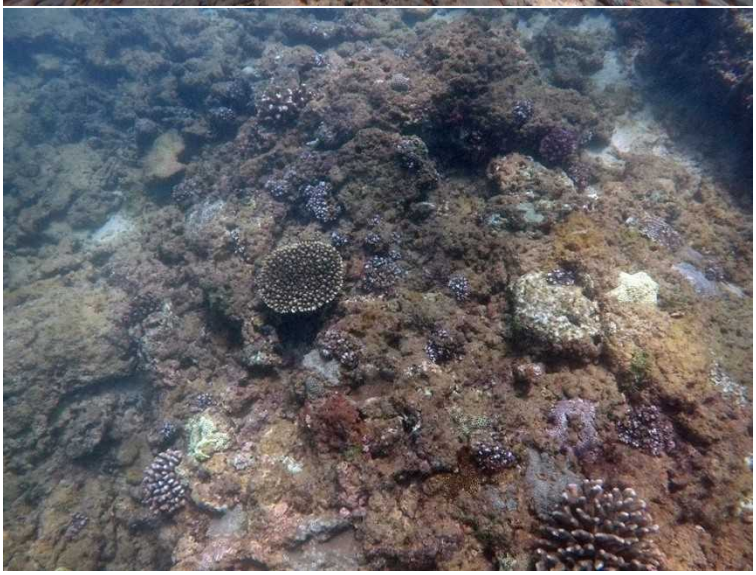
Hydrolithon (c.f.) sp.

** The Invertebrate and Algae species records are not sufficiently sampled and documented. More work need to be carried out on these groups to assess the diversity of the reef.*



The reef habitats at the “Wal duuwa” Rocky Islets provide high relief substrates and higher diversity of habitats than the reef lagoon.

The area contain more species of reef fishes and invertebrates than the inner reef lagoon habitats.

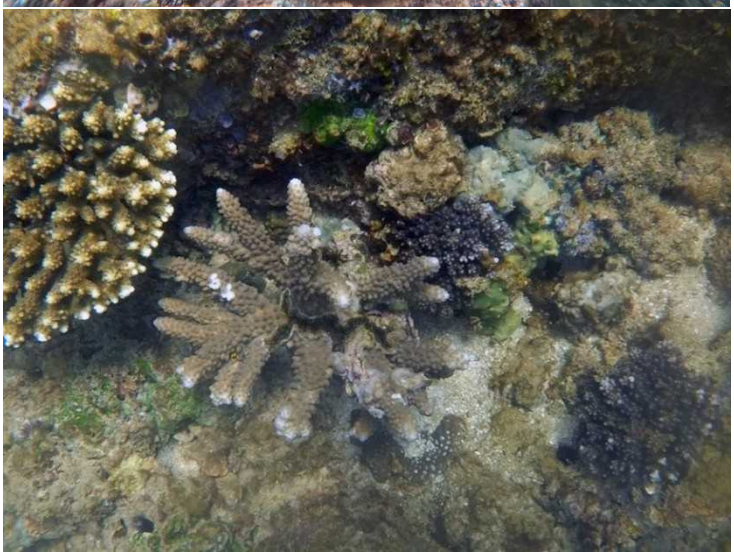


The reef lagoon is now composed mostly of coral rubble floors or Low relief rocky substrates that create low habitat diversity.

The low relief environments are less favorable for coral growth and survival than High relief habitats.

Caves ledges and overhangs are important habitats for many reef fishes and Invertebrates.

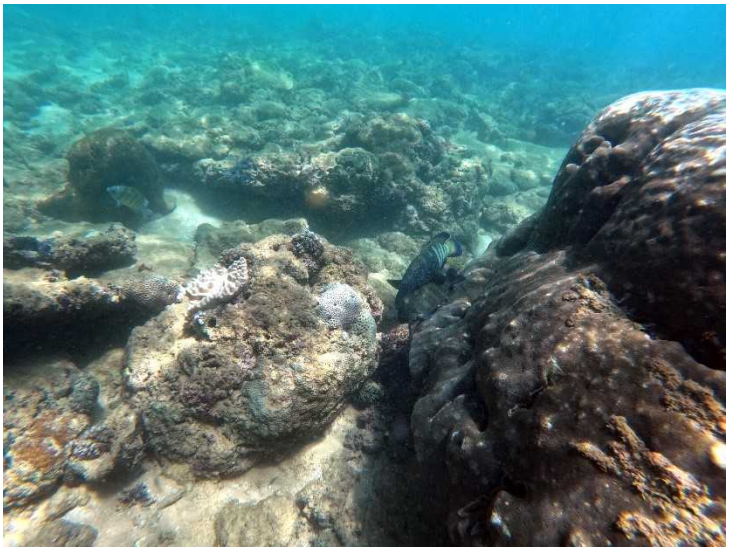
The structural degrading and sand filling has reduced and smothered most of the natural cave habitats at Hikkaduwa with the few remaining degraded in to very shallow caves and overhangs.

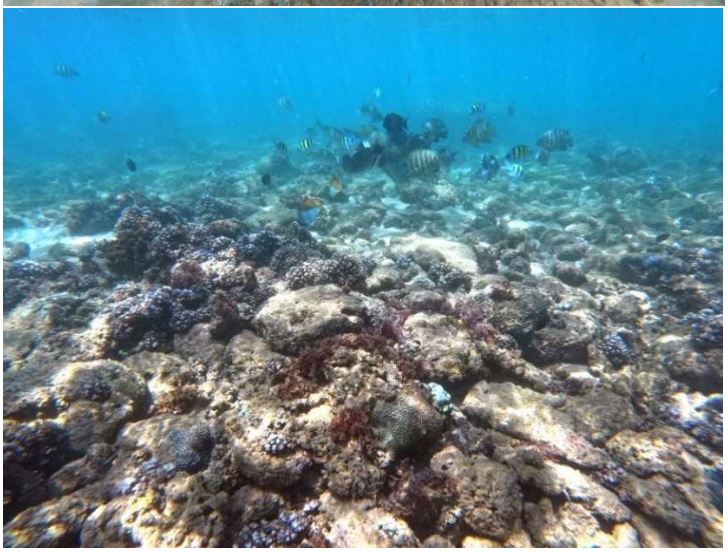


The reef supports a good diversity of coral species though the live Coral cover of the reef is still relatively low.

The coral species diversity is lacking in several keystone species and fast-growing coral species that could significantly speed up the reef recovery process.

A selective translocation of these species back on to the reef could make a significant change to the recovery potential of the reef.





The fish life at Hikkaduwa reef shows limited and declining species diversity as the Habitat diversity of the reef is degrading.

The protection from fisheries within the park boundaries has led to proliferation of some species of fishes within the reef.

- Glass bottom boats within the reef
- Broken coral fragments on the reef floor which can be used for restoration of other suitable reef substrates within the reef.
- Team members engaging in substrate surveying.