

Appendix 4.1 Coral Dive Survey Results

THE OCEANWAY CORPORATION LTD

REPORT

CORAL DIVE SURVEY

IMPROVEMENT DREDGING FOR LAMMA
POWER STATION NAVIGATION CHANNEL

REF: 14/8206

Revised Report



June 2014

EXECUTIVE SUMMARY

- In June 2014, a coral area survey was carried out nearby the Lamma Power Station in order to provide a baseline information of the coral community prior to the improvement dredging for the Lamma Power Station navigation channel.
- Four main areas have been identified to be investigated, namely artificial seawall along the coast of the power station, and rocky shores of Hung Shing Yeh Beach, Lo So Shing Beach and Ha Mei Tsui. Data on such selected areas have been collected through a series of spot-check dive surveys. Ecological Assessment (REA) will be conducted if coral communities are identified.
- Results of these dive surveys will be used to verify the previous findings in the approved EIA report for “Lamma Power Station Navigation Channel Improvement” project (EIAO Register No. AEIAR-069/2003).
- Coral communities occur at the locations at the rocky shores of Hung Shing Yeh Beach and Lo So Shing Beach.
- At Hung Shing Yeh Beach northern rocky shore, seven hard coral species were recorded. Six of them are hermatypic (reef-building), including *Cyphastrea serailia*, *Turbinarea peltata*, *Favites abdita*, *Psammocora superficialis*, *Coscinaraea* n sp., *Hydnophora exesa* and and one ahermatypic (non-reef building) *Balanophyllia* sp. This was the same result as recorded in the Diver Survey conducted out in this area. This area has the highest number of hard coral species recorded among the four survey areas. Coral cover is < 5%.
- At Hung Shing Yeh Beach southern rocky shore, a total of six hard coral species occurs in this area. These include five hermatypic corals including *Goniopora stutchburyi*, *Oulastrea crispata*, *Leptastrea purpurea*, *Favites abdita*, *Favites chinensis* and ahermatypic *Balanophyllia* sp. This area has the second highest number of hard coral species among the survey areas. Coral cover is <5%. Both the coral community structure and coral cover are very similar to those of the northern shore of the Hung Shing Yeh Beach.
- At Lo So Shing Beach northern rocky shore, two species of hard corals were recorded. They are *Coscinaraea* sp. and *Leptastrea purpurea*, with low coral cover of <1%.
- At Lo So Shing Beach southern rocky shore, only one coral species, *Porites lutea*, was recorded in this area. The coral cover value is low at <1%.
- At the artificial seawall of the Power Station, only one hard coral, *Oulastrea crispata*, was recorded.
- There were no other rare or endangered species recorded in the areas surveyed.
- The following mitigation measures are suggested for this project:

- A silt curtain should be set up around the dredge equipment to minimize the suspended sediment generated. This should be from surface to seabed.
- Periodic water quality measurements should be considered. These should be surface, mid-water and bottom measurements. Upon reaching limits, dredging activity (or rate) should be adjusted to lower levels.
- The contractor should be reminded that precautions should be made to prevent sediment leakage when transferring sediment from grab to barge or from one barge to another.

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INTRODUCTION

In June 2014, a coral area survey was carried out nearby the Lamma Power Station in order to provide a baseline information of the coral community prior to the improvement dredging for the Lamma Power Station navigation channel. Four main areas have been identified to be investigated, namely artificial seawall along the coast of the power station, and rocky shores of Hung Shing Yeh Beach, Lo So Shing Beach and Ha Mei Tsui. Data on such selected areas have been collected through a series of spot-check dive surveys. Ecological Assessment (REA) will be conducted if coral communities are identified. Results of these dive surveys will be used to verify the previous findings in the approved EIA report for “Lamma Power Station Navigation Channel Improvement” project (EIAO Register No. AEIAR-069/2003).

The spot-check dive survey has been conducted by swimming in a search pattern along pre-determined areas at a density sufficient to cover any major coral areas and to assess the type of benthos existing in the proposed survey area, recording any presence of hard corals (order Scleractinia), octocorals (sub-class Octocorallia), and black corals (order Antipatharia). Information including estimated number of colonies, number of species, coral cover, and partial mortality (if any) was recorded during the actual dive. The following physical parameters were recorded during the survey:

Temperature, time and date;

Location (GPS);

Depth range;

Visibility;

Substratum type (i.e. hard substratum seabed, intertidal rocky area); and

Other invertebrates present.

Any special features encounter in the coral areas, such as non-typical reef structures, unusual coral species associations, unique or peculiar assemblages of the local incipient reef formations, and reefs that are almost completely dominated by one particular species, would be recorded. Representative photographs of any important ecological habitat, coral species and other ecological features would also be taken.

With reference to the data collected during the spot-check dive survey, Rapid Ecological Assessment (REA) surveys will be carried out at locations where coral communities are identified (Coral coverage >1%). The REA survey will be conducted underwater in a two-tier approach to assess the sub-littoral substrata and benthic

organisms in an area, i.e., Tier I, which assesses the relative coverage of major benthic groups and substrata, and, Tier II, which provides an inventory of sedentary/ sessile benthic taxa, which are ranked in terms of their abundance at the survey site. The benthic coverage, taxon abundance, and ecological attributes of the REA transects will be recorded. Representative photographs of any important ecological features and corals would also be taken.

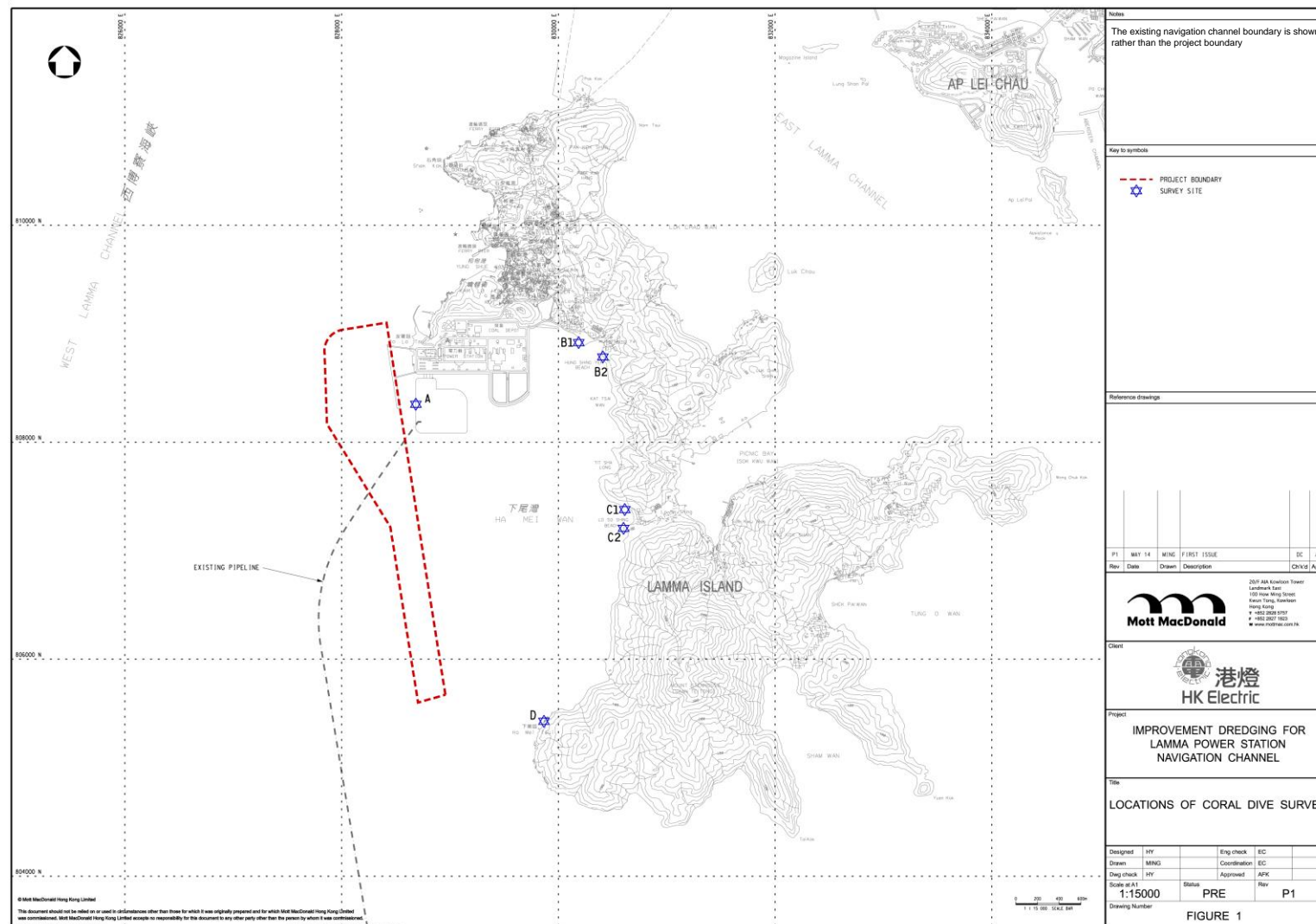
MATERIALS AND METHODS

The survey techniques used was a tiered methodology used to assess sub-littoral benthic communities, in particular, presence of hard corals within the four identified survey areas (i.e. artificial seawall along the coast of the power station, and rocky shores of Hung Shing Yeh Beach, Lo So Shing Beach and Ha Mei Tsui) at hard bottom habitats within the assessment area (as shown in Figure 1). The coordinates of the center of transect locations are listed in Table 1.

Table 1. Coordinates for the center of each coral area surveyed

Station	Location	GPS Readings	
A	The Lamma Power station, artificial seawall	114 06 180 E	22 12 809 N
B1	Hung Shing Yeh Beach, northern rocky shore	114 07 074 E	22 13 079 N
B2	Hung Shing Yeh Beach, southern rocky shore	114 07 171 E	22 12 966 N
C1	Lo So Shing Beach, northern rocky shore	114 07 171 E	22 12 360 N
C2	Lo So Shing Beach, southern rocky shore	114 07 275 E	22 12 198 N
D	Ha Mei Tsui, rocky shore	114 06 842 E	22 11 226 N

All the dive surveys were conducted during daytime. Such surveys consist of a two tiered multi survey approach with simple Spot-check Dive Surveys, and detailed Area Survey. The simple Diver Survey consists of a suite of three standardized 'nested' survey methods targeting coral damage and coral health: More detail surveys included detailed quantitative surveys, i.e., Rapid Ecological Assessment (REA), This would be conducted if coral communities were identified. Coral species, abundance and coverage would be recorded.



Note
The existing navigation channel boundary is shown rather than the project boundary

Key to symbols

- PROJECT BOUNDARY
- ★ SURVEY SITE

Reference drawings

Rev	Date	Drawn	Description	Checked	App'd
P1	MAY 14	MING	FIRST ISSUE	EC	AFK

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Project
IMPROVEMENT DREDGING FOR
LAMMA POWER STATION
NAVIGATION CHANNEL

Title
LOCATIONS OF CORAL DIVE SURVEY

Designed	HY	Eng check	EC
Drawn	MING	Coordination	EC
Design check	HY	Approved	AFK

Scale as of 1:15000
Drawing Number: PRE P1

FIGURE 1

Figure 1. Map of Lamma Island showing the survey locations.

LEVEL 1: SPOT-CHECK DIVE SURVEYS

These surveys provide general information and gives a general indication of a coral area. Suitably trained SCUBA divers dived within each coral area to look for specific indicators or situations within that area. The dives covered each area at a density that was sufficient to satisfactorily cover the majority of the area concerned. For each dive the following information was recorded:

- Depth range.
- Visibility.
- Estimated % of hard coral cover.
- Estimated % overturned or damaged coral.
- Estimate the anthropogenic and natural coral damage %.
- Approximate locations of the damage.
- Distance surveyed.
- Type and amount of rubbish present.

Data was recorded on waterproof paper attached to a suitable slate. This data should be transferred to the report as general comments and observations.

CORALWATCH SURVEY

This survey technique provides a simple method of monitoring the condition of hard corals by the use of simple graded colour charts underwater. The colour charts are a standard and are based upon the actual colours of bleached and healthy corals. Each colour square corresponds to a concentration of symbionts (zooxanthellae) contained in the coral tissue and this is directly related to the coral's condition. The process is simple, accurate and non-invasive. The University of Queensland, Australia, was responsible for developing this survey methodology.

A total of 20 random coral colonies were surveyed using the standard Chinese CoralWatch Chart. These corals were examined *in situ* and the lightest and darkest colour intensity match determined against the standard colour intensity chart. Care was taken to avoid the colour of the tips of the corals since there can be a delay in the colouration due to the required up-take time for zooxanthellae to enter the coral tissue.

The data collected in each area is arranged graphically for ease of comparison with previous results and other surveyed areas. The CoralWatch raw data values vary from B1~B6, C1~C6, D1~D6 and E1~E6. From this data ordinate values from 0~5 will be used to show bleaching / blanching. Blanching represents mild changes of colour intensity, bleaching represents more severe changes in colour intensity. A value of 0 means no blanching; values of 1 or 2 indicate mild and severe blanching. Values of 3 or above indicate levels of bleaching with 3 meaning mild, 4, acute and 5, severe bleaching.

The numerical average of accumulated individual calculated averages, the Cumulative Average (CA) has also been determined for each area as well. In Hong Kong a CA value of 3.6 is considered the average result based upon 68 coral surveys carried out around Hong Kong.

LEVEL 2 : RAPID ECOLOGICAL ASSESSMENT (REA) SURVEY METHODOLOGY

Rapid Ecological Assessment (REA) methods have been developed to provide highly informative baseline information on many coral regions, including the Florida Reef Tract (Chiappone and Sullivan 1997), Palau (Maragos and Cook 1995), the Great Barrier Reef (DeVantier *et al.* 1998) and Red Sea (DeVantier *et al.* 2000). The REA method developed for the Indo-Pacific (DeVantier *et al.* 1998, 2000) was refined for use in local waters and a standardized methodology was employed for the dive surveys. The field and analytical methods described below are modified from DeVantier *et al.* (1998, 2000). These methods have been applied successfully in a wide range of coral reef and community types, including those in Hong Kong waters (Fabricius 2001, Oceanway 2001a, 2001b).

The field data was recorded by observers experienced in the underwater identification of sessile benthic taxa, swimming down-current along coral communities or identified sections of coastline on SCUBA from haphazardly-chosen starting points. The swims covered most of the coral community at each site in that they encompassed the main characteristics of each coral community surveyed.

Two types of information was recorded during each survey swim in each area:

- 1) Tier I: An assessment of the relative cover of the major benthic groups; and
- 2) Tier II: An inventory of sessile benthic taxa.

Tier I: Categorization of ecological (benthic cover) and environmental variables. Ecological variables – benthic cover site descriptors.

At completion of each survey swim, six ecological and seven substratum attributes (Table 2a) were assigned to one of seven standard ranked (ordinal) categories (Table 2b), based on an assessment integrated over the length of the swim. These broad categories have been shown to be relatively insensitive to biases among different observers and capable of discriminating among contrasting benthic assemblages (Miller and De'Ath 1995).

Table 2. Categories of a) benthic attributes, b) ordinal ranks of percentage cover and c) ordinal ranks of taxon abundance.

a) Attributes		b) Cover		c) Taxon Abundance	
Ecological	Substratum	Rank	Percentage	Rank	Abundance
Hard coral	Hard substrate	0	not recorded	0	absent
Dead standing coral	Continuous pavement	1	1-5%	1	rare
Soft coral	Large blocks (diam. > 50 cm)	2	6-10%	2	uncommon
Black Coral	Small blocks (diam. < 50 cm)	3	11 - 30%	3	common
	Rubble	4	31 - 50%	4	abundant
	Sand	5	51 - 75%	5	dominant
	Silt	6	76 - 100%		

Environmental variables:

- Salinity
- Turbidity
- Depth
- Slope of the community at regular intervals along the transect.
- Exposure.
- Sediment

Water clarity - turbidity was measured as horizontal visibility along transect tape (m), while vertical light penetration was measured with a secchi disk (m). Salinity was measured with a portable refractometer. The depth of sites (maximum and minimum) and average angle of community slope to the horizontal (nearest 10 %) was recorded at 2m intervals.

Tier II. Taxonomic inventories to define types of benthic communities

An inventory of benthic taxa was compiled during each swim. Taxa was identified *in situ* to the following levels:

- **Hard corals** (Class Anthozoa, Order Scleractinia) - species wherever possible (Veron and Pichon 1976, 1980, 1982, Veron, Veron and Wallace 1984, Scott 1984, Veron 1982, 1986, 1993, 2000, Wallace 1999, Lam et al. 2008), AECD 2005, otherwise genus and growth form (e.g. *Porites* spp. of massive growth-form).
- **Soft corals** (Class Anthozoa, Subclass Octocorallia) and conspicuous macroalgae - genus (Allen and Steene 1994, Colin and Arneson 1995, Goslinger *et al.* 1996, Fabricius and Alderslade 2000, Lam and Morton 2008).
- **Black Corals** (Class Anthozoa, Order Antipathes and Cirripathes) – there is not that much known about the local species. . (Lam and Morton 2008) .
- **Other benthos** (including sponges, zoanthids, ascidians, bryozoans) - higher taxonomic level (usually phylum plus growth form, Allen and Steene 1994, Colin and Arneson 1995, Goslinger *et al.* 1996)

All data was input to Excel spreadsheets for initial storage and preliminary analyses.

RESULTS

LEVEL 1: DIVER SURVEYS

Diver Survey dives covering 735 m (Six locations × >100 m) were carried out in the six stations (Figure 1 and Table 1). All these were carried out on 19th June 2014. These dives were concentrated in areas where corals were found and thus those areas that had little hard substrate or low coral cover received less attention. Table 3 gives details of the number of dives and distance surveyed within each area.

Table 3. Distance surveyed and number of dives conducted during the spot dive surveys within each coral survey area

Station Number	Location	Distance surveyed (m)	Number of dives
A	The Lamma Power station, artificial seawall	120	1
B1	Hung Shing Yeh Beach, northern rocky shore	110	1
B2	Hung Shing Yeh Beach, southern rocky shore	130	1
C1	Lo So Shing Beach, northern rocky shore	125	1
C2	Lo So Shing Beach, southern rocky shore	130	1
D	Ha Mei Tsui, rocky shore	120	1

Summary Results

The results of the Diver Survey are shown in Table 4. The physical parameters such as weather, air and water temperature, water depth and visibility and biological parameters such as occurrences of hard and soft corals and invertebrates have been recorded.

CoralWatch graphs for Station B and C are shown in Figure 2A and 2B, respectively. At both sites, ~60% of hard corals are at the very healthy state.

Accumulative average of the CoralWatch value of Location B and C are 3.4 and 4, respectively. Raw data is in Annex 1.

List of reference is shown in Annex 2.

Photographs of the species occur in all the locations are shown in Annex 3.

Table 4. Summary results of the Diver Survey.

Parameter /Station	A	B1	B2	C1	C2	D
Survey date	19 th June 2014	19 th June 2014	19 th June 2014	19 th June 2014	19 th June 2014	19 th June 2014
Survey time start	10:12	11:01	11:40	12:20	12:52	13:55
Survey time end	10:45	11:35	12:05	12:45	13:20	14:25
Survey Length (m)	120	110	130	125	130	120
Weather	Sunny with overcast periods	Sunny	Sunny	Sunny with overcast periods	Sunny with overcast periods	Sunny with overcast periods
Air temperature (°C)	27	27	27	28	28	27
Water temperature (°C at 1m depth)	30	28	28	28	28	27
Minimum depth (m)	3.7	2.7	1.8	2.8	2.6	1.5
Maximum depth (m)	4.8	4.7	3.6	4.2	5.2	6.2
Visibility (m)	1	2	2	1.5	1.5	2
Substratum type	Sloping artificial sea wall, large rocks & boulders, silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt
Occurrence of hard coral	<i>Oulastrea crispata</i>	<i>Cyphastrea serailia</i> <i>Turbinarea peltata</i> <i>Favites abdita</i> <i>Psammocora superficialis</i> <i>Coscinaraea</i> n sp. <i>Balanophyllia</i> sp. <i>Hydnophora exesa</i>	<i>Goniopora stutchburyi</i> <i>Oulastrea crispata</i> <i>Leptastrea purpurea</i> <i>Favites abdita</i> <i>Favites chinensis</i> <i>Balanophyllia</i> sp.	<i>Coscinaraea</i> sp. <i>Leptastrea purpurea</i>	<i>Porites lutea</i>	<i>Porites lutea</i>
Occurrence of soft coral					<i>Dendronephthya gigantea</i>	

Parameter / Station	A	B1	B2	C1	C2	D
Occurrence of other invertebrates	Blue sponge Barnacles <i>Spirobranchus tricornis</i> <i>Myxicola infundibulum</i> Tube worms Oysters <i>Diadema setosum</i> <i>Salmacis sphaeroides</i> <i>Ergalatax contractus</i> <i>Thais luteostoma</i> <i>Thais clavigera</i> <i>Morula musica</i> Hermit crabs Coralline algae	<i>Schizoporella unicornis</i> bryozoan <i>Perna viridis</i> Oysters <i>Bugula neritina</i> Red sponge <i>Diadema setosum</i> <i>Anthocidaris crassispina</i> <i>Thalamita sp.</i> <i>Holothuria leucospilota</i> <i>Thais luteostoma</i> <i>Thais clavigera</i> <i>Ergalatax contractus</i> Nudibranch eggs Coralline algae Cyno-bacterial mat	<i>Schizoporella unicornis</i> Oysters Scallop <i>Perna viridis</i> Red sponge <i>Diadema setosum</i> <i>Anthocidaris crassispina</i> <i>Holothuria leucospilota</i> <i>Thais luteostoma</i> <i>Thais clavigera</i>	<i>Schizoporella unicornis</i> Oysters <i>Perna viridis</i> <i>Diadema setosum</i> <i>Salmacis sphaeroides</i> <i>Anthocidaris crassispina</i> <i>Stichopus sp.</i> <i>Holothuria leucospilota</i> <i>Thais luteostoma</i> <i>Thais clavigera</i> Coralline algae	<i>Spirobranchus tricornis</i> <i>Schizoporella unicornis</i> Oysters <i>Perna viridis</i> <i>Diadema setosum</i> <i>Anthocidaris crassispina</i> <i>Salmacis sphaeroides</i> <i>Temnopleurus reevesii</i> <i>Stichopus sp.</i> <i>Holothuria leucospilota</i> <i>Thais luteostoma</i> <i>Thais clavigera</i> Cynobacteria mat Coralline algae	Bryozoan <i>Schizoporella unicornis</i> <i>Spirobranchus tricornis</i> <i>Diadema setosum</i> <i>Anthocidaris crassispina</i> <i>Salmacis sphaeroides</i> <i>Temnopleurus reevesii</i> <i>Holothuria leucospilota</i>
Remarks	Ghost fish trap Ghosed net fragment	Ghost net Plastic rubbish	Nil	Nil	Nil	Nil

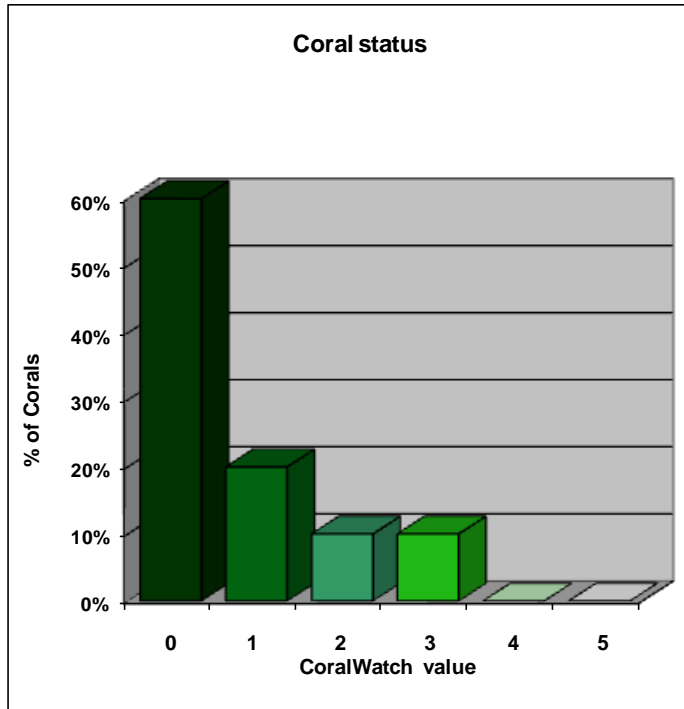


Figure 2A. The Coral Watch results at Station B .

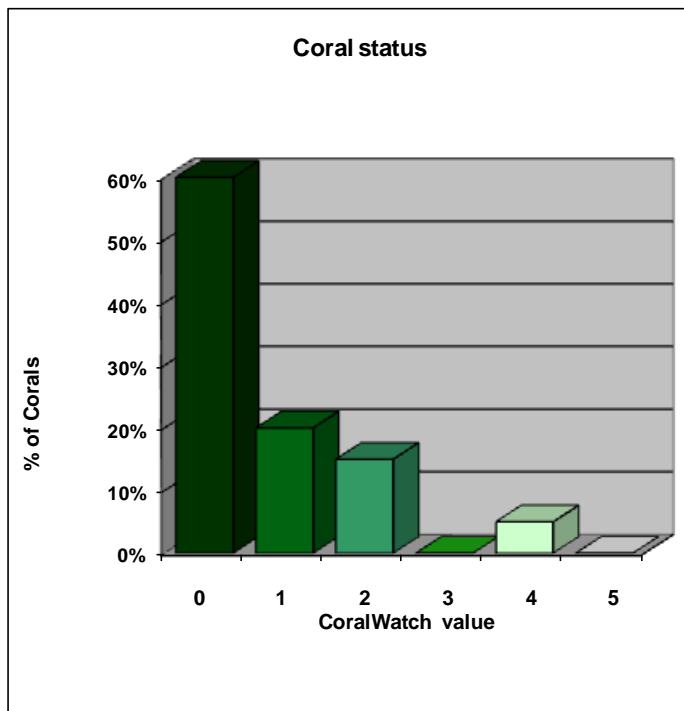


Figure 2B. The Coral Watch results at Station C .

A. The Lamma Power station, artificial seawall

This area is a sloping artificial sea wall covered by large rocks and boulders on the sea bottom. The substratum is covered with silt and thus the only hard coral occur is a sediment-tolerant one, *Oulastrea crispata*. This species occur as very small colonies scattered on the hard bottom substratum. This area is also shown to be disturbed by fishing activities as ghost fish traps and nets occur. This area is colonized by a rich fauna of invertebrates other than corals. The invertebrates include blue sponge, barnicles, attaching polychaetes (tube worms) such as *Spirobranchus tricornis*, *Myxicola infundibulum*. As this area is colonized by coralline algae, a population of sea urchin of *Diadema setosum* and *Salmacis sphaeroides* occur. The substratum is also colonized by small size oysters and some mobile gastropods such as *Ergalatax contractus*, *Thais luteostoma*, *Thais clavigera* and *Morula musica* and hermit crabs.

B1, B2. Hung Shing Yeh Beach, rocky shore

These are rocky shores on both sides of the Hung Shing Yeh Beach. The substratum is composed of natural rocky coastline covered with large rocks & boulders near shore and with smaller rocks & boulders, sand, rubble and silt as the shore is further away from the coastline. A rich coral community occur in these areas. On the northern shore, major hard coral species include *Cyphastrea serailia*, *Turbinarea peltata*, *Favites abdita*, *Psammocora superficialis*, *Coscinaraea* n sp., *Hydnophora exesa* and *Balanophyllia* sp. On the southern shore, major hard coral species include *Goniopora stutchburyi*, *Oulastrea crispata*, *Leptastrea purpurea*, *Favites abdita*, *Favites chinensis* and *Balanophyllia* sp. The CoralWatch Accumulative Average (CA) value was calculated as 3.4.

Attaching and mobile invertebrates colonized these areas are typical ones occur at the Hong Kong coral communities. Attaching invertebrates include *Schizoporella unicornis*, green mussel *Perna viridis*, oysters, red sponge, bryozoan *Bugula neritina*, etc. Identified mobile invertebrates include sea urchins *Anthocidaris crassispina* and *Diadema setosum*, common crab *Thalamita* sp., gastropods *Ergalatax contractus*, *Thais luteostoma*, and *Thais clavigera* and sea cucumber *Holothuria leucospilota*. Attached nudibranch eggs also occur although nudibranch is not seen on the substratum surface during the dive. These coral communities are subjected to disturbances by fishing activities and rubbish as ghost nets and plastic bags occur.

C1, C2. Lo So Shing Beach, rocky shore

These are rocky shores on both sides of the northern and southern side of the Lo So Shing Beach. The substratum is composed of natural rocky coastline covered with large rocks & boulders near shore and with smaller rocks & boulders, sand, rubble and silt as the shore is further away from the coastline. A coral community occur in these areas. The number of hard coral species is lower than that at the Hung Shing Yeh Beach rocky shore locations. Hard coral species include *Coscinaraea* sp., *Leptastrea purpurea* and *Porites lutea*. Soft coral *Dendronephthya gigantea* also occur in this area. The CoralWatch Accumulative Average (CA) value was calculated as 4.0

Other attaching invertebrates include *Schizoporella unicornis*, *Spirobranchus tricornis*, oysters, *Perna viridis* and bryozoans. Mobile invertebrates include sea urchins *Diadema setosum*, *Anthocidaris crassispina*, *Salmacis sphaeroides*, *Temnopleurus reevesii* and *Anthocidaris crassispina*, sea cucumbers *Stichopus* sp. and *Holothuria leucospilota* and gastropods *Thais luteostoma* and *Thais clavigera*.

D. Ha Mei Tsui, rocky shore

The substratum is composed of natural rocky coastline covered with large rocks & boulders near shore and with smaller rocks & boulders, sand, rubble and silt as the shore is further away from the coastline. Hard coral colonies *Porites lutea* occur in this area. Other invertebrates include bryozoans, *Schizoporella unicornis*, *Spirobranchus tricornis*, *Diadema setosum*, *Anthocidaris crassispina*, *Salmacis sphaeroides*, *Temnopleurus reevesii* and *Holothuria leucospilota*. These invertebrates are also typical inhabitants of coral communities in Hong Kong.

LEVEL 2: RAPID ECOLOGICAL ASSESSMENT

REA surveys were conducted on Locations B1, B2, C1 and C2 only where coral communities occur.

B1. Hung Shing Yeh Beach, northern rocky shore

In this area, seven hard coral species were recorded. Six of them are hermatypic (reef-building), including *Cyphastrea serailia*, *Turbinarea peltata*, *Favites abdita*, *Psammocora superficialis*, *Coscinaraea* n sp., *Hydnophora exesa* and one ahermatypic (non-reef building) *Balanophyllia* sp. This was the same result as recorded in the Diver Survey conducted out in this area. This area has the highest number of hard coral species recorded among the four survey areas. Coral cover is < 5%.

B2. Hung Shing Yeh Beach, southern rocky shore

A total of six hard coral species occurs in this area. These include five hermatypic corals including *Goniopora stutchburyi*, *Oulastrea crispata*, *Leptastrea purpurea*, *Favites abdita*, *Favites chinensis* and ahermatypic *Balanophyllia* sp. This area has the second highest number of hard coral species among the survey areas. Coral cover is <5%. Both the coral community structure and coral cover are very similar to those of the northern shore of the Hung Shing Yeh Beach.

C1 Lo So Shing Beach, northern rocky shore

Two species of hard corals were recorded. They are *Coscinaraea* sp. and *Leptastrea purpurea*, with low coral cover of <1%.

C2. Lo So Shing Beach, southern rocky shore

Only one coral species, *Porites lutea*, was recorded in this area. The coral cover value is low at <1%.

CONCLUSIONS

Coral communities occur at the locations at the rocky shores of Hung Shing Yeh Beach and Lo So Shing Beach.

At Hung Shing Yeh Beach northern rocky shore, seven hard coral species were recorded. Six of them are hermatypic (reef-building), including *Cyphastrea serailia*, *Turbinarea peltata*, *Favites abdita*, *Psammocora superficialis*, *Coscinaraea* n sp., *Hydnophora exesa* and one ahermatypic (non-reef building) *Balanophyllia* sp. This was the same result as recorded in the Diver Survey conducted out in this area. This area has the highest number of hard coral species recorded among the four survey areas. Coral cover is < 5%.

At Hung Shing Yeh Beach southern rocky shore, a total of six hard coral species occurs in this area. These include five hermatypic corals including *Goniopora stutchburyi*, *Oulastrea crispata*, *Leptastrea purpurea*, *Favites abdita*, *Favites chinensis* and ahermatypic *Balanophyllia* sp. This area has the second highest number of hard coral species among the survey areas. Coral cover is <5%. Both the coral community structure and coral cover are very similar to those of the northern shore of the Hung Shing Yeh Beach.

At Lo So Shing Beach northern rocky shore, two species of hard corals were recorded. They are *Coscinaraea* sp. and *Leptastrea purpurea*, with low coral cover of <1%.

At Lo So Shing Beach southern rocky shore, only one coral species, *Porites lutea*, was recorded in this area. The coral cover value is low at <1%.

The coral communities at the Hung Shing Yeh Beach and Lo So Shing Beach are in a moderately healthy state as the CoralWatch cumulative average values are between 3.4 and 4.0. The average value of CA for Hong Kong corals is 3.6.

At the artificial seawall of the Power Station, only one hard coral, *Oulastrea crispata*, was recorded.

This area is periodically dredged, so it is reasonable to assume that the ecology in the area is tolerant to this activity.

The area A is the closest to the dredging area. This area is an artificial seawall with only one hard coral, *Oulastrea crispata*, recorded. The sessile species recorded is not rare and have a high tolerance to sediment. Areas B, C & D do have coral areas.

The species recorded are in the table below:

Species	Location	Status
<i>Oulastrea crispata</i>	A, B2	Common
<i>Cyphastrea serailia</i>	B1	Dominant
<i>Turbinarea peltata</i>	B1	Common
<i>Favites abdita</i>	B1, B2	Dominant
<i>Coscinaraea</i> n sp.	B1, C1	Not determined
<i>Hydnophora exesa</i>	B1	Abundant
<i>Goniopora stutchburyi</i>	B2	Common
<i>Favites chinensis</i>	B2	Dominant
<i>Leptastrea purpurea</i>	B2, C1	Abundant
<i>Porites lutea</i>	C2, D	Dominant
<i>Balanophyllia</i> sp.	B1, B2	Abundant

There were no other rare or endangered species recorded in the areas surveyed.

ANNEX 1: DIVER SURVEY RAW DATA - CORALWATCH DATA

Coral Number	Value for the lightest colour	Value for the darkest colour	Average value	Cumulative average for each location
Location B				
1	2	5	3.5	
2	2	4	3	
3	3	4	3.5	
4	2	5	3.5	
5	4	4	4	
6	3	3	3	
7	2	4	3	
8	2	3	2.5	
9	3	4	3.5	
10	4	5	4.5	3.4
Location C				
1	3	5	4	
2	4	5	4.5	
3	3	4	3.5	
4	4	6	5	
5	2	3	2.5	
6	2	4	3	
7	1	5	3	
8	4	4	4	
9	5	5	5	
10	5	6	5.5	4

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ANNEX 3: SELECTED PHOTOGRAPHS



Plate 1. Underwater substratum at Station A at the artificial seawall at the Lamma Power Station.

Photo : June 2014.



Plate 2. Sponges at Station A.

Photo: June 2014.



Plate 3. Sea urchin at Station A.

Photo: June 2014.

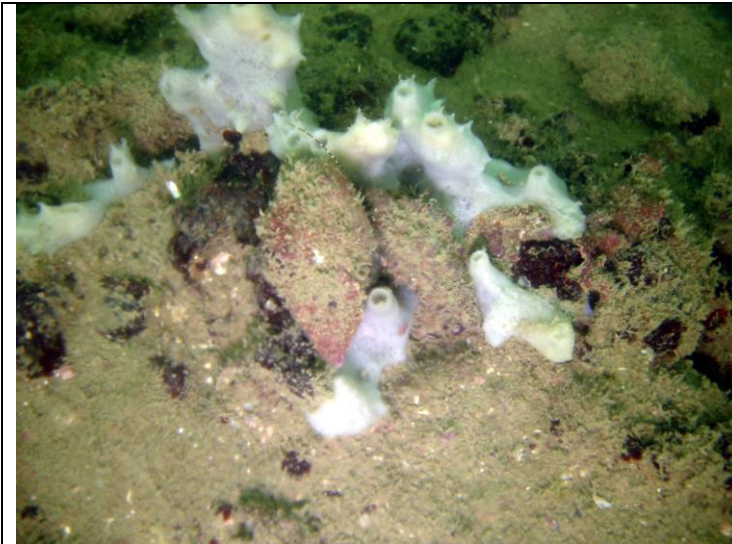


Plate 4. Gastropods and sponges at Station A.

Photo: June 2014.



Plate 5. Rocky substratum at Station A colonized by coral *Oulastrea crispata*.

Photo: June 2014.



Plate 6. Polychaete at Station A.

Photo: June 2014.



Plate 7. Fish cage at Station A.

Photo : June 2014.



Plate 8. *Cyphastrea serailia* at Station B1, the Hung Shing Yeh Beach, northern rocky shore.

Photo: June 2014.



Plate 9. *Turbinarea peltata* at Station B1.

Photo: June 2014.



Plate 10. Bryozoan at Station B1.

Photo: June 2014.



Plate 11. *Favites abdita* at Station B1.

Photo: June 2014.

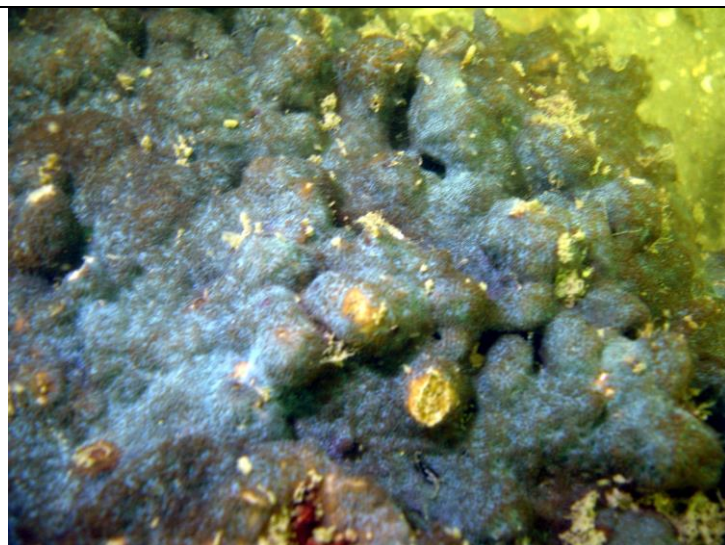


Plate 12. *Psammocora superficialis* at Station B1.

Photo: June 2014.

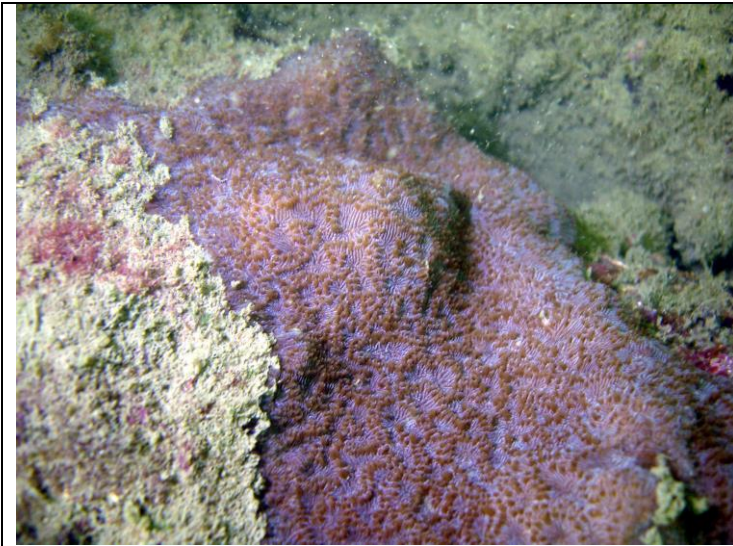


Plate 13. *Hydnophora exesa*
at Station B1.

Photo: June 2014.



Plate 14. Gastropod egg
capsules at Station B1.

Photo: June 2014.



Plate 15. Nudibranch egg
capsules at Station B1.

Photo: June 2014.



Plate 16. *Perna viridis* at Station B1.

Photo: June 2014.

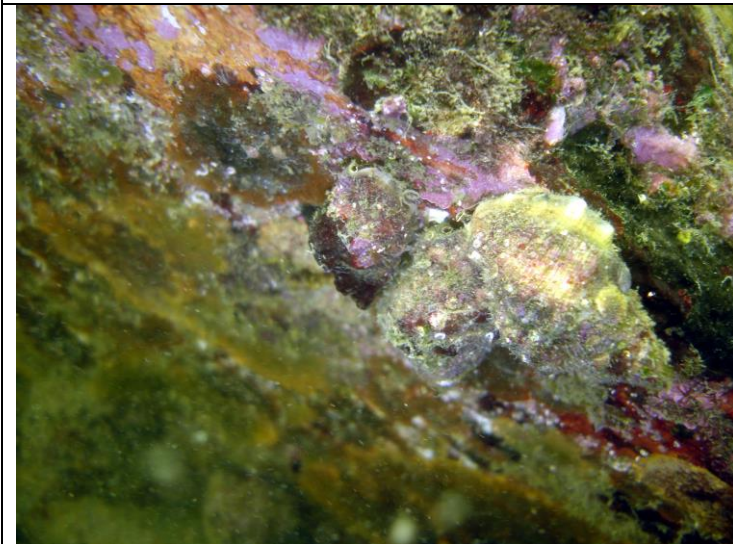


Plate 17. Gastropods at Station B1.

Photo: June 2014.

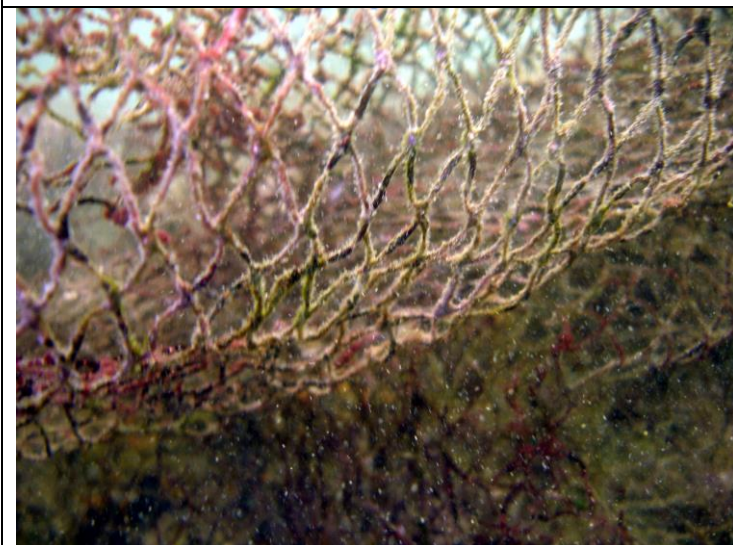


Plate 18. Ghost fish net at Station B1.

Photo: June 2014.



Plate 19. Coral colony *Favites abdita* at Station B2.

Photo: June 2014.

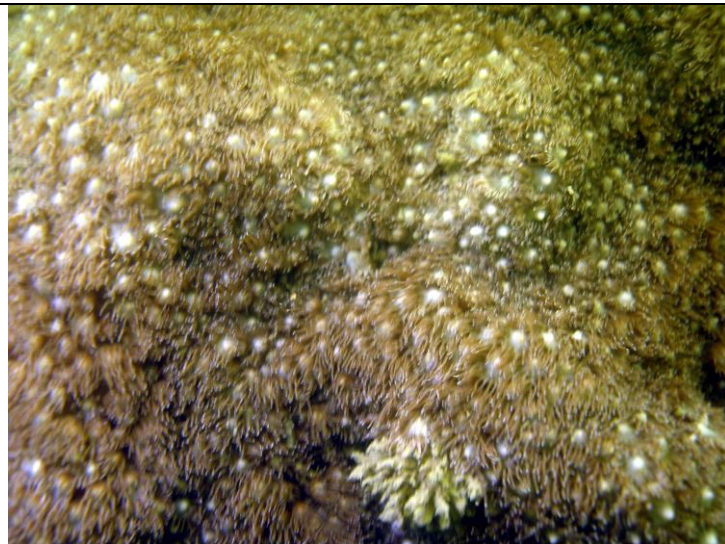


Plate 20. *Leptastrea purpurea* at Station B2.

Photo: June 2014.

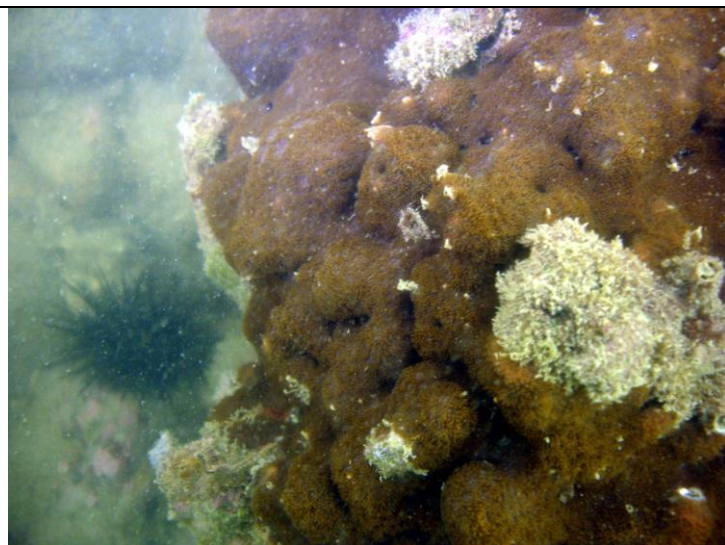


Plate 21. *Goniopora stutchburyi* at Station B2.

Photo: June 2014.



Plate 22. Scallops and oysters at Station B2.

Photo: June 2014.



Plate 23. Sea urchin at Station B2.

Photo: June 2014.



Plate 24. *Cosinaraea* sp. at Station C1.

Photo: June 2014.

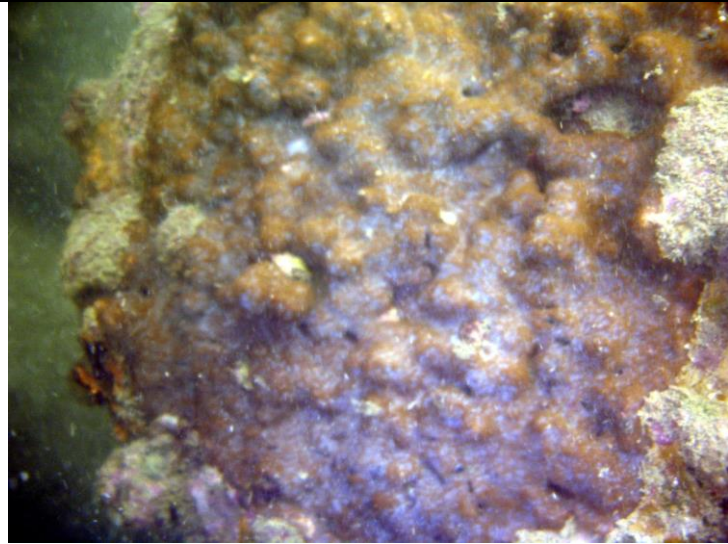


Plate 25. *Leptastrea purpurea* at Station C1.

Photo: June 2014.



Plate 26. Sea cucumber at Station C1.

Photo: June 2014.



Plate 27. Sea urchin at Station C1.

Photo: June 2014.

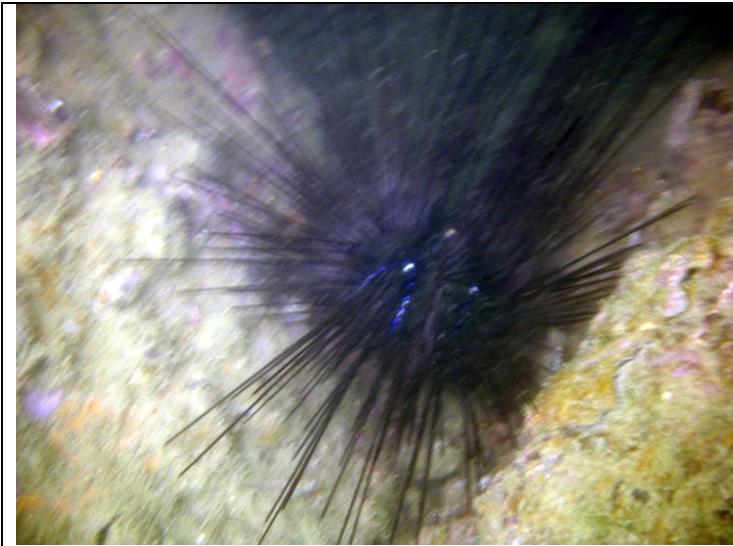


Plate 28. Sea urchin at Station C1.

Photo: June 2014.



Plate 29. Soft coral *Dendronephthya gigantea* at Station C2.

Photo: June 2014.



Plate 30. Tube worm at Station C2.

Photo: June 2014.



Plate 31. *Porites lutea* at Station D.

Photo: June 2014.

THE OCEANWAY CORPORATION LTD

REPORT

CORAL DIVE SURVEY

EIA FOR IMPROVEMENT DREDGING FOR
LAMMA POWER STATION NAVIGATION
CHANNEL

REF: 15/8004

Revised Report



November 2015

EXECUTIVE SUMMARY

- In October 2015, a coral area survey was carried out nearby the Lamma Power Station in order to provide information about the coral community in the EIA for improvement dredging for the Lamma Power Station navigation channel.
- Three stations have been identified to be investigated, namely artificial seawall along the coast of the power station, and rocky shores of the northern and southern coastline of Lo So Shing Beach. Data on such selected areas have been collected through a series of spot-check dive surveys and REA (Rapid Ecological Assessment).
- Results of these dive surveys and REA will be used to verify the previous findings in the approved EIA report for “Lamma Power Station Navigation Channel Improvement” project (EIAO Register No. AEIAR-069/2003).
- Station 1 is the closest to the dredging area. This area is an artificial seawall recorded soft corals but no hard corals. The sessile species recorded are common and typical to the Hong Kong rocky benthic invertebrate communities and have a high tolerance to sediment.
- Station 2 and 3 have occurrence of hard corals.
- Coral communities occur at the locations at the rocky shores of Lo So Shing Beach. These areas are periodically dredged, so it is reasonable to assume that the ecology in the area is tolerant to this activity.
- At Lo So Shing Beach northern rocky shore, i.e., Station 2, A rich coral community occur in these areas. Major hard coral species include *Cyphastrea serailia*, *Turbinarea peltata*, *Goniopora columna*, *Coscinaraea* n sp., *Goniastrea aspera*, *Goniopora stutchburyi*, *Favites pentagona*, *Porites lutea* and *Balanophyllia* sp., CoralWatch accumulative average value is 4.45. This area has the highest number of hard coral species recorded among the three survey areas. Coral cover is < 5%.
- At Lo So Shing Beach southern rocky shore, i.e., Station 3, one hard coral species occurs in this area. This is *Porites lutea*. This area has the second highest number of hard coral species among the survey areas. Coral cover is <1%.
- There were no other rare or endangered species recorded in the areas surveyed.

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INTRODUCTION

In October 2015, a coral area survey was carried out nearby the Lamma Power Station in order to provide information about the coral community in the EIA for the improvement dredging for the Lamma Power Station navigation channel. Three main areas have been identified to be investigated, namely artificial seawall along the coast of the power station, and rocky shores at the north and south of Lo So Shing Beach. Data on such selected areas have been collected through a series of spot-check dive surveys. Results of these dive surveys will be used to verify the previous findings in the approved EIA report for “Lamma Power Station Navigation Channel Improvement” project (EIAO Register No. AEIAR-069/2003).

The spot-check dive survey has been conducted by swimming in a search pattern along pre-determined areas at a density sufficient to cover any major coral areas and to assess the type of benthos existing in the proposed survey area, recording any presence of hard corals (order Scleractinia), octocorals (sub-class Octocorallia), and black corals (order Antipatharia). Information including estimated number of colonies, number of species, coral cover, and partial mortality (if any) was recorded during the actual dive. The following physical parameters were recorded during the survey:

Temperature, time and date;

Location (GPS);

Depth range;

Visibility;

Substratum type (i.e. hard substratum seabed, intertidal rocky area); and

Other invertebrates present.

Any special features encounter in the coral areas, such as non-typical reef structures, unusual coral species associations, unique or peculiar assemblages of the local incipient reef formations, and reefs that are almost completely dominated by one particular species, would be recorded. Representative photographs of any important ecological habitat, coral species and other ecological features would also be taken.

With reference to the data collected during the spot-check dive survey, Rapid Ecological Assessment (REA) surveys will be carried out at locations where coral communities are identified (Coral coverage >1%). The REA survey will be conducted underwater in a two-tier approach to assess the sub-littoral substrata and benthic organisms in an area, i.e., Tier I, which assesses the relative coverage of major benthic

groups and substrata, and, Tier II, which provides an inventory of sedentary/ sessile benthic taxa, which are ranked in terms of their abundance at the survey site. The benthic coverage, taxon abundance, and ecological attributes of the REA transects will be recorded. Representative photographs of any important ecological features and corals would also be taken.

MATERIALS AND METHODS

The survey techniques used was a tiered methodology used to assess sub-littoral benthic communities, in particular, presence of hard corals within the three identified survey areas (i.e. artificial seawall along the coast of the power station (Station 1 of Figure 1), and rocky shores on the north and south of Lo So Shing Beach, which is Stations 2 and 3 of Figure 1) at hard bottom habitats within the assessment area (as shown in Figure 1). The coordinates of the center of transect locations are listed in Table 1.

Table 1. Coordinates for the center of each coral area surveyed

Station	Location	GPS Readings	
1	The Lamma Power station, artificial seawall	114 06 402 E	22 12 660 N
2	Rocky shore on the north of Lo So Shing Beach	114 07 203 E	22 12 608 N
3	Rocky shore on the south of Lo So Shing Beach	114 07 222 E	22 11 742 N

All the dive surveys were conducted during daytime in October 2015. Waves were less than 0.1m high; weather was sunny with patches of cloud.

At all the above three survey areas, spot dive survey and CoralWatch survey have been conducted. Rapid Ecological Assessment (REA) methods, however, have been carried out at Station 1 and 2 only, where there are occurrence of corals.

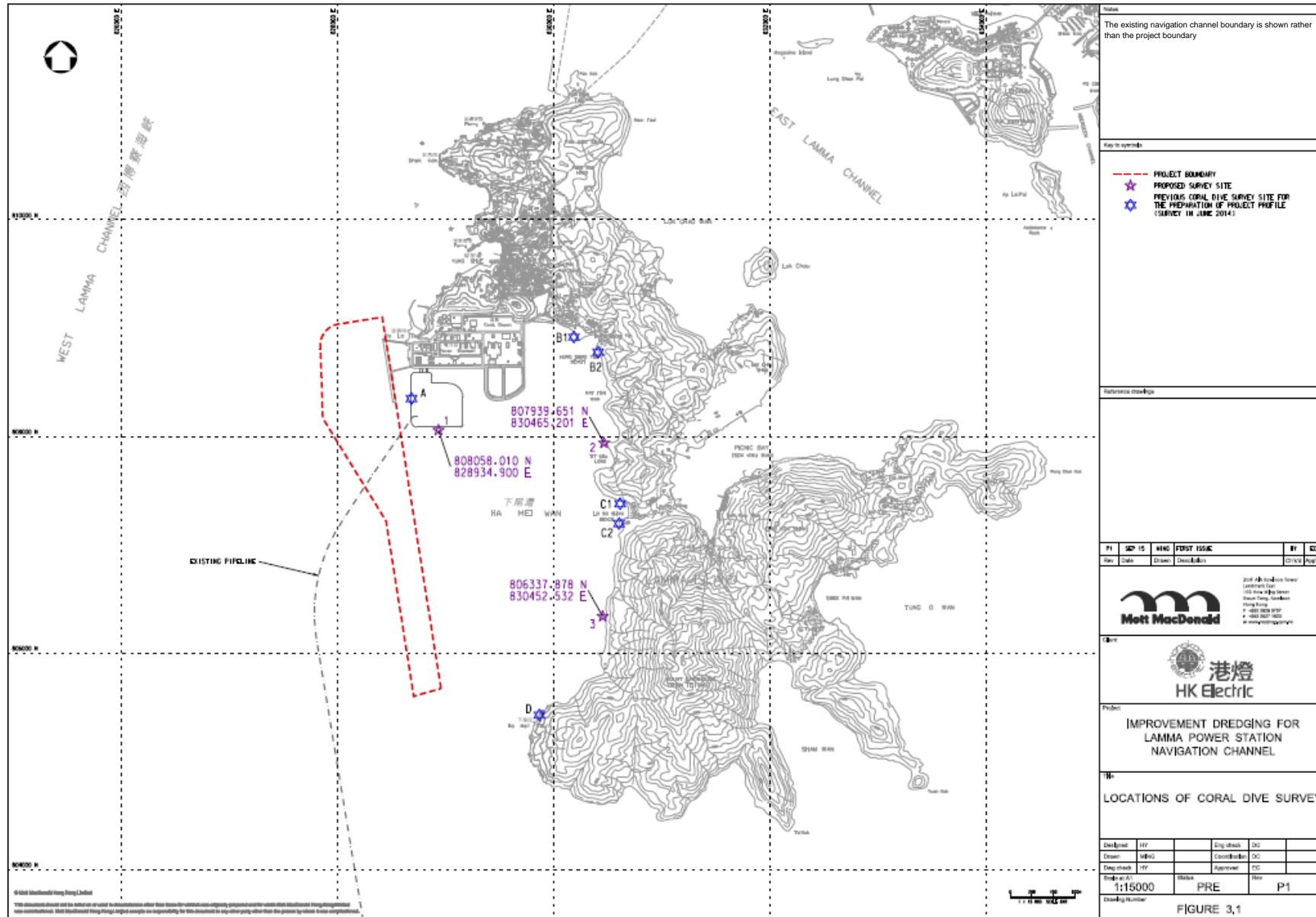


Figure 1. Map of Lamma Island showing the survey locations.

LEVEL1: SPOT-CHECK DIVE SURVEYS

These surveys provide general information and gives a general indication of a coral area. Suitably trained SCUBA divers dived within each coral area to look for specific indicators or situations within that area. The dives covered each area at a density that was sufficient to satisfactorily cover the majority of the area concerned. For each dive the following information was recorded:

- Depth range.
- Visibility.
- Estimated % of hard coral cover.
- Estimated % overturned or damaged coral.
- Estimate the anthropogenic and natural coral damage %.
- Approximate locations of the damage.
- Distance surveyed.
- Type and amount of rubbish present.

Data was recorded on waterproof paper attached to a suitable slate. This data was transferred to the report as general comments and observations.

CORALWATCH SURVEY

This survey technique provides a simple method of monitoring the condition of hard corals by the use of simple graded colour charts underwater. The colour charts are a standard and are based upon the actual colours of bleached and healthy corals. Each colour square corresponds to a concentration of symbionts (zooxanthellae) contained in the coral tissue and this is directly related to the coral's condition. The process is simple, accurate and non-invasive. The University of Queensland, Australia, was responsible for developing this survey methodology.

A total of 20 random coral colonies were surveyed using the standard Chinese CoralWatch Chart. These corals were examined *in situ* and the lightest and darkest colour intensity match determined against the standard colour intensity chart. Care was taken to avoid the colour of the tips of the corals since there can be a delay in the colouration due to the required up-take time for zooxanthellae to enter the coral tissue.

The data collected in each area is arranged graphically for ease of comparison with previous results and other surveyed areas. The CoralWatch raw data values vary from B1~B6, C1~C6, D1~D6 and E1~E6. From this data ordinate values from 0~5 will be used to show bleaching / blanching. Blanching represents mild changes of colour intensity, bleaching represents more severe changes in colour intensity. A value of 0 means no blanching; values of 1 or 2 indicate mild and severe blanching. Values of 3 or above indicate levels of bleaching with 3 meaning mild, 4, acute and 5, severe bleaching.

The numerical average of accumulated individual calculated averages, the Cumulative Average (CA) has also been determined. In Hong Kong a CA value of 3.6 is considered the average result based upon 68 coral surveys carried out around Hong Kong.

LEVEL2: RAPID ECOLOGICAL ASSESSMENT (REA) SURVEY METHODOLOGY

Rapid Ecological Assessment (REA) methods have been developed to provide highly informative baseline information on many coral regions, including the Florida Reef Tract (Chiappone and Sullivan 1997), Palau (Maragos and Cook 1995), the Great Barrier Reef (DeVantier *et al.* 1998) and Red Sea (DeVantier *et al.* 2000). The REA method developed for the Indo-Pacific (DeVantier *et al.* 1998, 2000) was refined for use in local waters and a standardized methodology was employed for the dive surveys. The field and analytical methods described below are modified from DeVantier *et al.* (1998, 2000). These methods have been applied successfully in a wide range of coral reef and community types, including those in Hong Kong waters (Fabricius 2001, Oceanway 2001a, 2001b).

The field data was recorded by observers experienced in the underwater identification of sessile benthic taxa, swimming down-current along coral communities or identified sections of coastline on SCUBA from haphazardly-chosen starting points. The swims covered most of the coral community at each site in that they encompassed the main characteristics of each coral community surveyed.

Two types of information was recorded during each survey swim in each area:

- 1) Tier I: An assessment of the relative cover of the major benthic groups; and
- 2) Tier II: An inventory of sessile benthic taxa.

Tier I: Categorization of ecological (benthic cover) and environmental variables. Ecological variables – benthic cover site descriptors.

At completion of each survey swim, six ecological and seven substratum attributes (Table 2a) were assigned to one of seven standard ranked (ordinal) categories (Table 2b), based on an assessment integrated over the length of the swim. These broad categories have been shown to be relatively insensitive to biases among different observers and capable of discriminating among contrasting benthic assemblages (Miller and De'Ath 1995).

a) Attributes		b) Cover		c) Taxon Abundance	
Ecological	Substratum	Rank	Percentage	Rank	Abundance
Hard coral	Hard substrate	0	not recorded	0	absent
Dead standing coral	Continuous pavement	1	1-5%	1	rare
Soft coral	Large blocks (diam. > 50 cm)	2	6-10%	2	uncommon
Black Coral	Small blocks (diam. < 50 cm)	3	11 - 30%	3	common
	Rubble	4	31 - 50%	4	abundant
	Sand	5	51 - 75%	5	dominant
	Silt	6	76 - 100%		

Table 2. Categories of a) benthic attributes, b) ordinal ranks of percentage cover and c) ordinal ranks of taxon abundance.

Environmental variables:

- Salinity
- Turbidity
- Depth
- Slope of the community at regular intervals along the transect.
- Exposure.
- Sediment

Water clarity - turbidity was measured as horizontal visibility along transect tape (m), while vertical light penetration was measured with a secchi disk (m). Salinity was measured with a portable refractometer. The depth of sites (maximum and minimum) and average angle of community slope to the horizontal (nearest 10 %) was recorded at 2m intervals.

Tier II. Taxonomic inventories to define types of benthic communities

An inventory of benthic taxa was compiled during each swim. Taxa was identified *in situ* to the following levels:

- **Hard corals** (Class Anthozoa, Order Scleractinia) - species wherever possible (Veron and Pichon 1976, 1980, 1982, Veron, Veron and Wallace 1984, Scott 1984, Veron 1982, 1986, 1993, 2000, Wallace 1999, Lam et al. 2008), AECD 2005, otherwise genus and growth form (e.g. *Porites* spp. of massive growth-form).
- **Soft corals** (Class Anthozoa, Subclass Octocorallia) and conspicuous macroalgae - genus (Allen and Steene 1994, Colin and Arneson 1995, Goslinger *et al.* 1996, Fabricius and Alderslade 2000, Lam and Morton 2008).
- **Black Corals** (Class Anthozoa, Order Antipathes and Cirripathes) – there is not that much known about the local species. . (Lam and Morton 2008) .
- **Other benthos** (including sponges, zoanthids, ascidians, bryozoans) - higher taxonomic level (usually phylum plus growth form, Allen and Steene 1994, Colin and Arneson 1995, Goslinger *et al.* 1996)

All data was input to Excel spreadsheets for initial storage and preliminary analyses.

RESULTS

LEVEL 1: DIVER SURVEYS

Diver Survey dives covering 420 m (three locations \times >100 m) were carried out in the three stations (Figure 1 and Table 1). All these were carried out on 23rd October 2015. These dives were concentrated in areas where corals were found and thus those areas that had little hard substrate or low coral cover received less attention. Table 3 gives details of the number of dives and distance surveyed within each area.

Table 3. Distance surveyed and number of dives conducted during the spot dive surveys within each coral survey area

Station Number	Location	Distance surveyed (m)	Number of dives
1	The Lamma Power station, artificial seawall	150	1
2	Rocky shore on the north of Lo So Shing Beach	150	1
3	Rocky shore on the south of Lo So Shing Beach	120	1

Summary Results

The results of the Diver Survey are shown in Table 4. The physical parameters such as weather, air and water temperature, water depth and visibility and biological parameters such as occurrences of hard and soft corals and invertebrates have been recorded.

Among the stations, only Station 2 is applicable for CoralWatch survey. The CoralWatch graph for Station 2 is shown in Figure 2. At this site, ~70% (e.g. 25% + 45%, Figure 2) of hard corals are at the very healthy state.

Cumulative average of the CoralWatch value is 4.45. The average value of CA for Hong Kong corals is 3.6. Raw data is in Annex 1.

The list of references and photographs of the species occur in all the locations are shown in Annex 2 and Annex 3, respectively.

Table 4. Summary results of the Diver Survey.

Parameter /Station	1	2	3
Survey date	23 rd October 2015	23 rd October 2015	23 rd October 2015
Survey time start	11:10	12:10	13:50
Survey time end	11:51	13:30	14:30
Survey Length (m)	150	150	120
Weather	Sunny with overcast periods	Sunny	Sunny
Air temperature (°C)	29	29	28
Water temperature (°C at 1m depth)	27	27	28
Salinity (‰)	35	32	35
Minimum depth (m)	1.8	1.9	1.8
Maximum depth (m)	8.9	4.8	3.6
Visibility (m)	0.75	0.75	2
Substratum type	Sloping artificial sea wall, large rocks & boulders, silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt	Natural rocky coastline pavement, large rocks & boulders small rocks & boulders sand rubble silt
Occurrence of hard coral	Nil	<i>Cyphastrea serailia</i> <i>Turbinarea peltata</i> <i>Goniopora columna</i> <i>Coscinaraea</i> n sp. <i>Goniastrea aspera</i> <i>Goniopora stutchburyi</i> <i>Favites pentagona</i> <i>Porites lutea</i> <i>Balanophyllia</i> sp.	<i>Porites lutea</i>

Parameter / Station	1	2	3
Occurrence of soft coral	<i>Dendronephthya gigantea</i> <i>Echinomuricea</i> spp. <i>Echinogorgia</i> sp. <i>Carijoa</i> sp.	Nil	<i>Dendronephthya gigantea</i>
Occurrence of other invertebrates	<i>Schizoporella unicornis</i> Blue sponge Red Sponge Grey Sponge Barnacles Tube worms <i>Perna viridis</i> Coralline algae <i>Thais luteostoma</i> <i>Thais clavigera</i> <i>Ergalatax contractus</i> Hermit crabs Small oysters Feather star	<i>Schizoporella unicornis</i> <i>Ergalatax contractus</i> <i>Perna viridis</i> Barnacles Oysters <i>Anthocidaris crassispina</i> <i>Diadema setosum</i> <i>Temnopleura reevesi</i> White sponge <i>Holothuria leucospilota</i> <i>Thais clavigera</i>	<i>Schizoporella unicornis</i> <i>Diadema setosum</i> <i>Perna viridis</i> Oysters <i>Cerianthus</i> cf. <i>filiformis</i> <i>Anthocidaris crassispina</i> <i>Thais clavigera</i> <i>Holothuria leucospilota</i> <i>Pseudocholochirus violaceus</i>
Remarks	Ghosted net fragment Plastic bags Colonys of <i>Echinomuricea</i> sp. = ~5 per m ² in patches of ~10m ² All new recruits Coral cover <1% Colonies at 5~8 m depth	Ghost net fragment Plastic rubbish Some hard coral colonies with partial mortality ~20% Hard coral cover is <1% Coral colonies at 2.5~3.5m depth	Cans Only one hard coral and one soft coral colonies are recorded. They are at ~ 3m depth.

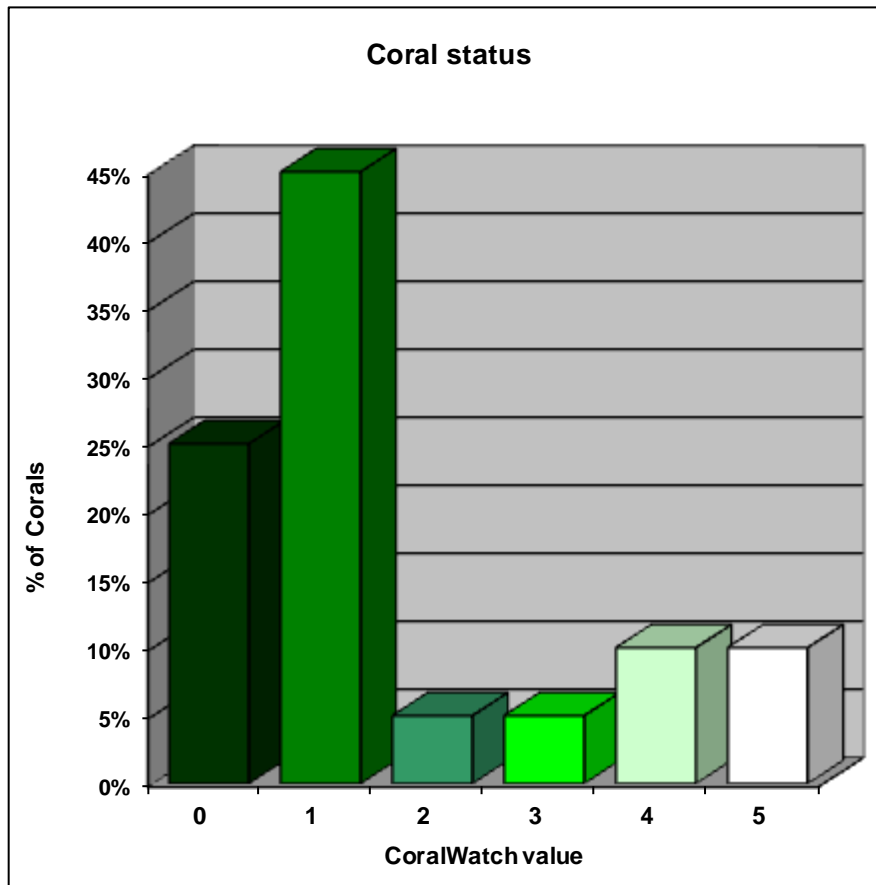


Figure 2. The Coral Watch results at Station 2.

1. *The Lamma Power station, artificial seawall*

This area is a sloping artificial sea wall covered by large rocks and boulders on the sea bottom. The substratum is covered with silt and thus no hard coral occurs. This area is also shown to be disturbed by fishing activities as ghost fish traps and nets occur. Only sediment-tolerant soft corals such as *Dendronephthya gigantea*, *Echinomuricea* spp., *Echinogorgia* sp. and *Carijoa* sp. occur.

This area is colonized by a rich fauna of invertebrates other than hard corals. The invertebrates include blue, red (or orange) and grey sponges, barnacles, attaching polychaetes (tube worms) such as *Schizoporella unicornis*. This area is also colonized by coralline algae and green mussel *Perna viridis*. The substratum is also colonized by small size oysters and some mobile gastropods such as *Ergalatax contractus*, *Thais luteostoma* and *Thais clavigera*, hermit crabs and feather star.

2. *Rocky shore on the north of Lo So Shing Beach*

These are rocky shores near the northern coastline of the Lo So Shing Beach. The substratum is composed of natural rocky coastline covered with large rocks & boulders near shore and with smaller rocks & boulders, sand, rubble and silt as the

shore is further away from the coastline. A rich coral community occur in these areas. Major hard coral species include *Cyphastrea serailia*, *Turbinarea peltata*, *Goniopora columna*, *Coscinaraea* n sp., *Goniastrea aspera*, *Goniopora stutchburyi*, *Favites pentagona*, *Porites lutea* and *Balanophyllia* sp., CoralWatch accumulative average value is 4.45.

Attaching and mobile invertebrates colonized these areas are typical ones occur at the Hong Kong coral communities. Attaching invertebrates include *Schizoporella unicornis*, green mussel *Perna viridis*, oysters, white sponge, barnacles, etc. Identified mobile invertebrates include sea urchins *Anthocidaris crassispina*, *Diadema setosum* and *Temnopleura reevesi*, gastropods *Ergalatax contractus*, *Thais luteostoma*, and sea cucumber *Holothuria leucospilota*. These coral communities are subjected to disturbances by fishing activities and rubbish as ghost nets and plastic bags occur.

3. Rocky shore on the north of Lo So Shing Beach

These are rocky shores on near the coastline of the southern side of the Lo So Shing Beach. The substratum is composed of natural rocky coastline covered with large rocks & boulders near shore and with smaller rocks & boulders, sand, rubble and silt as the shore is further away from the coastline. Only few colonies of hard coral *Porites lutea* occur in these areas. The number of hard coral species is lower than that at the Station 2. Soft coral *Dendronephthya gigantea* also occur in this area.

Other attaching invertebrates include *Schizoporella unicornis*, oysters and *Perna viridis* and tube worm *Cerianthus* cf. *filiformis*. Mobile invertebrates include sea urchins *Anthocidaris crassispina*, sea cucumbers *Holothuria leucospilota* and *Pseudocholochirus violaceus*, and gastropods *Thais clavigera*.

LEVEL 2: RAPID ECOLOGICAL ASSESSMENT

REA surveys were conducted on Stations 1 and 2 only.

Station 1. The Lamma Power station, artificial seawall

In this area, nine ahermatypic (non reef-building) and soft coral species were recorded. These include *Tubastrea* spp., *Tubastrea diaphana*, *Anthipanthes* spp., *Guaiagorgia* sp., *Euplexaura* sp., *Echinomuricea* sp., *Dendronephthya gigantea*, *Scleronephthya gracillimum* and an unidentified soft coral. Hard coral cover is ~0%. This was the similar result as recorded in the Diver Survey, which recorded no hard coral species.

Station 2. Rocky shore on the north of Lo So Shing Beach

A total of eleven hard coral species occurs in this area. These include eleven hermatypic (reef-building) corals including *Psammocora superficialis*, *Coscinaraea* n sp., *Favia speciosa*, *Favites chinensis*, *Favites abdita*, *Goniastrea aspera*, *Leptastrea pruinosa*, *Cyphastrea serailia*, *Cyphastrea japonica*, *Porites lutea* and *Goniopora stutchburyi*. This area has the highest number of hard coral species among the survey

areas. This was the same result as recorded in the Diver Survey conducted out in this area. Coral cover is <5%.

CONCLUSIONS

Coral communities occur at the locations on the rocky shore in the north of Lo So Shing Beach, i.e., Station 2.

In this Station, Nine hard coral species were recorded by the Spot Dive survey. Eight of them are hermatypic (reef-building), including *Cyphastrea serailia*, *Turbinarea peltata*, *Goniopora columna*, *Coscinaraea* n sp., *Goniastrea aspera*, *Goniopora stutchburyi*, *Favites pentagona* and *Porites lutea* and one ahermatypic (non-reef building) *Balanophyllia* sp. This area has the highest number of hard coral species recorded among the three survey stations. Coral cover is < 5%. The coral communities are in a healthy state as the CoralWatch cumulative average values are between 4 and 5.

Using the REA method, a total of eleven hard coral species occurs in Station 2. These include eleven hermatypic (reef-building) corals including *Psammocora superficialis*, *Coscinaraea* n sp., *Favia speciosa*, *Favites chinensis*, *Favites abdita*, *Goniastrea aspera*, *Leptastrea pruinosa*, *Cyphastrea serailia*, *Cyphastrea japonica*, *Porites lutea* and *Goniopora stutchburyi*. This area has the highest number of hard coral species among the survey areas. This was the same result as recorded in the Diver Survey conducted out in this area. Coral cover is <5%.

At Lo So Shing Beach southern rocky shore, one species of hard corals were recorded. This is *Porites lutea*, with low coral cover of <1%.

At the artificial seawall of the Power Station, no hard coral was recorded by the spot dive survey.

This area is periodically dredged, so it is reasonable to assume that the ecology in the area is tolerant to this activity.

Station 1 is the closest to the dredging area. This area is an artificial seawall with no hard coral recorded. The sessile species recorded is common and typical of the Hong Kong rocky benthic invertebrate communities and have a high tolerance to sediment. Station 2 and 3 have occurrence of hard corals.

The species recorded are in the table below:

Species	Occurrence at Station	Status (See note)
<i>Cyphastrea serailia</i>	2	Dominant
<i>Turbinarea peltata</i>	2	Common
<i>Goniopora columna</i>	2	Abundant
<i>Coscinaraea</i> n sp.	2	Not determined
<i>Goniastrea aspera</i>	2	Common
<i>Goniopora stutchburyi</i>	2	Common
<i>Favites pentagona</i>	2	Dominant
<i>Porites lutea</i>	2, 3	Dominant
<i>Balanophyllia</i> sp.	2	Abundant
<i>Psammocora superficialis</i>	2	Abundant
<i>Favia speciosa</i>	2	Abundant
<i>Favites chinensis</i>	2	Dominant
<i>Favites abdita</i>	2	Dominant
<i>Leptastrea pruinosa</i>	2	Abundant

Note: The status of the coral species was determined from the Field Guide to Hard Corals of Hong Kong, published by Agriculture, Fisheries and Conservation Department, 2005..

There were no other rare or endangered species recorded in the areas surveyed.

**ANNEX 1: DIVER SURVEY RAW DATA - CORALWATCH
DATA**

Coral Number	Value for the lightest colour	Value for the darkest colour	Average value	Cumulative average for each location
Station 2				
1	4	5	4.5	
2	4	5	4.5	
3	5	6	5.5	
4	5	5	5	
5	6	6	6	
6	4	6	5	
7	4	5	4.5	
8	1	6	3.5	
9	5	6	5.5	
10	2	6	4	
11	1	6	3.5	
12	2	5	3.5	
13	3	3	3	
14	4	5	4.5	
15	5	5	5	
16	5	6	5.5	
17	1	5	3	
18	3	4	3.5	
19	5	5	5	
20	4	5	4.5	
				4.45

ANNEX 2: REFERENCES

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ANNEX 3: SELECTED PHOTOGRAPHS



Plate 1. Station 1 at the artificial seawall at the Lamma Power Station.

Photo : October 2015.



Plate 2. Sponges at Station 1.

Photo: October 2015.

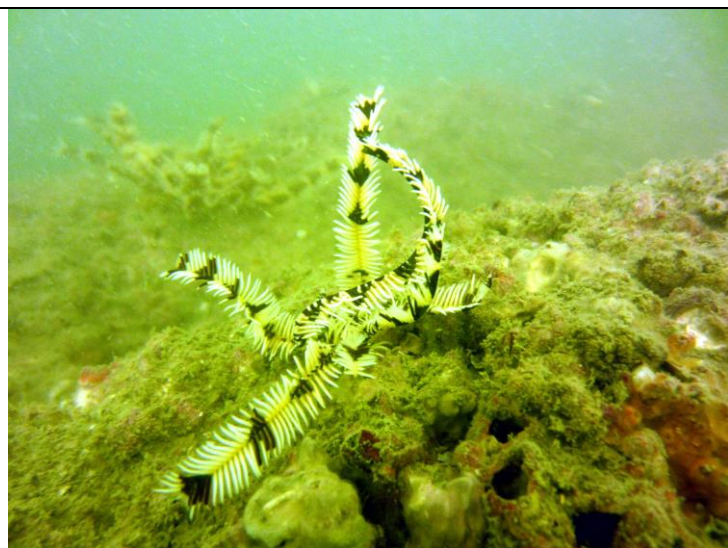


Plate 3. Feather star at Station 1.

Photo: October 2015.



Plate 4. Green mussel and sponges at Station 1.

Photo: October 2015.



Plate 5. Gastropod at Station 1.

Photo: October 2015.



Plate 6. Orange sponge at Station 1.

Photo: October 2015.



Plate 7. *Echinomuricea* spp. at Station 1.

Photo : October 2015.




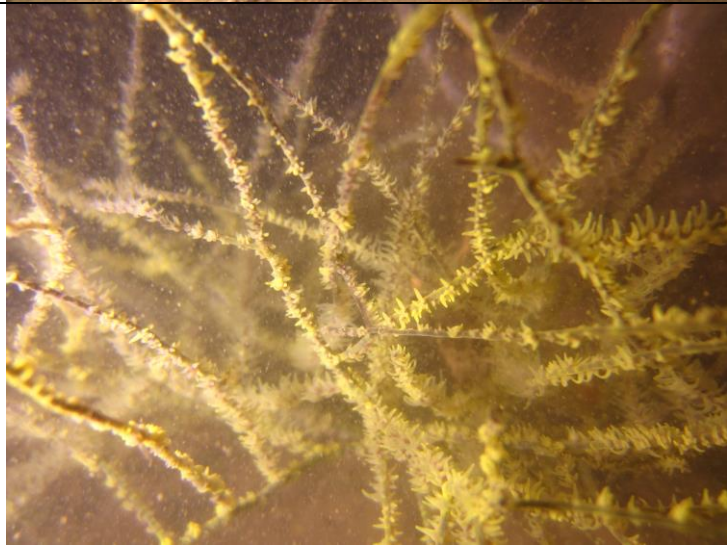

Plate 8. *Echinogorgia* sp. at Station 1,

Photo: October 2015.



Plate 9. *Dendronephthya gigantea* at Station 1.

Photo: October 2015.

 A photograph of a cluster of pinkish-red corals with prominent yellow-orange oral disc openings, resting on a sandy seabed.	<p>Plate 10. <i>Turbastrea</i> sp. at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>
 A photograph of a branching coral structure with a yellowish-green hue, set against a dark underwater background.	<p>Plate 11. <i>Antipathes</i> sp. at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>
 A photograph of a soft coral with a delicate, branching, pinkish-white structure, illuminated against a dark background.	<p>Plate 12. Soft coral at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>



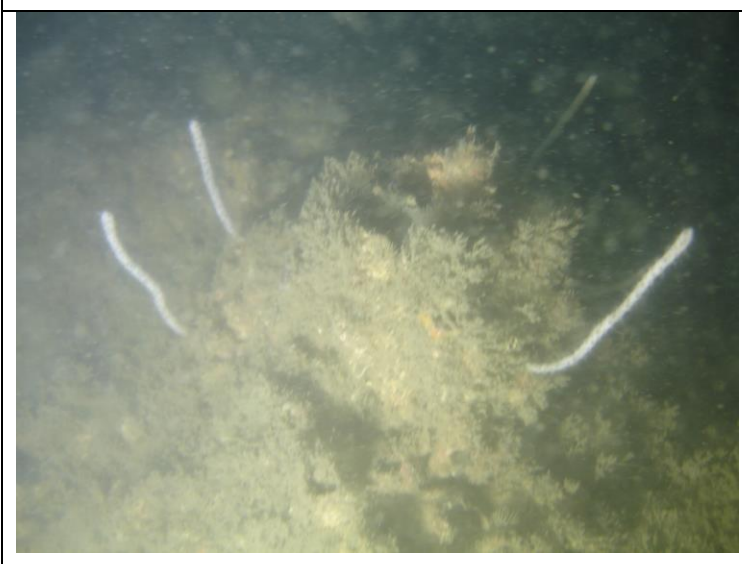
	<p>Plate 13. Crinoids associated with soft coral at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>
	<p>Plate 14. Soft coral at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>
	<p>Plate 15. Soft coral at Station 1, recorded by REA.</p> <p>Photo: November 2015.</p>



Plate 16. Station 2.

Photo: October 2015.



Plate 17. *Perna viridis*
at Station 2.

Photo: October 2015.

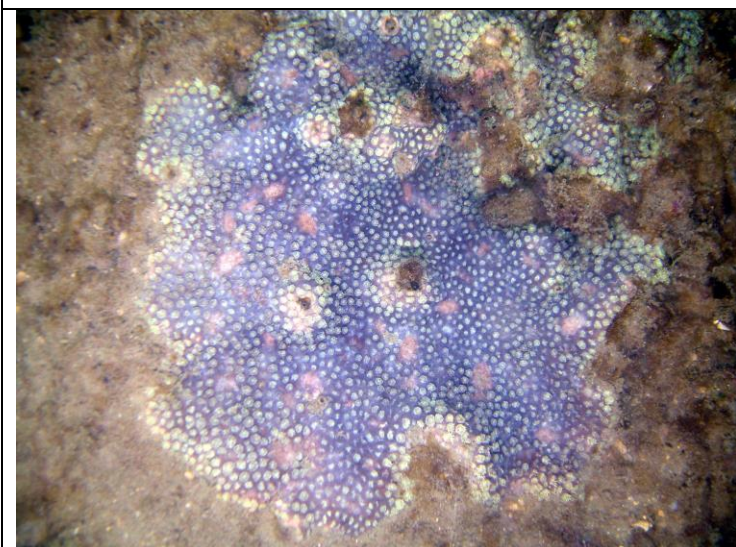


Plate 18. *Porites lutea*
at Station 2.

Photo: October 2015.



Plate 19. *Goniastrea aspera*
at Station 2.

Photo: October 2015.



Plate 20. *Goniopora columna*
at Station 2.

Photo: October 2015.



Plate 21. *Turbinarea peltata*
at Station 2.

Photo: October 2015.

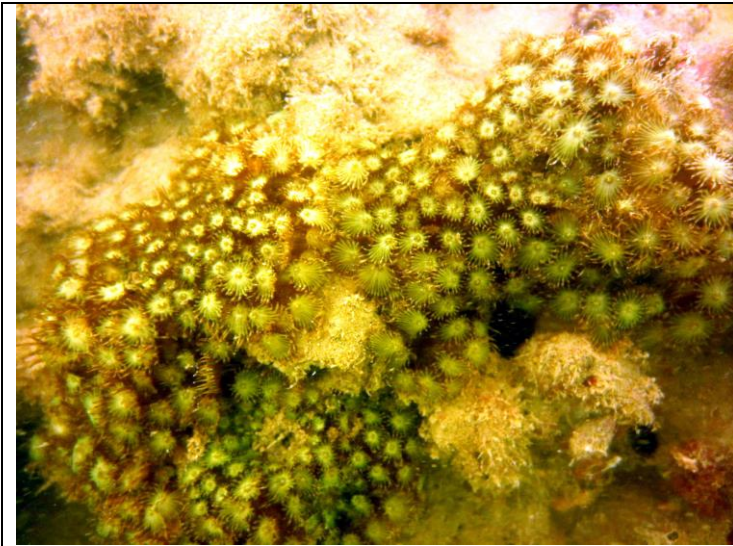


Plate 22. *Goniopora stutchburyi*
at Station 2.

Photo: October 2015.



Plate 23. *Coscinaraea* n sp.
at Station 2.

Photo: October 2015.



Plate 24. *Goniopora stutchburyi*
at Station 2.

Photo: October 2015.



Plate 25. Station 3.

Photo: October 2015.



Plate 26. *Porites lutea* at Station 3.

Photo: October 2015.



Plate 27. Soft coral
Dendronephthya gigantea at
Station 3.

Photo: October 2015.

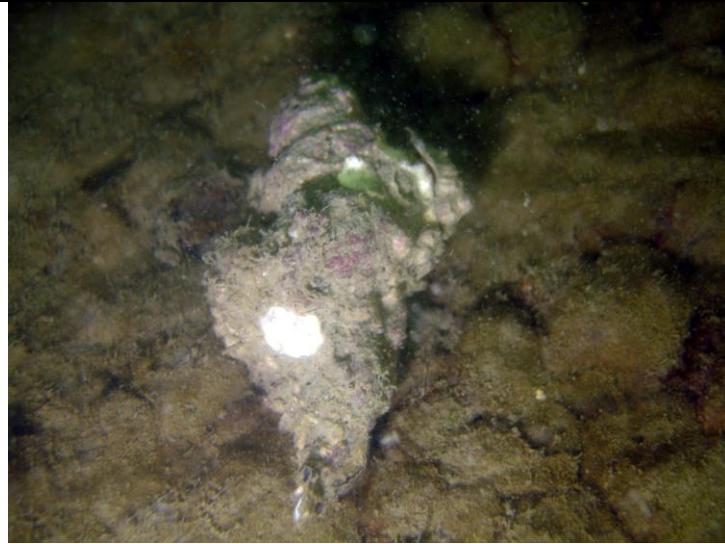


Plate 28. gastropod at Station 3.

Photo: October 2015.



Plate 29. Sponge at Station 3.

Photo: October 2015.



Plate 30. Mussels and oysters at Station 3.

Photo: October 2015.

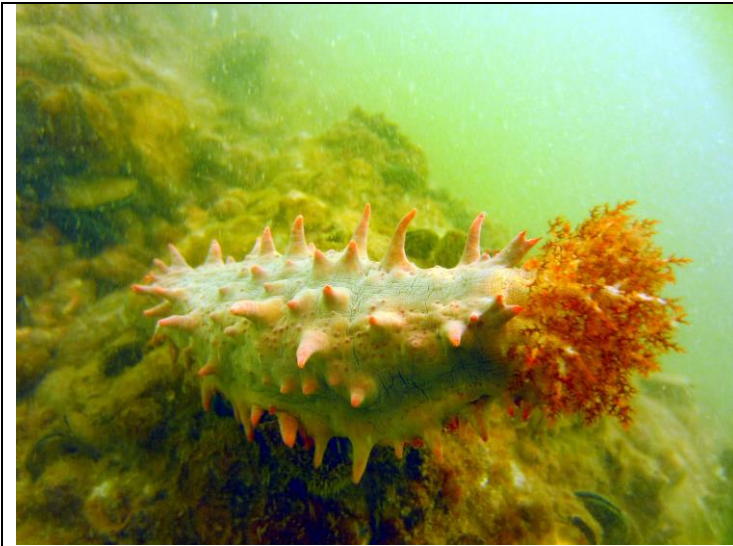


Plate 31. Sea cucumber at Station 3.

Photo: October 2015.



Plate 32. Sea cucumber at Station 3.

Photo: October 2015.

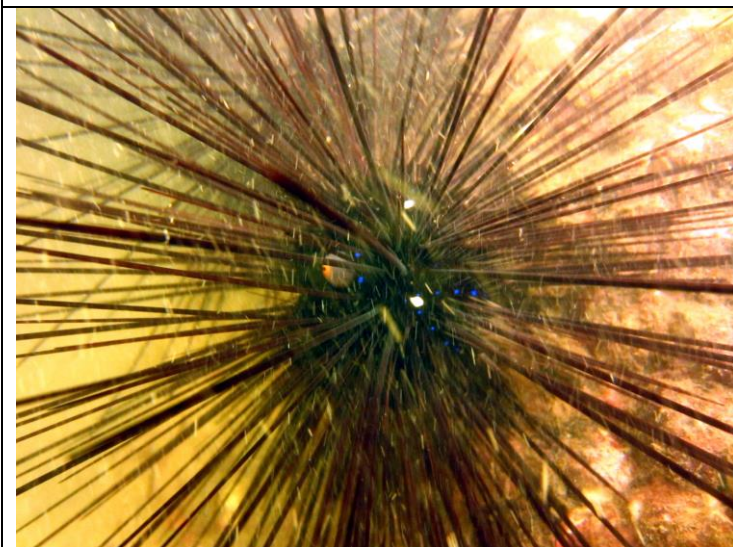


Plate 33. Sea urchin at Station 3.

Photo: October 2015.



Plate 34. Sea urchin at Station 3.

Photo: October 2015.



Plate 35. Tube worm at Station 3.

Photo: October 2015.



Plate 36. Benthic fish at Station 3.

Photo: October 2015.