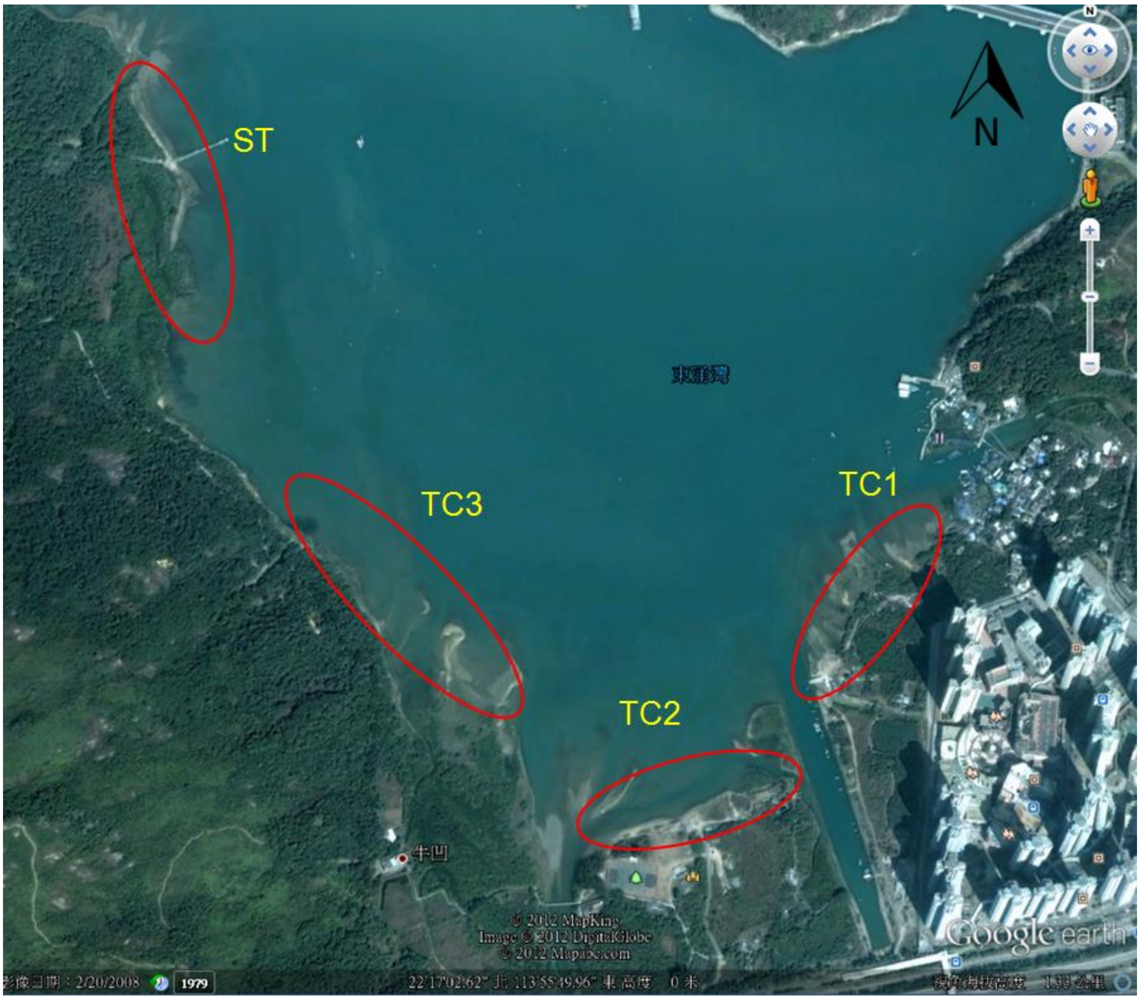


Figure 2.1. *Locations of sampling zones. The study site was divided into three sampling zones (TC1, TC2, TC3) in Tung Chung Bay and one zone in San Tau (ST) (map generated from Google Map).*

TC1

TC2

TC3

ST

Figure 2.2 *Photographic record of the environment in every sampling zone. (March 2022)*

TC1

Plastic waste

Trash gill net

TC3

Boat wreckage

Trash gill net

ST

Trash gill net and hand trolley

A tangled horseshoe crab on a trash net (record in June 2017)

Figure 2.3 *Examples of photographic record of the big trashes found on the mudflat.*

3. RESULTS & DISCUSSION

3.1 Horseshoe crabs

In total of 10 individuals of juveniles *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* were found in present survey. The recorded individuals were mainly distributed along the shoreline in ST and TC3. No adult specimen was recorded. All of them were observed on similar substratum (fine sand or soft mud, slightly submerged). Photo records of the observed horseshoe crab are shown in **Figure 3.1** and the present survey result regarding horseshoe crab are presented in **Table 3.1**. The complete survey records are presented in **Appendix II**.

For *Carcinoscorpius rotundicauda,* more individuals (5 ind.) were found in ST with average body size 53.89mm (prosomal width ranged 51.22-56.66mm). In TC3, 2 individuals with average body size 53.42mm (prosomal width ranged 52.21-54.63mm) were found in present survey. The search record in ST (0.83 ind. hr-1. Person-1) and TC3 (0.33 ind. hr-1. Person-1) were very low. No *Carcinoscorpius rotundicauda* was recorded in TC1 and TC2 in present survey.

For *Tachypleus tridentatus,* 2 individuals with average body size 77.59 mm (prosomal width ranged 76.32-78.86 mm) were found in ST in present survey. The search records in ST (0.33 ind. hr-1. Person-1) was very low. No *Tachypleus tridentatus* was found in TC1, TC2 and TC3 in present survey.

No mating pair or large individual (≥100mm) was found in present survey.

In the survey of March 2015, there was one important finding that a mating pair of *Carcinoscorpius rotundicauda* was found in ST (prosomal width: male 155.1mm, female 138.2mm). It indicated the importance of ST as a breeding ground of horseshoe crab. In June 2017, mating pairs of *Carcinoscorpius rotundicauda* were found in TC2 (male 175.27 mm, female 143.51 mm) and TC3 (male 182.08 mm, female 145.63 mm) **(Figure 3.2)**. In December 2017 and June 2018, one mating pair was of *Carcinoscorpius rotundicauda* was found in TC3 (December 2017: male 127.80 mm, female 144.61 mm; June 2018: male 139 mm, female 149 mm). In June 2019, two mating pairs of *Tachypleus tridentatus* with large body sizes (male 150mm and Female 200mm; Male 180mm and Female 220mm) were found in TC3. Another mating pair of *Tachypleus tridentatus* was found in ST (male 140mm and Female 180mm). In March 2020, a pair of *Tachypleus tridentatus* with large body sizes (male 123mm and Female 137mm was recorded in TC1. **Figure 3.2** shows the photographic records of the mating pair found. The recorded mating pairs were found nearly burrowing in soft mud at low tidal level (0.5-1.0 m above C.D.). The smaller male was holding the opisthosoma (abdomen carapace) of larger female from behind. A mating pair was found in TC1 in March 2020, it indicated that breeding of horseshoe crab could be possible along the coast of Tung Chung Wan rather than ST only, as long as suitable substratum was available. Based on the frequency of encounter, the shoreline between TC3 and ST should be more suitable mating ground. Moreover suitable breeding period was believed in wet season (March – September) because tiny individuals (i.e. newly hatched) were usually recorded in June and September every year **(Figure 3.3)**. No mating pair was found in Mar 2022 (present survey).

No large individuals (prosomal width >100mm) of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* was recorded in Mar 2022 (present survey). In December 2018, one large individual of *Carcinoscorpius rotundicauda* was found in TC3 (prosomal width 148.9 mm). In March 2019, 3 large individuals (prosomal width ranged 220 – 310mm) of *Carcinoscorpius rotundicauda* were observed in TC2. In June 2019, there were 3 and 7 large individuals of *Tachypleus tridentatus* recorded in ST (prosomal width ranged 140 – 180mm) and TC3 (prosomal width ranged 150 – 220mm), respectively. In March 2020, a mating pair of *Tachypleus tridentatus* was recorded in TC1 with prosomal width 123 mm and 137mm. Base on their sizes, it indicated that individuals of prosomal width larger than 100 mm would progress its nursery stage from intertidal habitat to sub-tidal habitat of Tung Chung Wan. The photo records of the large horseshoe crab are shown in **Figure 3.4.** These large individuals might move onto intertidal shore occasionally during high tide for foraging and breeding. Because they should be inhabiting sub-tidal habitat most of the time. Their records were excluded from the data analysis to avoid mixing up with juvenile population living on intertidal habitat.

No marked individual of horseshoe crab was recorded in Mar 2022 (present survey). Some marked individuals were found in the previous surveys of September 2013, March 2014 and September 2014. All of them were released through a conservation programme in charged by Prof. Paul Shin (Department of Biology and Chemistry, The City University of Hong Kong (CityU)). It was a re-introduction trial of artificial bred horseshoe crab juvenile at selected sites. So that the horseshoe crabs population might be restored in the natural habitat. Through a personal conversation with Prof. Shin, about 100 individuals were released in the sampling zone ST on 20 June 2013. All of them were marked with color tape and internal chip detected by specific chip sensor. There should be second round of release between June and September 2014 since new marked individuals were found in the survey of September 2014.

The artificial bred individuals, if found, would be excluded from the results of present monitoring programme in order to reflect the changes of natural population. However, the mark on their prosoma might have been detached during moulting after a certain period of release. The artificially released individuals were no longer distinguishable from the natural population without the specific chip sensor. The survey data collected would possibly cover both natural population and artificially bred individuals.

Population difference among the sampling zones

Figure 3.5 and **3.6** show the changes of number of individuals, mean prosomal width and search record of horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* in respectively in each sampling zone throughout the monitoring period.

To consider the entire monitoring period for TC3 and ST, medium to high search records (i.e. number of individuals) of both species (*Carcinoscorpius rotundicauda* and *Tachypleus tridentatus*) were usually found in wet season (June and September). The search record of ST was higher from September 2012 to June 2014 while it was replaced by TC3 from September 2014 to June 2015. The search records were similar between two sampling zones from September 2015 to June 2016. In September 2016, the search record of *Carcinoscorpius rotundicauda* in ST was much higher than TC3. From March to June 2017, the search records of both species were similar again between two sampling zones. It showed a natural variation of horseshoe crab population in these two zones due to weather condition and tidal effect. No obvious difference of horseshoe crab population was noted between TC3 and ST. In September 2017, the search records of both horseshoe crab species decreased except the *Carcinoscorpius rotundicauda* in TC3. The survey results were different from previous findings that there were usually higher search records in September. One possible reason was that the serial cyclone hit decreased horseshoe crab activity (totally 4 cyclone records between June and September 2017, to be discussed in 'Seagrass survey' section). From December 2017 to September 2018, the search records of both species increased again to low-moderate level in ST and TC3. From December 2018 to September 2019, the search records of *Carcinoscorpius rotundicauda* change from very low to low while the change of *Tachypleus tridentatus* was similar during this period. Relatively higher population fluctuation of *Carcinoscorpius rotundicauda* was observed in TC3. From March 2020 to September 2020, the search records of both species, *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* were increased to moderate level in ST. However, the search records of both species, *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* were decreased from very low to none in TC3 in this period. From March 2021 to September 2021, the search records of both species, *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* were kept at low-moderate level in both ST and TC3. It is similar to the previous findings of June. It shows another growing phenomenon of horseshoe crabs and it may due to the weather variation of starting of wet season. The survey results were different from previous findings that there were usually higher search records in September. One possible reason was that September of 2021 was one of the hottest month in Hong Kong in record. As such, hot and shiny weather decreased horseshoe crab activity. In December 2021, no juvenile was recorded similar to the some previous in December due to the season. In March 2022, only juvenils recorded in both ST and TC3, no adult specimen was observed.

For TC1, the search record was at low to moderate level throughout the monitoring period. The change of *Carcinoscorpius rotundicauda* was relatively more variable than that of *Tachypleus tridentatus*. Relatively, the search record was very low in TC2. There were occasional records of 1 to 4 individuals between March and September throughout the monitoring period. The maximum record was 6 individuals only in June 2016.

About the body size, larger individuals of *Carcinoscorpius rotundicauda* were usually found in ST and TC1 relative to that in TC3 from September 2012 to June 2017. But the body size was higher in TC3 and ST followed by TC1 from September 2017 to March 2020. From June 2020 to December 2020, there was no individuals of *Carcinoscorpius rotundicauda* recorded in TC3 but in ST. The body size of *Carcinoscorpius rotundicauda* in ST was recorded gradually increased (from mean prosomal width 23.6mm to 49.6mm) since March 2020 to September 2020. From December 2020 to March 2021, the body size of *Carcinoscorpius rotundicauda* in ST was recorded decreased (from mean prosomal width 49.6mm to 43.3mm). In March 2021, the body size of *Carcinoscorpius rotundicauda* in TC3 (mean prosomal width 46.2mm) was recorded larger than that in ST (mean prosomal width 43.3mm). From September 2021 to March 2022, the body size of *Carcinoscorpius rotundicauda* in ST was recorded increased (from mean prosomal width 39.8mm to 53.89mm).
For *Tachypleus tridentatus*, larger individuals were usually found in ST and TC3 followed by TC1 throughout the monitoring period. In June 2019, all found horseshoe crabs were large individuals and mating pairs. It is believed that the sizes of the horseshoe crabs would be decrease and gradually rise afterward due to the stable growth of juveniles after the spawning season. From March 2019 to September 2021,

Tachypleus tridentatus were only recorded in TC3 and ST. The body size in TC3 was increased from September 2019 to December 2019 then decreased in March 2020 and no recorded species in TC3 for three consecutive quarters from June 2020 to December 2020. From March 2020 to Sep 2021, the body size of *Tachypleus tridentatus* in TC3 increased (from mean prosomal width 34.00mm to 38.8mm). It showed a natural variation of horseshoe crab population in TC3. Apart from natural mortality, migration from nursery soft shore to subtidal habitat was another possible cause. The body size in ST was gradually growth since December 2019 to September 2020 then slightly dropped in December 2020. In March 2022 (present survery), *Tachypleus tridentatus* were only recorded in ST, the body size in ST increased from mean prosomal width 40.9 mm in September 2021 to 77.59mm.

In general, it was obvious that the shoreline along TC3 and ST (western shore of Tung Chung Wan) was an important nursery ground for horseshoe crab especially newly hatched individuals due to larger area of suitable substratum (fine sand or soft mud) and less human disturbance (far from urban district). Relatively, other sampling zones were not a suitable nursery ground especially TC2. Possible factors were less area of suitable substratum (especially TC1) and higher human disturbance (TC1 and TC2: close to urban district and easily accessible). In TC2, large daily salinity fluctuation was a possible factor either since it was flushed by two rivers under tidal inundation. The individuals inhabiting TC1 and TC2 were confined in small foraging area due to limited area of suitable substratum. Although there were mating pairs seldomly found in TC1 and TC2, the hatching rate and survival rate of newly hatched individuals were believed very low.

<u>Seasonal variation of horseshoe crab population</u>

Throughout the monitoring period, the search records of horseshoe crabs were fluctuated and at moderate – very low level in June (**Figure 3.5 and 3.6**). Low – Very low search record was found in June 2013, totally 82 individuals of *Tachypleus tridentatus* and 0 ind. of *Carcinoscorpius rotundicauda* were found in TC1, TC3 and ST. Compare with the search record of June 2013, the numbers of *Tachypleus tridentatus* were gradually decreased in June 2014 and 2015 (55 ind. in 2014 and 18 ind. in 2015); the number of *Carcinoscorpius rotundicauda* raise to 88 and 66 ind. in June 2014 and 2015 respectively. In June 2016, the search record increased about 3 times compare with June 2015. In total, 182 individuals of *Carcinoscorpius rotundicauda* and 47 individuals of *Tachypleus tridentatus* were noted, respectively. Then, the search record was similar to June 2016. The number of recorded *Carcinoscorpius rotundicauda* (133 ind.) slightly dropped in June 2017. However, that of *Tachypleus tridentatus* rapidly increased (125 ind.). In June 2018, the search record was low to moderate while the numbers of *Tachypleus tridentatus* dropped sharply (39 ind.). In June 2019, 10 individuals of *Tachypleus tridentatus* were observed in TC3 and ST. All of them, however, were large individuals (prosomal width >100mm), their records are excluded from the data analysis to avoid mixing up with the juvenile population living on intertidal habitat. Until September 2020, the number of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* gradually increased to 39 ind. and 28 ind., respectively. In December 2020, the number of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* greatly decreased to 3 ind. and 7 ind., respectively. In March 2022, the number of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* gradually decreased to 7 ind. and 2 ind., respectively in comparing with the March of previous record. The drop of abundance may be related to the unusual cold weather in the beginning of March 2022. Throughout the monitoring period, similar distribution of horseshoe crab population were found.

The search record of horseshoe crab declined obviously in all sampling zones during dry season especially December (**Figure 3.5 and 3.6**) throughout the monitoring period. Very low – low search record was found in December from 2012 to 2015 (0-4 ind. of *Carcinoscorpius rotundicauda* and 0 – 12 ind. of *Tachypleus tridentatus*). The horseshoe crabs were inactive and burrowed in the sediments during cold weather (<15 ºC). Similar results of low search record in dry season were reported in a previous territory-wide survey of horseshoe crab. For example, the search records in Tung Chung Wan were 0.17 ind. hr^{-1} $person^{-1}$ and 0.00 ind. hr^{-1} $person^{-1}$ in wet season and dry season respectively (details see Li, 2008). Compare with the search record of December from 2012 to 2015, which of December 2016 were much higher relatively. There were totally 70 individuals of *Carcinoscorpius rotundicauda* and 24 individuals of *Tachypleus tridentatus* in TC3 and ST. Since the survey was carried in earlier December with warm and sunny weather (~22 ºC during dawn according to Hong Kong Observatory database, Chek Lap Kok station on 5 December 2016), the horseshoe crab was more active (i.e. move onto intertidal shore during high tide for foraging and breeding) and easier to be found. In contrast, there was no search record in TC1 and TC2 because the survey was conducted in mid December with colder and cloudy weather (~20°C during dawn on 19 December). The horseshoe crab activity would decrease gradually with the colder climate. In December of 2017, 2018 and 2019, very low search records were found again as mentioned above.

From September 2012 to December 2013, *Carcinoscorpius rotundicauda* was less common species relative to *Tachypleus tridentatus*. Only 4 individuals were ever recorded in ST in December 2012. This species had ever been believed of very low density in ST hence the encounter rate was very low. In March 2014, it was found in all sampling zones with higher abundance in ST. Based on its average size (mean prosomal width 39.28 – 49.81 mm), it indicated that breeding and spawning of this species had occurred about 3 years ago along the coastline of Tung Chun Wan. However, these individuals were still small while their walking trails were inconspicuous. Hence there was no search record in previous sampling months. Since March 2014, more individuals were recorded due to larger size and higher activity (i.e. more conspicuous walking trail).

For *Tachypleus tridentatus,* sharp increase of number of individuals was recorded in ST during the wet season of 2013 (from March to September). According to a personal conversation with Prof. Shin (CityU), his monitoring team had recorded similar increase of horseshoe crab population during wet season. It was believed that the suitable ambient temperature increased its conspicuousness. However similar pattern was not recorded in the following wet seasons. The number of individuals increased in March and June 2014 and followed by a rapid decline in September 2014. Then the number of individuals fluctuated slightly in TC3 and ST until March 2017. Apart from natural mortality, migration from nursery soft shore to subtidal habitat was another possible cause. Since the mean prosomal width of *Tachypleus tridentatus* continued to grow and reached about 50 mm since March 2014. Then it varied slightly between 35-65 mm from September 2014 to March 2017.Most of the individuals might have reached a suitable size (e.g. prosomal width 50 – 60 mm) strong enough to forage in sub-tidal habitat. In June 2017, the number of individuals increased sharply again in TC3 and ST. Although mating pair of *Tachypleus tridentatus* was not found in previous surveys, there should be new round of spawning in the wet season of 2016. The individuals might have grown to a more conspicuous size in 2017 accounting for higher search record. In September 2017, moderate numbers of individual were found in TC3 and ST indicating a stable population size. From September 2018 to March 2020, the population size was low while natural mortality was the possible cause. From June 2020 to September 2020, the population size of *Tachypleus tridentatus* increased to moderate level in ST while the mean proposal width of them conitued to grow and reach about 55mm. The population size of *Tachypleus tridentatus* slightly decreased in ST from March 2021 to March 2022 and the mean proposal width of them increased to about 77.59mm.

Recently, *Carcinoscorpius rotundicauda* was a more common horseshoe crab species in Tung Chung Wan. It was recorded in the four sampling zones while the majority of population located in TC3 and ST. Due to potential breeding last year, the number of *Tachypleus tridentatus* increased in ST. Since TC3 and ST were regarded as important nursery ground for both horseshoe crab species, box plots of prosomal width of two horseshoe crab species were constructed to investigate the changes of population in details.

<u>Box plot of horseshoe crab population in TC3</u>

Figure 3.7 shows the changes of prosomal width of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* in TC3. As mentioned above, *Carcinoscorpius rotundicauda* was rarely found between September 2012 and December 2013 hence the data were lacking. In March 2014, the major size (50% of individual records between upper (top box) and lower quartile (bottom box)) ranged 40 – 60 mm while only few individuals were found. From March 2014 to September 2018, the median prosomal width (middle line of whole box) and major size (whole box) decreased after March of every year. It was due to more small individuals found in June indicating new rounds of spawning. Also there were slight increasing trends of body size from June to March of next year since 2015. It indicated a stable growth of individuals. Focused on larger juveniles (upper whisker), the size range was quite variable (prosomal width 60 – 90 mm) along the sampling months. Juveniles reaching this size might gradually migrate to sub-tidal habitats. In March 2022, 2 *Carcinoscorpius rotundicauda* with body size (prosomal width 52.21-54.63mm) were found in TC3. The findings were relatively lower than the previous record in March. This can due to the natural variation caused by multi-environmental factors.

For *Tachypleus tridentatus,* the major size ranged 20-50 mm while the number of individuals fluctuated from September 2012 to June 2014. Then a slight but consistent growing trend was observed from September 2014 to June 2015. The prosomal width increased from 25 – 35 mm to 35 – 65 mm. As mentioned, the large individuals might have reached a suitable size for migrating from the nursery soft shore to subtidal habitat. It accounted for the declined population in TC3. From March to September 2016, slight increasing trend of major size was noticed again. From December 2016 to June 2017, similar increasing trend of major size was noted with much higher number of individuals. It reflected new round of spawning. In September 2017, the major size decreased while the trend was different from previous two years. Such decline might be the cause of serial cyclone hit between June and September 2017 (to be discussed in the 'Seagrass survey' section). From December 2017 to September 2018, increasing trend was noted again. It indicated a stable growth of individuals. From September 2018 to that of next year, the average prosomal widths were decreased from 60mm to

36mm. It indicated new rounds of spawning occurred during September to November 2018. In December 2019, an individual with larger body size (prosomal width 65mm) was found in TC3 which reflected the stable growth of individuals. In March 2020, the average prosomal width (middle line of the whole box) of *Tachypleus tridentatus* in TC3 was 33.97mm which is smaller than that in December 2019. It was in normal fluctuation. From June 2020 to December 2020, no horseshoe crab was recorded in TC3. In Sep 2021, only one *Tachypleus tridentatus* with body size (prosomal width 38.78mm) was found in TC3. The decrease in the species population was considered to be related to hot weather in September, which may affect their activity. Across the whole monitoring period, the larger juveniles (upper whisker) usually reached 60 – 80 mm in prosomal width, even 90 mm occasionally. The juveniles reaching this size might gradually migrate to sub-tidal habitats.

<u>Box plot of horseshoe crab population in ST</u>

Figure 3.8 shows the changes of prosomal width of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* in ST. As mentioned above, *Carcinoscorpius rotundicauda* was rarely found between September 2012 and December 2013 hence the data were lacking. From March 2014 to September 2018, the size of major population decreased and more small individuals (i.e. lower whisker) were recorded after June of every year. It indicated new round of spawning. Also there were similar increasing trends of body size from September to June of next year between 2014 and 2017. It indicated a stable growth of individuals. The larger juveniles (i.e. upper whisker usually ranged 60 – 80 mm in prosomal width except one individual (prosomal width 107.04 mm) found in March 2017. It reflected juveniles reaching this size would gradually migrate to sub-tidal habitats.

For *Tachypleus tridentatus,* a consistent growing trend was observed for the major population from December 2012 to December 2014 regardless of change of search record. The prosomal width increased from 15 – 30 mm to 60 – 70 mm. As mentioned, the large juveniles might have reached a suitable size for migrating from the nursery soft shore to subtidal habitat. From March to September 2015, the size of major population decreased slightly to a prosomal width 40 – 60 mm. At the same time, the number of individuals decreased gradually. It further indicated some of large juveniles might have migrated to sub-tidal habitat, leaving the smaller individuals on shore. There was an overall growth trend. In December 2015, two big individuals (prosomal width 89.27 mm and 98.89 mm) were recorded only while it could not represent the major population. In March 2016, the number of individual was very few in ST that no box plot could be produced. In June 2016, the prosomal width of major population ranged 50 – 70 mm. But it dropped clearly to 30 – 40 mm in September 2016 followed by an increase to 40 – 50 mm in December 2016, 40 – 70 mm in March 2017 and 50 – 60mm in June 2017. Based on overall higher number of small individuals from June 2016 to September 2017, it indicated another round of spawning. From September 2017 to June 2018, the major size range increased slightly from 40 – 50 mm to 45 – 60 mm indicating a continuous growth. In September 2018, decrease of major size was noted again that might reflect new round of spawning. Throughout the monitoring period, the larger juveniles ranged 60-80 mm in prosomal width. Juveniles reaching this size would gradually migrate to sub-tidal habitats.

As a summary for horseshoe crab populations in TC3 and ST, there were spawning ground of *Carcinoscorpius rotundicauda* from 2014 to 2018 while the spawning time should be in spring. The population size was consistent in these two sampling zones. For *Tachypleus tridentatus*, small individuals were rarely found in both zones from 2014 to 2015. It was believed no occurrence of successful spawning. The existing individuals (that recorded since 2012) grew to a mature size and migrated to sub-tidal habitat. Hence the number of individuals decreased gradually. From 2016 to 2018, new rounds of spawning were recorded in ST while the population size increased to a moderate level.

In March 2019 to June 2019 and Dec 2021, no horseshoe crab juveniles (prosomal width <100mm) were recorded in TC3 and ST. All recorded horseshoe crabs were large individuals (prosomal width >100mm) or mating pairs which were all excluded from the data analysis. From September 2019 to September 2020, the population size of both horseshoe crab species in ST gradually increased to moderate level while their body sizes were mostly in small to medium range (~23 – 55mm). It indicated the natural stable growth of the horseshoe crab juveniles. In December 2020, the population size of both horseshoe crab species in ST dropped to low level while their body sizes were mostly in small to medium range (~28 – 56mm). It showed the natural mortality and seasonal variation of horseshoe crab. In March 2022, the population size of both horseshoe crab species in ST was kept as low-moderate level while their body sizes were mostly in small to medium range (~51–78mm).

Impact of the HKLR project

It was the 38th survey of the EM&A programme during construction period. Based on the monitoring results, no detectable impact on horseshoe crab was revealed due to HKLR project. The population change was mainly determined by seasonal variation, no abnormal phenomenon of horseshoe crab individual, such as large number of dead individuals on the shore had been reported.

ST *Carcinoscorpius rotundicauda*

ST *Tachypleus tridentatus*

Figure 3.1 *Examples of photographic records of horseshoe crab (Mar 2022)*

Table 3.1. *Summary of juvenile horseshoe crab survey in every sampling zone*

	TC1	TC2	TC3	ST
Search duration (hr)	2	2	3	3
Carcinoscorpius rotundicauda				
No. of individuals	0	0	2	5
Mean prosomal width (mm)	\	\	53.42	53.89
Max..prosomal width (mm)	\	\	54.63	56.66
Min. prosomal width (mm)	\	\	52.21	51.22
Search record (ind. hr-1 person-1)	0.00	0.00	0.33	0.83
Tachypleus tridentatus				
No. of individuals	0	0	0	2
Mean prosomal width (mm)	\	\	\	77.59
Max..prosomal width (mm)	\	\	\	78.86
Min. prosomal width (mm)	\	\	\	76.32
Search record (ind. hr-1 person-1)	0.00	0.00	0	0.33

Remark: No adult horseshoe crab was recorded in the present survey.

March 2015 - ST

June 2017 – TC2

(Female) (Male)

June 2017 – TC3

Figure 3.2 Photographic records of mating pairs of horseshoe crab

December 2017 – TC3

June 2018 – TC3

(Female) (Male)

Figure 3.2(Cont’d) *Photographic records of mating pair of* horseshoe crab

March 2019 – TC2

June 2019 – TC3

March 2020 – TC1

Figure 3.2 (Cont'd). *Photographic records of mating pair of horseshoe crab*

TC1

TC2

Figure 3.3 *Photographic records of newly hatched individuals of horseshoe crab (September 2018)*

Carcinoscorpius rotundicauda

June 2017

December 2017

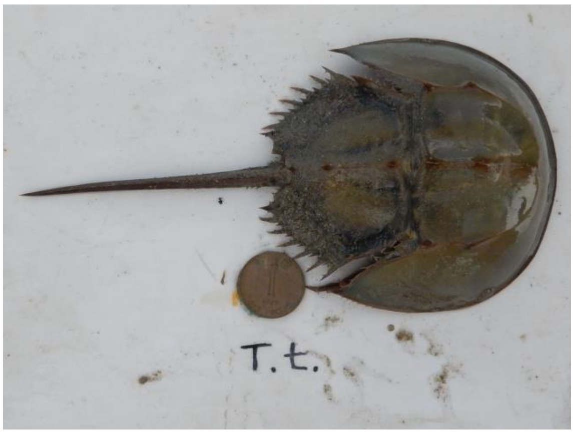
December 2018

March 2019

Figure 3.4 *Photographic records of large individuals (>100 mm) of horseshoe crabs records were excluded from data analysis*

Tachypleus tridentatus

September 2017



June 2019

March 2020

Figure 3.4 (Cont'd) *Photographic records of large individuals (>100 mm) of horseshoe crabs records were excluded from data analysis*

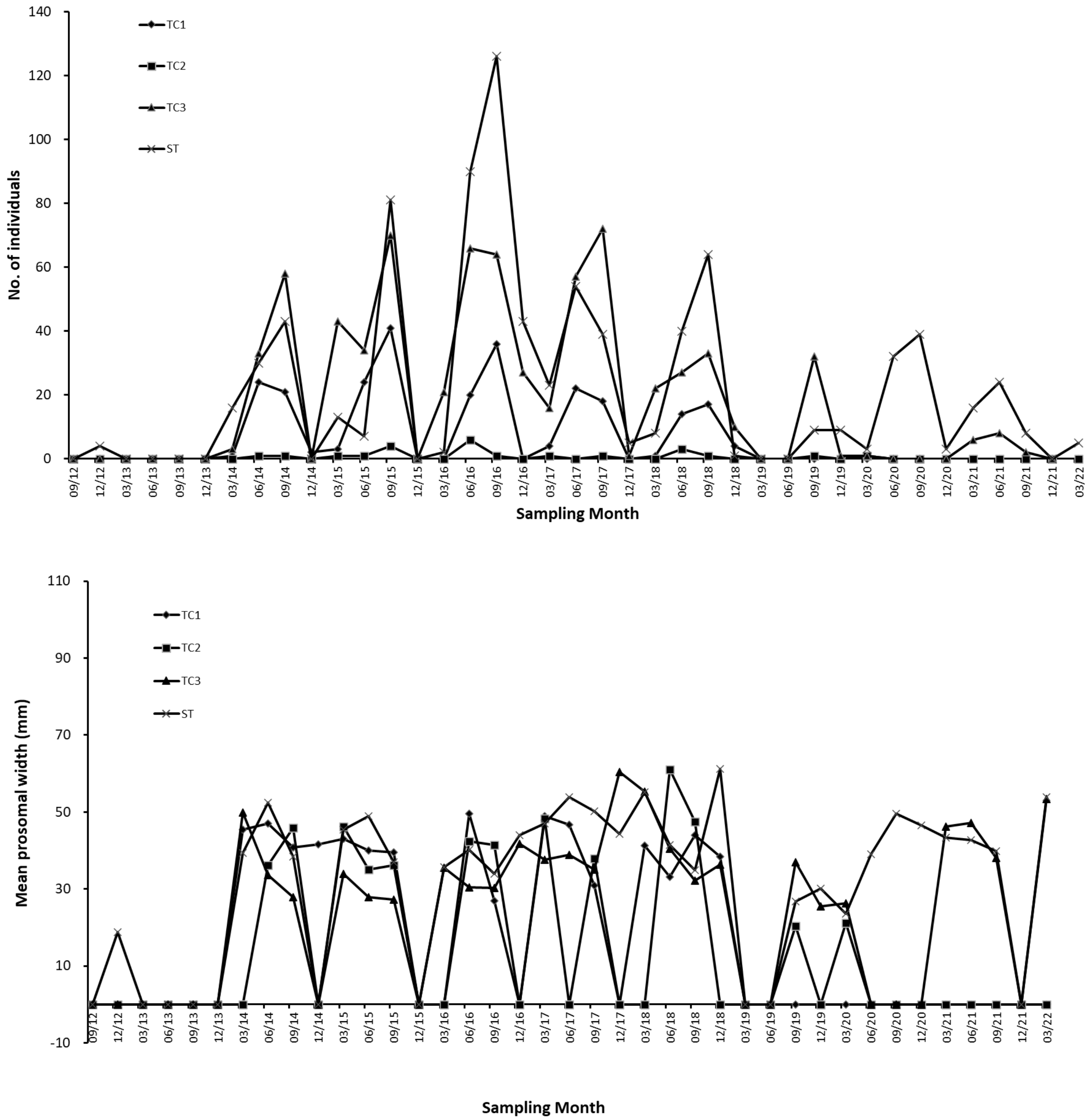


Figure 3.5 *Changes of number of individuals mean prosomal width and search record of horseshoe crab Carcinoscorpius rotundicauda in every sampling zone along the sampling months*

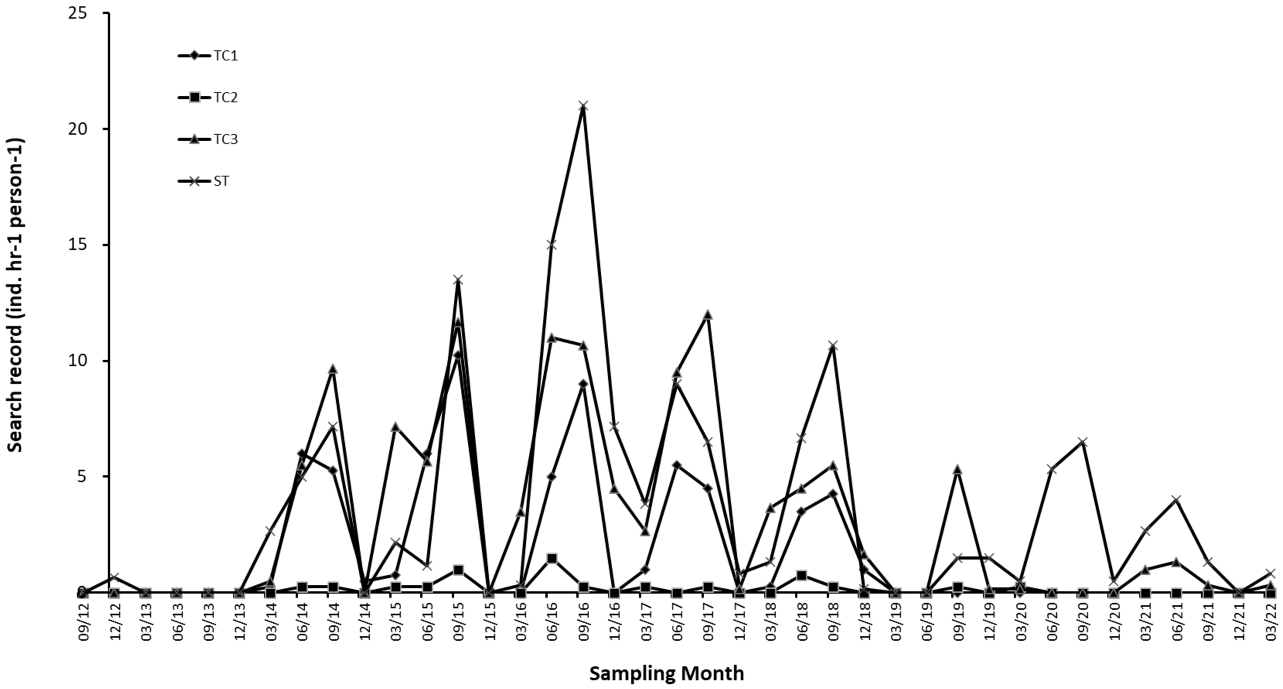
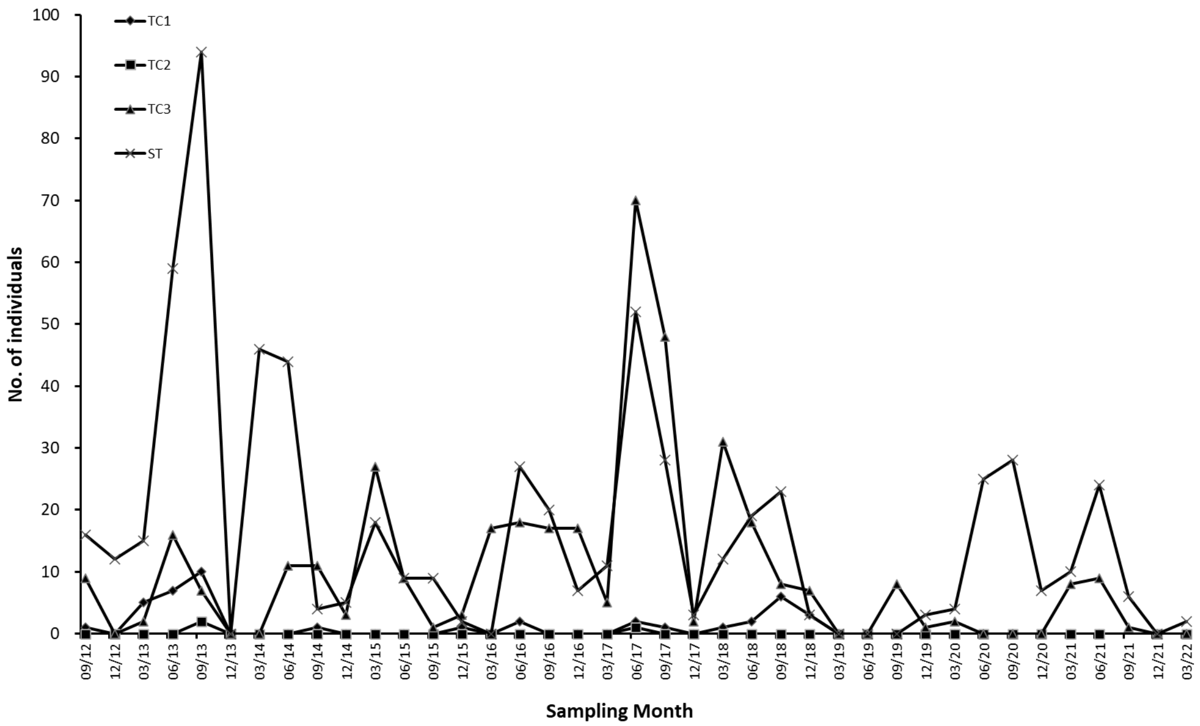


Figure 3.5 (Cont'd) *Changes of number of individuals mean prosomal width and search record of horseshoe crab Carcinoscorpius rotundicauda in every sampling zone along the sampling months*



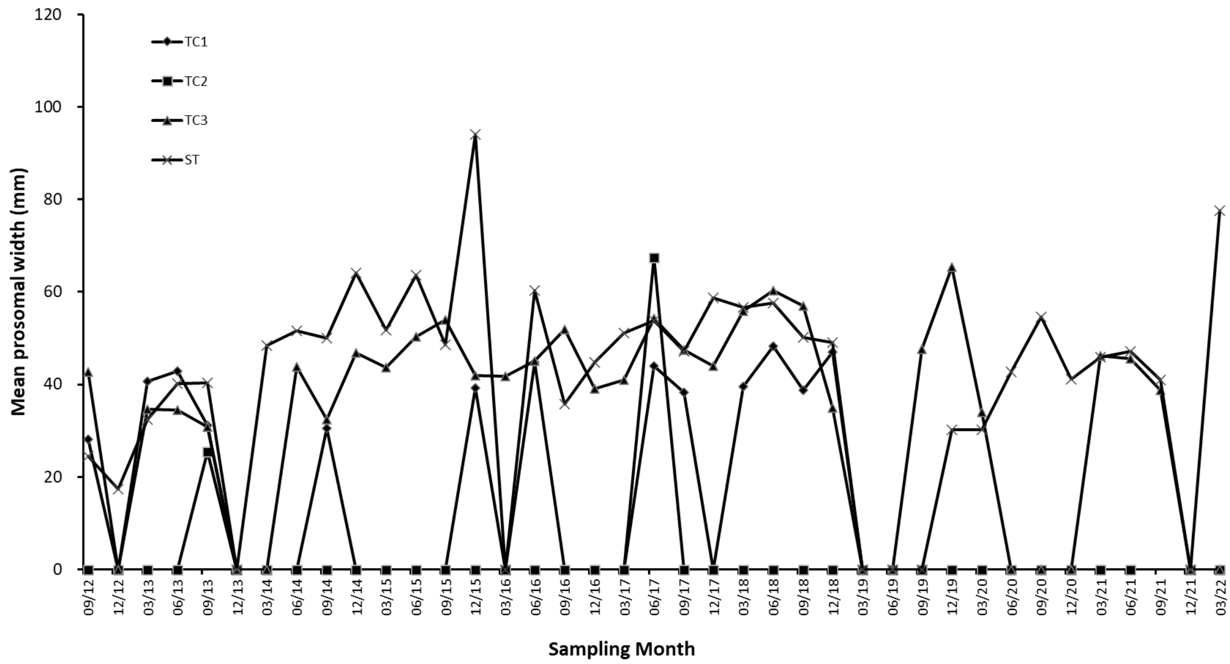


Figure 3.6 *Changes of number of individuals mean prosomal width and search record of horseshoe crab Tachypleus tridentatus in every sampling zone along the sampling months*

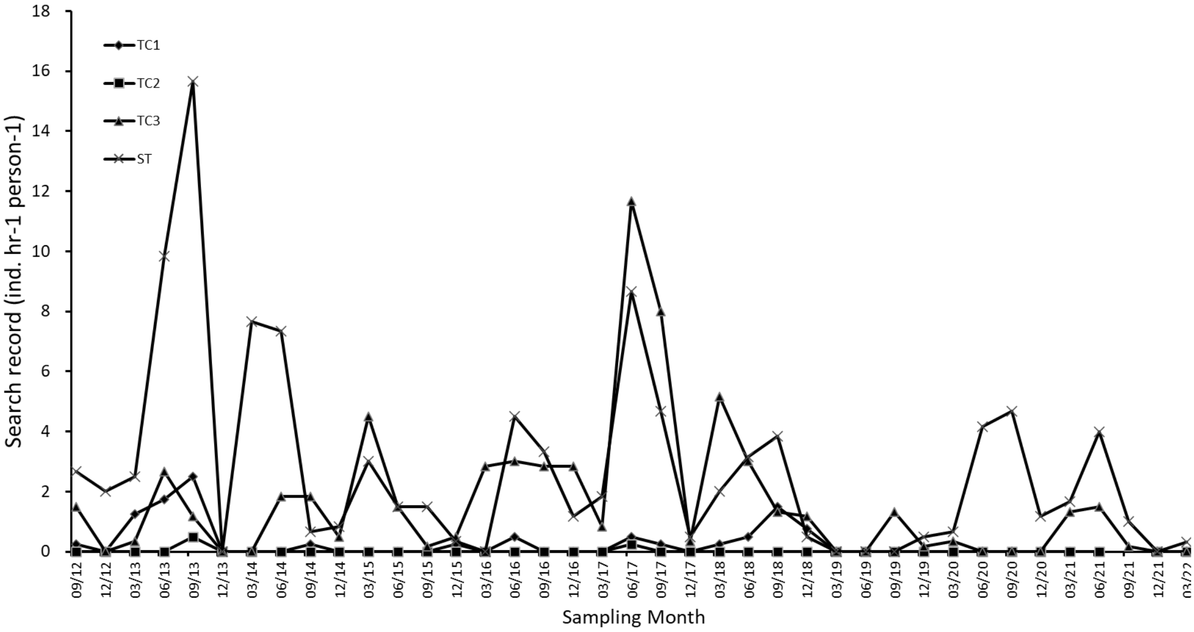


Figure 3.6 (Cont'd) *Changes of number of individuals mean prosomal width and search record of horseshoe crab Tachypleus tridentatus in every sampling zone along the sampling months*

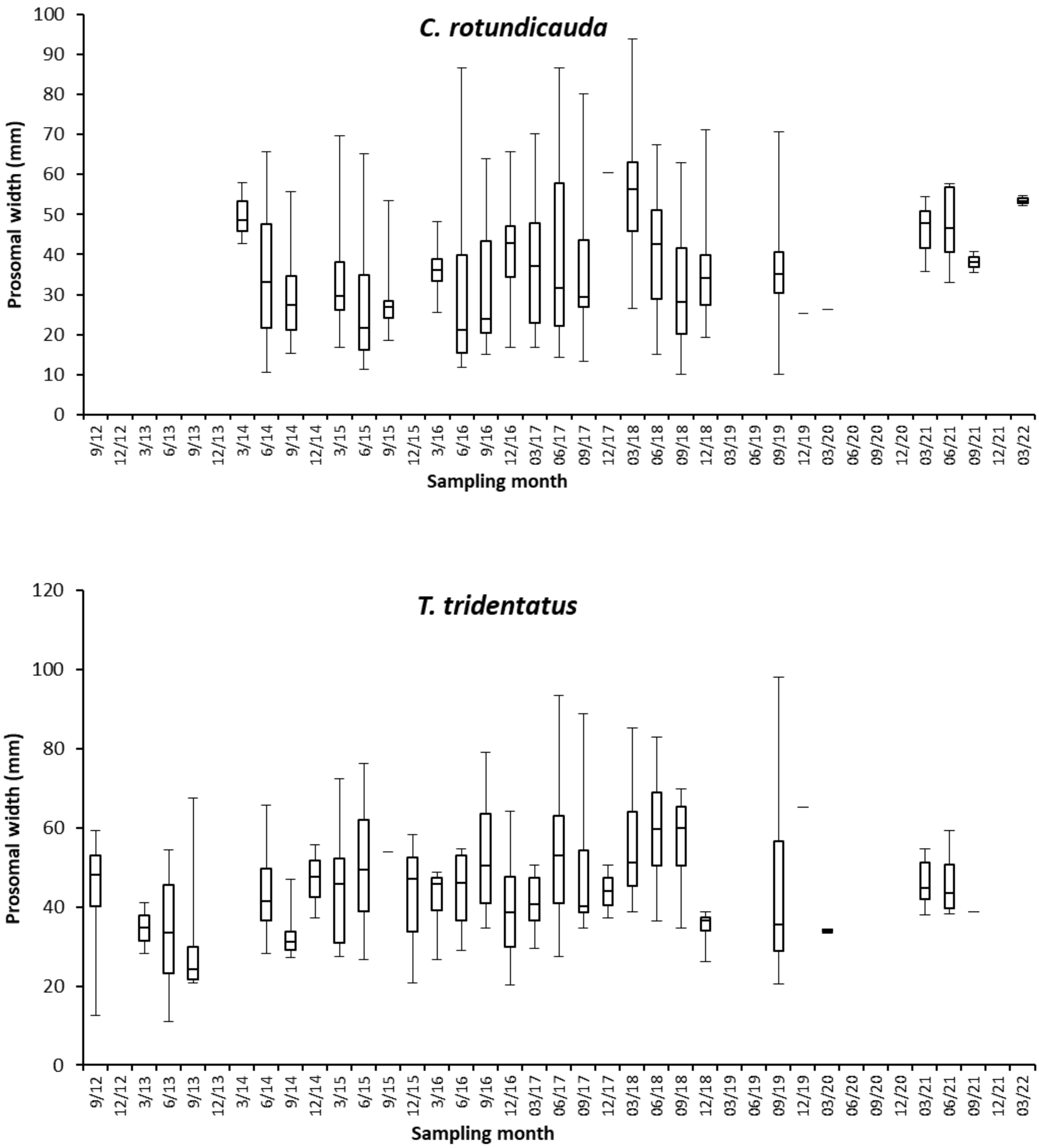


Figure 3.7 *Box plot of prosomal width of horseshoe crab in the sampling zone TC3 along the sampling months. (The box represents 50% of the sample (upper to lower quartile) with a middle line showing the median value. The upper whisker and lower whisker showed the 25% of sample above upper quartile and below the lower quartile respectively)*

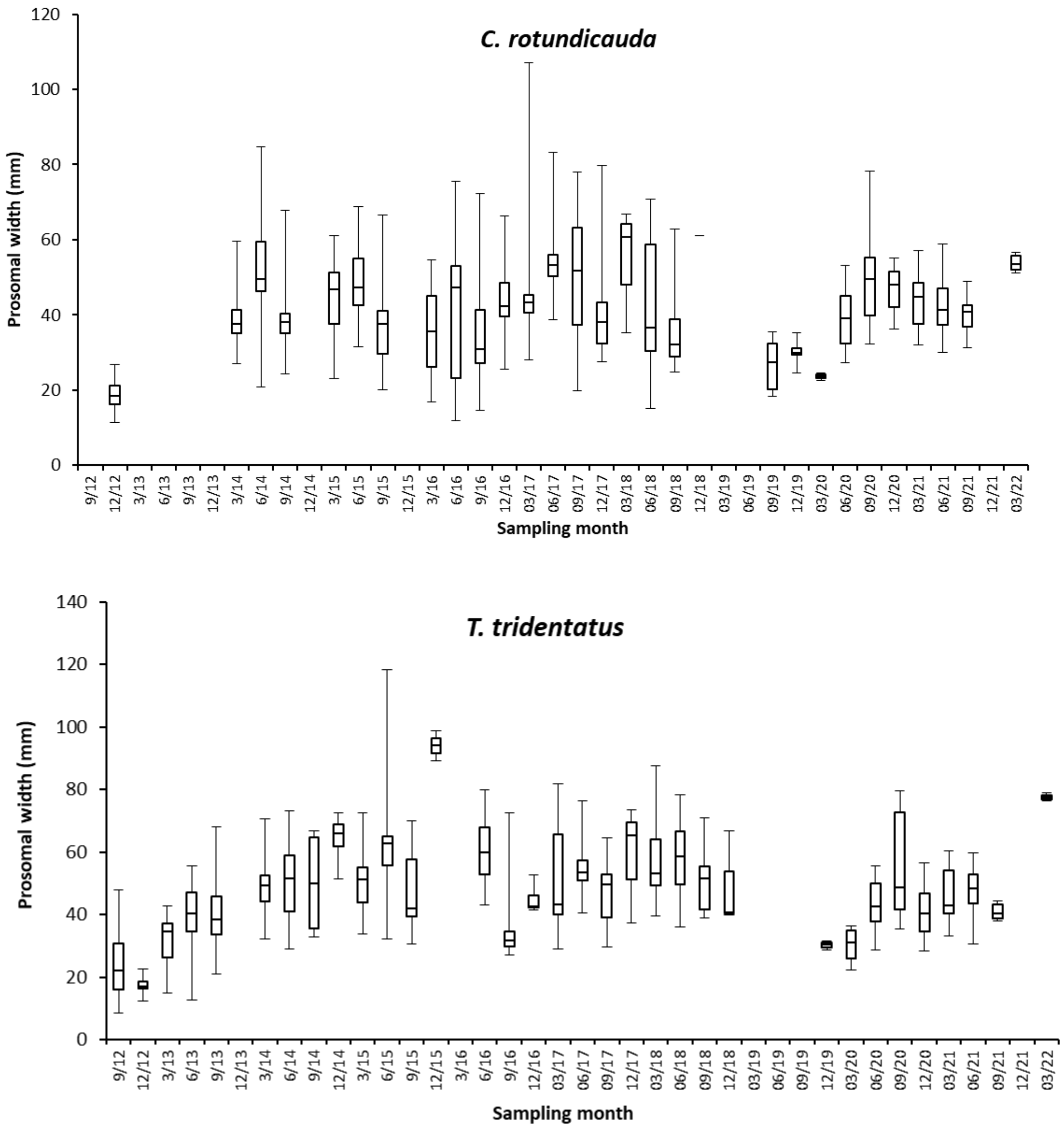


Figure 3.8 *Box plot of prosomal width of horseshoe crabin the sampling zone ST along the sampling months. (The box represents 50% of the sample (upper to lower quartile) with a middle line showing the median value. The upper whisker and lower whisker showed the 25% of sample above upper quartile and below the lower quartile respectively.)*

3.2 Seagrass beds

Two seagrass species *Halophila ovalis* and *Zostera japonica* were found in present survey. *Halophila ovalis* was found in TC3 and ST and *Zostera japonica* was found in ST. In ST, there were three small sized and three large sized of *Halophila ovalis* found at tidal zone 1.5m above C.D nearby mangroves plantation. The larger strand had area ~680m^2 in moderate to high vegetation coverage (40 – 70%), ~480m^2 in moderate to high vegetation coverage (40 – 70%) and ~840m^2 in moderate to high vegetation coverage (40 – 80%) At close vicinity, three small sized (~2m^2 -30m^2) of *Halophila ovalis* beds were observed at tidal zone 1.5m above C.D. All the small sized of *Halophila ovalis* beds were in moderate vegetation coverage ranging from 40-70%. In TC3, 1 large patch and 2 small patches of *Halophila ovalis* were found at tidal zone 1.5m above C.D. The larger strand had area ~460m^2 in moderate to high vegetation coverage (40 – 70%), while two small patches with area size in ~20m^2 and 80m^2 had moderate coverage (40 to 70%). Another seagrass species *Zostera japonica* was found at tidal zone 2.0m above C.D nearby mangroves plantation with ~10m^2 in low to moderate vegetation coverage (30 - 60%) in ST. **Table 3.2** summarizes the results of present seagrass beds survey and the photograph records of the seagrass are shown on **Figure 3.9**. The complete record throughout the monitoring period is presented in **Appendix III**.

Since the commencement of the EM&A monitoring programme, two species of seagrass *Halophila ovalis* and *Zostera japonica* were recorded in TC3 and ST (**Figure 3.10**). In general *Halophila ovalis* was occasionally found in TC3 in few, small to medium patches. But it was commonly found in ST in medium to large seagrass bed. Moreover it had sometimes grown extensively and had covered significant mudflat area at 0.5 – 2.0 m above C.D. between TC3 and ST. Another seagrass species *Zostera japonica* was found in ST only. It was relatively lower in vegetation area and co-existed with *Halophila ovalis* nearby the mangrove strand at 2.0 m above C.D.

According to the previous results, majority of seagrass bed was confined in ST, the temporal change of both seagrass species were investigated in details:

<u>Temporal variation of seagrass beds in ST</u>

Figure 3.11 shows the changes of estimated total area of seagrass beds in ST along the sampling months. For *Zostera japonica*, it was not recorded in the 1st and 2nd surveys of monitoring programme. Seasonal recruitment of few, small patches (total seagrass area: 10 m^2) was found in March 2013 that grew within the large patch of seagrass *Halophila ovalis*. Then, the patch size increased and merged gradually with

the warmer climate from March to June 2013 (15 m^2). However the patch size decreased and remained similar from September 2013 (4 m^2) to March 2014 (3 m^2). In June 2014, the patch size increased obviously again (41 m^2) with warmer climate followed by a decrease between September 2014 (2 m^2) and December 2014 (5 m^2). From March to June 2015, the patch size increased sharply again (90 m^2). It might be due to the disappearance of the originally dominant seagrass *Halophila ovalis* resulting in less competition for substratum and nutrients. From September 2015 to June 2016, it was found coexisting with seagrass *Halophila ovalis* with steady increasing patch size (from 44 m^2 to 115 m^2) and variable coverage. In September 2016, the patch size decreased again to (38 m^2) followed by an increase to a horizontal strand (105.4 m^2) in June 2017. And it did no longer co-exist with *Halophila ovalis*. Between September 2014 and June 2017, an increasing trend was noticed from September to June of next year followed by a rapid decline in September of next year. It was possibly the causes of heat stress, typhoon and stronger grazing pressure during wet season. However, such increasing trend was not found from September 2017 to March 2021, while no patch of *Zostera japonica* was found. From June 2021, the species was recorded again in area of 45m^2. The recorded area of the seagrass bed in present survey was slightly decreased to 15m^2.

For *Halophila ovalis*, it was recorded as 3 – 4 medium to large patches (area 18.9-251.7 m^2; vegetation coverage 50 – 80%) beside the mangrove vegetation at tidal level 2 m above C.D. in September 2012. The total seagrass bed area grew steadily from 332.3 m^2 in September 2012 to 727.4 m^2 in December 2013. Flowers were observed in the largest patch during its flowering period. In March 2014, 31 small to medium patches were newly recorded (variable area 1 – 72 m^2 per patch, vegetation coverage 40-80% per patch) in lower tidal zone between 1.0 and 1.5 m above C.D. The total seagrass area increased further to 1350 m^2. In June 2014, these small and medium patches grew and extended to each other. These patches were no longer distinguishable and were covering a significant mudflat area of ST. It was generally grouped into 4 large patches (1116 – 2443 m^2) of seagrass beds characterized of patchy distribution, variable vegetable coverage (40-80%) and smaller leaves. The total seagrass bed area increased sharply to 7629 m^2. In September 2014, the total seagrass area declined sharply to 1111m^2. There were only 3-4 small to large patches (6 – 253 m^2) at high tidal level and 1 large patch at low tidal level (786 m^2). Typhoon or strong water current was a possible cause (Fong, 1998). In September 2014, there were two tropical cyclone records in Hong Kong (7th – 8thSeptember: no cyclone name, maximum signal number 1; 14th – 17th September: Kalmaegi, maximum signal number 8SE) before the seagrass survey dated 21st September 2014. The strong water current caused by the cyclone, Kalmaegi especially, might have given damage to the seagrass beds. In addition, natural heat stress and grazing force were other possible causes reducing seagrass beds area. Besides, very small patches of *Halophila ovalis* could be found in other mud flat area in addition to the recorded patches. But it was hardly distinguished due to very low coverage (10 – 20%) and small leaves.

In December 2014, all the seagrass patches of *Halophila ovalis* disappeared in ST. **Figure 3.12** shows the difference of the original seagrass beds area nearby the mangrove vegetation at high tidal level between June 2014 and December 2014. Such rapid loss would not be seasonal phenomenon because the seagrass beds at higher tidal level (2.0 m above C.D.) were present and normal in December 2012 and 2013. According to Fong (1998), similar incident had occurred in ST in the past. The original seagrass area had declined significantly during the commencement of the construction and reclamation works for the international airport at Chek Lap Kok in 1992. The seagrass almost disappeared in 1995 and recovered gradually after the completion of reclamation works. Moreover, incident of rapid loss of seagrass area was also recorded in another intertidal mudflat in Lai Chi Wo in 1998 with unknown reason. Hence, *Halophila ovalis* was regarded as a short- lived and *r*- strategy seagrass that could colonize areas in short period but disappears quickly under unfavourable conditions (Fong, 1998).

<u>Unfavorable conditions to seagrass *Halophila ovalis*</u>

Typhoon or strong water current was suggested as one unfavorable condition to *Halophila ovalis* (Fong, 1998). As mentioned above, there were two tropical cyclone records in Hong Kong in September 2014. The strong water current caused by the cyclones might have given damage to the seagrass beds.

Prolonged light deprivation due to turbid water would be another unfavorable condition. Previous studies reported that *Halophila ovalis* had little tolerance to light deprivation. During experimental darkness, seagrass biomass declined rapidly after 3-6 days and seagrass died completely after 30 days. The rapid death might be due to shortage of available carbohydrate under limited photosynthesis or accumulation of phytotoxic end products of anaerobic respiration (details see Longstaff *et al*., 1999). Hence the seagrass bed of this species was susceptible to temporary light deprivation events such as flooding river runoff (Longstaff and Dennison, 1999).

In order to investigate any deterioration of water quality (e.g. more turbid) in ST, the water quality measurement results at two closest monitoring stations SR3 and IS5 of the EM&A programme were obtained from the water quality monitoring team. Based on the results from June to December 2014, the overall water quality was in normal fluctuation except there was one exceedance of suspended solids (SS) at both stations in September. On 10th September 2014, the SS concentrations measured during mid-ebb tide at stations SR3 (27.5 mg/L) and IS5 (34.5 mg/L) exceeded the Action Level (≤ 23.5 mg/L and 120% of upstream control station's reading) and Limit Level (≤ 34.4 mg/L and 130% of upstream control station's reading) respectively. The turbidity readings at SR3 and IS5 reached 24.8 – 25.3 NTU and 22.3 – 22.5 NTU, respectively.The temporary turbid water should not be caused by the runoff from upstream rivers. Because there was no rain or slight rain from 1st to 10th September 2014 (daily total rainfall at the Hong Kong International Airport: 0 – 2.1 mm; extracted from the climatological data of Hong Kong Observatory). The effect of upstream runoff on water quality should be neglectable in that period. Moreover the exceedance of water quality was considered unlikely to be related to the contract works of HKLR according to the 'Notifications of Environmental Quality Limits Exceedances' provided by the respective environmental team. The respective construction of seawall and stone column works, which possibly caused turbid water, was carried out within silt curtain as recommended in the EIA report. Moreover there was no leakage of turbid water, abnormity or malpractice recorded during water sampling. In general, the exceedance of suspended solids concentration was considered to be attributed to other external factors, rather than the contract works.

Based on the weather condition and water quality results in ST, the co-occurrence of cyclone hit and turbid waters in September 2014 might have combined the adverse effects on *Halophila ovalis* that leaded to disappearance of this short-lived and *r*-strategy seagrass species. Fortunately *Halophila ovalis* was a fast-growing species (Vermaat *et al*., 1995). Previous studies showed that the seagrass bed could be recovered to the original sizes in 2 months through vegetative propagation after experimental clearance (Supanwanid, 1996). Moreover it was reported to recover rapidly in less than 20 days after dugong herbivory (Nakaoka and Aioi, 1999). As mentioned, the disappeared seagrass in ST in 1995 could recover gradually after the completion of reclamation works for international airport (Fong, 1998). The seagrass beds of *Halophila ovalis* might recolonize in the mudflat of ST through seed reproduction as long as there was no unfavourable condition in the coming months.

Recolonization of seagrass beds

Figure 3.12 shows the recolonization of seagrass bed in ST from December 2014 to June 2017. From March to June 2015, 2 – 3 small patches of *Halophila ovalis* were newly found co-inhabiting with another seagrass species *Zostera japonica*. But the total patch area of *Halophila ovalis* was still very low compare with previous records. The recolonization rate was low while cold weather and insufficient sunlight were possible factors between December 2014 and March 2015. Moreover, it would need to compete with seagrass Zostera japonica for substratum and nutrient, because Zostera japonica had extended and covered the original seagrass bed of *Halophila ovalis* at certain degree. From June 2015 to March 2016, the total seagrass area of *Halophila ovalis* had increased rapidly from 6.8 m^2 to 230.63 m^2. It had recolonized its original patch locations and covered its competitor *Zostera japonica*. In June 2016, the total seagrass area increased sharply to 4707.3m^2. Similar to the previous records of March to June 2014, the original patch area of *Halophila ovalis* increased further to a horizontally long strand. Another large seagrass beds colonized the lower tidal zone (1.0 – 1.5 m above C.D.). In September 2016, this patch extended much and covered significant soft mud area of ST, resulting in sharp increase of total area (24245 m^2). It indicated the second extensive colonization of this *r*-selected seagrass. In December 2016, this extensive seagrass patch decreased in size and had separated into few, undistinguishable patches. Moreover, the horizontal strand nearby the mangrove vegetation decreased in size. The total seagrass bed decreased to 12550 m^2. From March to June 2017, the seagrass bed area remained generally stable (12438-17046.5 m^2) but the vegetation coverage fluctuated (20 – 50% in March 2017 to 80 – 100% in June 2017). The whole recolonization process took about 2.5 years.

<u>Second disappearance of seagrass bed</u>

In September 2017, the whole seagrass bed of *Halophila ovalis* disappeared again along the shore of TC3 and ST (**Figure 3.12**). Similar to the first disappearance of seagrass bed occured between September and December 2014, strong water current (e.g. cyclone) or deteriorated water qualities (e.g. high turbidity) was the possible cause.

Between the survey periods of June and September 2017, there were four tropical cyclone records in Hong Kong (Merbok in 12- 13^{th}, June; Roke in 23^{rd}, Jul.; Hato in22 – 23^{rd}, Aug.; Pakhar in 26 – 27^{th}, Aug.) (Online database of Hong Kong Observatory) All of them reached signal 8 or above, especially Hato with highest signal 10.

According to the water quality monitoring results (July to August 2017) of the two closest monitoring stations SR3 and IS5 of the respective EM&A programme, the overall water quality was in normal fluctuation. There was an exceedance of suspended solids (SS) at SR3 on 12 July 2017. The SS concentration reached 24.7 mg/L during mid-ebb tide, which exceeded the Action Level (≤ 23.5 mg/L). But it was far below the Limit Level (≤ 34.4 mg/L). Since such exceedance was slight and temporary, its effect to seagrass bed should be minimal.

Overall, the disappearance of seagrass beds in ST has believed the cause of serial cyclone hit in July and August 2017. Based on previous findings, the seagrass beds of both species were expected to recolonize in the mudflat as long as the vicinal water quality was normal. The whole recolonization process (from few, small patches to extensive strand) would be gradually lasting at least 2 years. From December 2017 to March 2018, there was still no recolonization of few, small patches of seagrass at the usual location (**Figure 3.12**). It was different from the previous round (March 2015 – June 2017). Until June 2018, the new seagrass patches with small-medium size were found at the usual location (seaward side of mangrove plantation at 2.0 m C.D.) again, indicating the recolonization. However, the seagrass bed area decreased sharply to 22.5 m^2 in September 2018. Again it was believed that the decrease was due to the hit of the super cyclone in September 2018 (Mangkhuton 16th September, highest signal 10). From December 2018 to June 2019, the seagrass bed area increased from 404 m^2 to 1229 m^2 while the vegetation coverage is also increased (December 2018: 5–85%; March 2019: 50 – 100% and June 2019: 60 – 100%). Relatively, the whole recolonization process would occur slower than the previous round (more than 2 years). From September 2019 to March 2021, the seagrass bed area in ST slightly decreased from 1200 m^2 to 942.05 m^2, which were in normal fluctuation. From March 2021 to December 2021, the seagrass bed area in ST decreased from 942.05 m^2 to 680m^2, which were in normal fluctuation. In March 2022, the seagrass bed area in ST increased significantly to approximately 2040 $m^{2,}$ which believed to be related to more rain in current dry season. It was observed that the brown filemental algae bloom occurred at ST site in March 2022. Distribution of the algae was overlap with seagrass beds, mainly the species *Halophila ovalis* and the algae was grown over the top of the seagrass. In some areas, the brown filemental algae full covered the seagrass bed, refer to Figure 3.9. The seagrass was still alive when checked during the field survey. Whether the algae bloom will kill seagrass in longer period time is unknown. The seagrass distritrution and health condition should be checked in coming June monitoring.

Impact of HKLR project

It was the 38th survey of the EM&A programme during construction period. Throughout the monitoring period, the disappearance of seagrass beds was believed the cause of cyclone hits rather than impact of HKLR project. The seagrass bed was recolonizing since there had been a gradual increase in the size and number from December 2018 to June 2019 after the hit of the super cyclone in September 2018. The seagrass bed area decreased from March 2021 to December 2021, which were in normal fluctuation.

Brown filemental algae bloom at ST


***Halophila ovalis* in TC3**




***Halophila ovalis* and *Zostera japonica* in ST**

Figure 3.9 (Cont'd) *Photographic record of seagrass beds in present survey.*

TC3

Single patch of *Halophila ovalis*

TC3 - ST

Extensive patch of *Halophila ovalis*

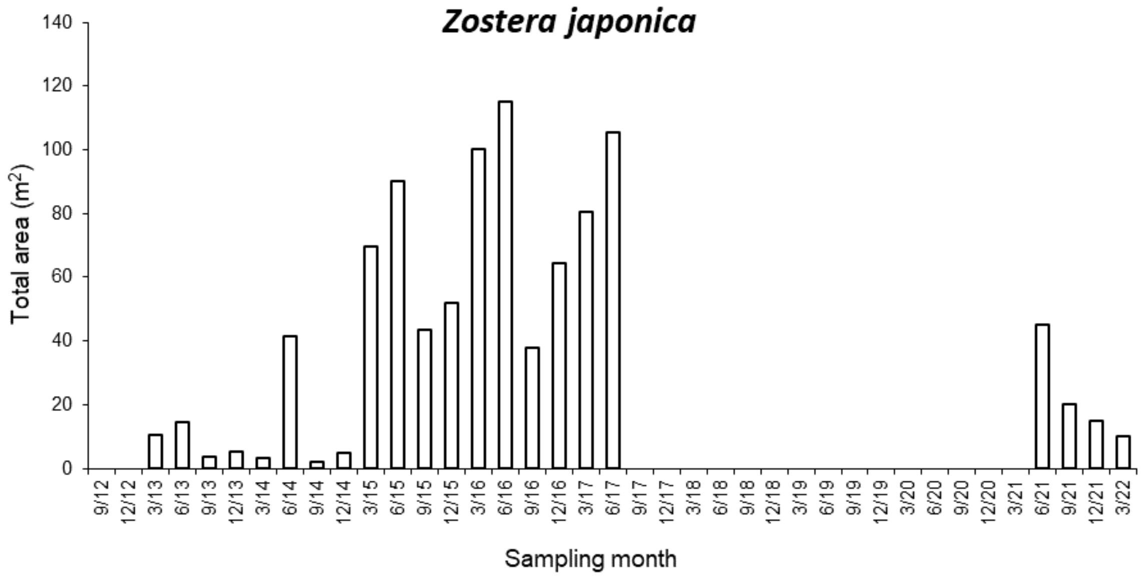
ST

Medium, horizontal patch of *Zostera japonica*

Figure 3.10 *Examples of photographic records of seagrass beds (record in June 2017)*

Table 3.2. Summary *of seagrassbeds survey*

Sampling zone	TC3 *Halophila ovalis*	ST *Halophila ovalis*	ST *Zostera japonica*
Number of patches	3	6	1
Total area (m^2)	560	2050	10
Average area (m^2)	186.67	341.67	10



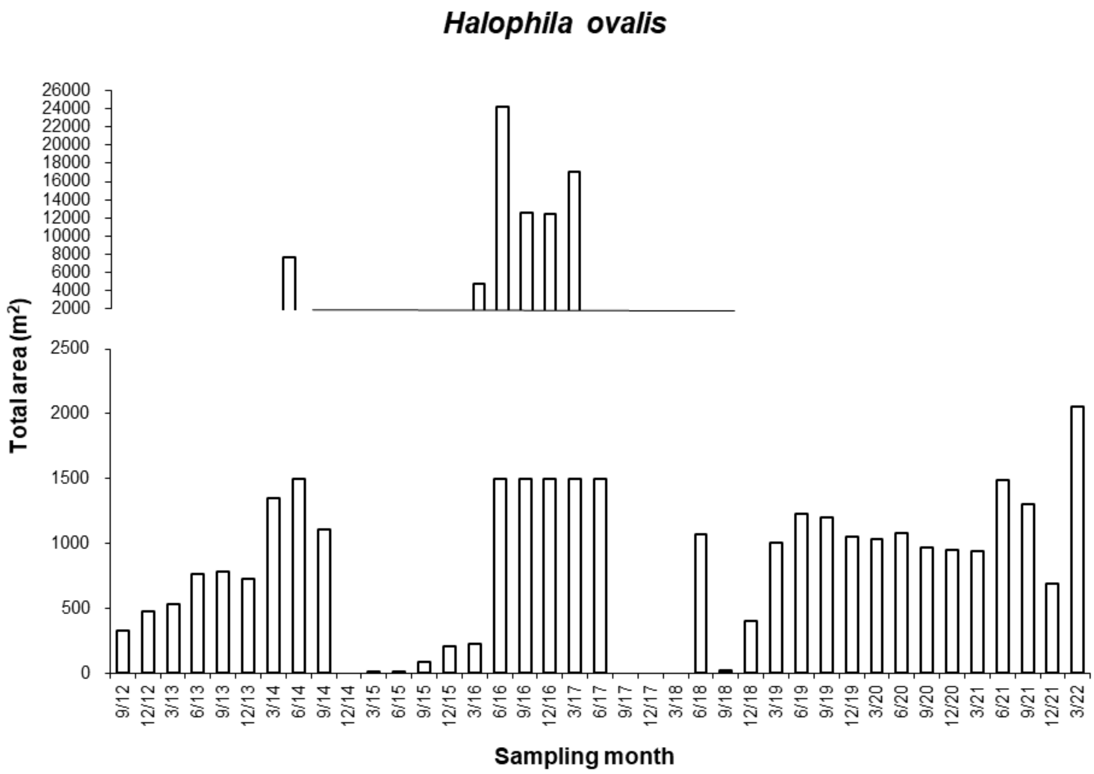


Figure 3.11 *Temporal changes of estimated total area of seagrass beds in ST*

June 2014

December 2014 (no seagrass)

September 2015

June 2017

September 2017-March 2018 (no seagrass)

September 2018

Figure 3.12 *Comparison of pictures taken in different sampling months shows the successive disappearance and recolonization of seagrass beds*. *The picture of December 2018 was lacking due to night-dawn survey time.*

March 2019

June 2019

September 2019

December 2019

March 2020

June 2020

September 2020

December 2020

March 2021

June 2021

September 2021

December 2021

March 2022

Figure 3.12 (Cont'd) *Comparison of pictures taken in different sampling months shows the successive disappearance and recolonization of seagrass beds. The picture of December 2018 was lacking due to night-dawn survey time.*

3.3 Intertidal soft shore communities

3.3.1 Substratum

Table 3.3 and **Figure 3.13** show the substratum types along the horizontal transect at every tidal level in all sampling zones. The relative distribution of substratum types was estimated by categorizing the substratum types (Gravels & Boulders / Sands / Soft mud) of the ten random quadrats along the horizontal transect. The distribution of substratum types varied among tidal levels and sampling zones:

- In TC1, high percentages of 'Gravels and Boulders' (H: 80%; M: 70%) were recorded at high and mid tidal levels. At low tidal level, 'Sands' was the main substratum type (70%), followed by 'Soft mud' (20%) and 'Gravels and Boulders' (10%).

- In TC2, high percentages of 'Gravels and Boulders' (90%) was recorded at high tidal level. At mid tidal level, 'Sands' was the main substratum type (60%), following by 'Soft mud' (35%). At low tidal level, 'Soft mud' covered 90% and 'Sands' covered 10% of the transect.

- In TC3, higher percentage of 'Gravels and Boulders' was recorded at high tidal level (85%). At mid tidal levels, 'Sands' was the main substratum type (60%), following by 'Soft mud' (20%) and 'Gravels and Boulders' (20%). At low tidal level, 'Soft mud' covered 95% and 'Sands' covered 5% of the transect.

- In ST, 'Gravels and Boulders' was the main substratum type (70%) at high tidal level. At mid tidal levels, 'Soft mud' was the main substratum type (50%), following by 'Sand' (30%) and 'Gravels and Boulders' (20%). At low tidal level, 'Soft mud' was the main substratum type (80%) and 'Sands' covered 20% of the transect.

There was neither consistent vertical nor horizontal zonation pattern of substratum type in all sampling zones. Such heterogeneous variation should be caused by different hydrology (e.g. wave in different direction and intensity) received by the four sampling zones.

3.3.2 Soft shore communities

Table 3.4 lists the total abundance, density and number of taxon of every phylum in this survey. A total of 9804 individuals were recorded. Mollusca was the most abundant phylum (total abundance 8938 ind., density 298 ind. m^{-2}, relative abundance 91.2%).

The second and third were Arthropoda (585 ind., 19 ind. m^{-2}, 5.9%) which followed by Annelida (138 ind., 5 ind. m^{-2}, 1.4%) and Sipuncula (81 ind., 3 ind. m^{-2}, 0.8%), respectively. The fiveth was Nemertea with total abundance 42 ind., density 1 ind.m^{-2} and relative abundance 0.4%. The sixth was Cnidania with total abundance 22 ind., density 1 ind.m^{-2} and relative abundance 0.2%.Platyhelminthes was very low in abundances (density <0 ind. m^{-2}, relative abundance $\leq$0.0%). Moreover, the most diverse phylum was Mollusca (32 taxa) followed by Arthropoda (6 taxa). Annelida (3 taxa) and Sipuncula (2 taxa). There was 1 taxon for Cnidaria and Platyhelminthes.

The taxonomic resolution and complete list of recorded fauna are shown in Appendix IV and V respectively. As reported in June 2018, taxonomic revision of three potamidid snail species was conducted according to the latest identification key published by Agriculture, Fisheries and Conservation Department (details see AFCD, 2018), the species names of following gastropod species were revised:

- *Cerithidea cingulata* was revised as *Pirenella asiatica*
- *Cerithidea djadjariensis* was revised as *Pirenella incisa*
- *Cerithidea rhizophorarum* was revised as *Cerithidea moerchii*

Moreover, taxonomic revision was conducted on another snail species while the specie name was revised:

- *Batillaria bornii* was revised as *Clypeomorus bifasciata*

In March 2021, an increased number of sea slugs and their eggs were observed in all sampling zones. It may due to the breeding season of sea slug and the increased of algae on the intertidal.

Table 3.5 shows the number of individuals, relative abundance and density of each phylum in every sampling zone. The total abundance (2095-2673 ind.) varied among the four sampling zones while the phyla distributions were similar. In general, Mollusca was the most dominant phylum (no. of individuals: 1,971 – 2,417 ind.; relative abundance 86.8 – 94.1%; density 263 - 322 ind. m^{-2}). Other phyla were much lower in number of individuals. Arthropoda (79 - 313 ind.; 3.3 – 11.7%; 11 - 42 ind. m^{-2}) was common phyla relatively. Other phyla were very low in abundance in all sampling zones.

<u>Dominant species in every sampling zone</u>

Table 3.6 lists the abundant species in every sampling zone. In the present survey, most of the listed abundant species were of high or very high density (>100 ind. m^{-2}), which were regarded as dominant species. Few of the listed species were of low to moderate densities (42 – 95 ind. m^{-2}). Other listed species of lower density (<42 ind.

m^{-2}) were regarded as common species.

In TC1, the substratum was mainly 'Gravels and Boulders' at high and mid tidal levels. At high tidal level, the rock oyster *Saccostrea cucullata (*mean density 109 ind. m^{-2}; relative abundance 34%) was the dominant species found at high density and the gastropod *Monodonta labio* (74 ind. m^{-2}; relative abundance 23%) was of low to moderate density. At mid tidal level, the rock oyster *Saccostrea cucullata* (118 ind. m^{-2}, 42%) and the gastropod *Monodonta labio* (57 ind. m^{-2}, 21%) were of dominant species with high and moderate density. At low tidal level (main substratum types 'Sands' and 'Soft mud'), the rock oyster *Saccostrea cucullata* (102 ind. m^{-2}, 42%) was dominant at high density and the gastropod *Monodonta labio* (50 ind. m^{-2}, 21%) was of moderate density.

In TC2, the substratum types were mainly ' Gravels and Boulders' at high tidal level. The rock oyster *Saccostrea cucullata* (120 ind. m^{-2}, 30%) was dominant at high density. The gastropod *Monodonta labio* (62 ind. m^{-2}, 16%) and *Batillaria multiformis* (49 ind. m^{-2}, 13%) were of moderate density. At mid tidal level (main substratum types 'Sands' and 'Soft mud'), rock oyster *Saccostrea cucullata* (129 ind. m^{-2}, 33%) was dominant at high density and gastropods *Monodonta labio* (71 ind. m^{-2}, 18%) and *Batillaria zonalis* (54 ind. m^{-2}, 14%) were dominant at moderate density. Substratum types 'Soft Mud' were mainly distributed at low tidal level, rock oyster *Saccostrea cucullata* (108 ind. m^{-2}, 38%) was dominant at high density while the gastropod *Monodonta labio* (54 ind. m^{-2}, 19%) was also at moderate density.

In TC3, the substratum type was mainly 'Gravels and Boulders' at high tidal level. The rock oyster *Saccostrea cucullata* (134 ind. m^{-2}, 47%) was of dominant species at high density and the gastropod *Monodonta labio* (52 ind. m^{-2}, 18%) was of moderate density. At mid tidal level (mixtures of three substratum types), the rock oyster *Saccostrea cucullata* (126 ind. m^{-2}, 29%) was of dominant species at high density. The gastropod *Monodonta labio* (59 ind. m^{-2}, 14%) was at low – moderare density level. At low tidal level, the major substratum type was 'Soft mud'. There was dominated by rock oyster *Saccostrea cucullata* (141 ind. m^{-2}, 43%) at high density. The gastropod *Monodonta labio* (40 ind. m^{-2}, 12%) was of low density.

In ST, the major substratum type was 'Gravels and Boulders' at high tidal level. At high tidal level, the rock oyster *Saccostrea cucullata* (116 ind. m^{-2}, 39%) was abundant at high density. The gastropods *Batillaria multiformis* (38 ind. m^{-2}, 13%) and *Monodonta labio* (48 ind. m^{-2}, 16%) were at low to moderate density. At mid tidal level (mixtures of three substratum types), the rock oyster *Saccostrea cucullata* (127 ind. m^{-2}, 33%) was the dominant species at high density, and followed by the gastropod *Monodonta labio* (72 ind. m^{-2}, 19%) at moderate density. At low tidal level (major substratum: 'Soft mud'), the rock oyster *Saccostrea cucullata* (94 ind. m^{-2}, 34 %) and the gastropod Monodonta labio (43 ind. m-2, 16%) were the dominant species at moderate density.

In general, there was no consistent zonation pattern of species distribution across all sampling zones and tidal levels. The species distribution was determined by the type of substratum primarily. In general, rock oyster *Saccostrea cucullata* (1422 ind.), gastropods *Monodonta labio* (683 ind.) and *Batillaria multiformis* (87 ind.) were the most common species on gravel and boulders substratum. Rock oyster *Saccostrea cucullata* (S: 356 ind.' M: 343 ind.) was the most common species on sands and soft mud substrata.

<u>Biodiversity and abundance of soft shore communities</u>

Table 3.7 shows the mean values of species number, density, and biodiversity index *H'*and species evenness *J* of soft shore communities at every tidal level and in every sampling zone. As mentioned above, the differences among sampling zones and tidal levels were determined by the major type of substratum primarily.

Among the sampling zones, the mean species number was varied from 14 - 20 spp. 0.25 m^{-2} among the four sampling zones. The mean densities of TC2 (356 ind. m^{-2}) was higher than TC3 (349 ind. m^{-2}) followed by ST (322 ind. m^{-2}) and TC1 (279 ind. m^{-2}). The higher densities of TC2 and TC3 are due to the relatively high number of individuals in each quadrat. The mean H' for TC2 was 2.13, both TC3 and ST were 2 and TC1 was 1.9, followed by while the mean J of ST and TC1 were 0.73, which were slightly lower than others, TC2(0.8) and TC3(0.77). This can be due to the relatively non-even taxa distribution.

In the present survey, no clear trend of mean species number, mean density, *H'* and *J* observed among the tidal level.

Figures 3.14-3.17 show the temporal changes of mean species number, mean density, *H'* and *J* at every tidal level and in every sampling zone along the sampling months. In general, all the biological parameters fluctuated seasonally throughout the monitoring period. Lower mean species number and density were recorded in dry season (December) but the mean *H'* and *J* fluctuated within a limited range.

From June to December 2017, there were steady decreasing trends of mean species number and density in TC2, TC3 and ST regardless of tidal levels. It might be an unfavorable change reflecting environmental stresses. The heat stress and serial cyclone hit were believed the causes during the wet season of 2017. From March 2018 to March 2022 (present survey), generally increases of mean species number and density were observed in all sampling zones. It indicated the recovery of intertidal community.

Impact of HKLR project

It was the 38th survey of the EM&A programme during the construction period. Based on the results, impacts of the HKLR project were not detected on intertidal soft shore community. Abnormal phenomena (e.g. rapid, consistent or non-seasonal decline of fauna densities and species number) were not recorded.

Table 3.3. *Relative distribution (%) of types of substratum along the horizontal transect at every tidal level and in every sampling zone.*

		Percentage		
Sampling zone	**Tidal level**	**Gravels and Boulders**	**Sands**	**Soft mud**
TC1	H	80	15	5
	M	70	25	5
	L	10	70	20
TC2	H	90	10	
	M	5	60	35
	L		10	90
TC3	H	85	15	
	M	20	60	20
	L		5	95
ST	H	70	25	5
	M	20	30	50
	L		20	80

H: 2.0 m above C.D.; M: 1.5 m above C.D.; L: 1.0 m above C.D.

TC1 H **TC1 L**

6/3/2022

TC2 H **TC2 L**

5/3/2022

TC3 H **TC3 L**

4/3/2022

Figure 3.13 *Examples of photographic records of quadrat for intertidal soft shore community survey (H: 2.0 m above C.D.; M: 1.5 m above C.D.; L: 1.0 m above C.D.)*

ST H **ST L**

3/3/2022

Figure 3.13.(Cont'd) *Examples of photographic records of quadrat for intertidal soft shore community survey (H: 2.0 m above C.D.; M: 1.5 m above C.D.; L: 1.0 m above C.D.)*

Table 3.4 *Total abundance, density and number of taxon of every phylum*

Phylum	Total Abundance	%	Density (ind. m^{-2})	Number of Taxon
December 2021				
Mollusca	8938	91.2	298	32
Arthropoda	582	5.9	19	6
Annelida	138	1.4	5	3
Sipuncula	81	0.8	3	2
Nemertea	42	0.4	1	1
Cnidaria	22	0.2	1	1
Platyhelminthes	1	0.0	0	1
Total	9804			

0.0 %: Total abundance of the phylum is less than 0.1% of relative abundance.

0 ind. m^{-2}: Density of the phylum is less than 1 ind. m^{-2}.

Table 3.5 *The number of individuals, relative abundance (percentage) and density of each phylum in every sampling zone*

Phylum	TC1	%	Density (ind. m^{-2})	TC2	%	Density (ind. m^{-2})	TC3	%	Density (ind. m^{-2})	ST	%	Density (ind. m^{-2})
Mollusca	1971	94.1	263	2320	86.8	309	2417	92.3	322	2230	92.3	297
Arthropoda	89	4.2	12	313	11.7	42	101	3.9	13	79	3.3	11
Annelida	15	0.7	2	0	0.0	0	60	2.3	8	63	2.6	8
Sipuncula	13	0.6	2	12	0.4	2	27	1.0	4	29	1.2	4
Nemertea	0	0.0	0	14	0.5	2	14	0.5	2	14	0.6	2
Cnidaria	7	0.3	1	14	0.5	2	0	0.0	0	1	0.0	0
Platyhelminthes	0	0.0	0	0	0.0	0	1	0.0	0	0	0.0	0
Sub-total	2095			2673			2620			2416		

0.0 %: Total abundance of the phylum is less than 0.1% of relative abundance of the sampling zone.

0 ind. m^{-2}: Density of the phylum is less than 1 ind. m^{-2} of the sampling zone.

Table 3.6 *The abundant species (relative abundance >10%) in every sampling zone*

Sampling zone TC1	Group	Species	Mean density (ind. m^{-2})	Relative abundance (%)	Cumulative relative abundance (%)
High	Bi	*Saccostrea cucullata*	109	34	9
	G	*Monodonta labio*	74	23	8
Mid	Bi	*Saccostrea cucullata*	118	42	19
	G	*Monodonta labio*	57	21	29
Low	Bi	*Saccostrea cucullata*	102	42	33
	G	*Monodonta labio*	50	21	53

Bi = Bivalve, G = Gastropod

Table 3.6(Cont'd) *The abundant species (relative abundance >10%) in every sampling zone*

Sampling zone TC2	Group	Species	Mean density (ind. m^{-2})	Relative abundance (%)	Cumulative relative abundance (%)
High	Bi	*Saccostrea cucullata*	120	30	41
	G	*Monodonta labio*	62	16	7
	G	*Batillaria multiformis*	49	13	67
Mid	Bi	*Saccostrea cucullata*	129	33	33
	G	*Monodonta labio*	71	18	9
	G	*Batillaria zonalis*	54	14	48
Low	Bi	*Saccostrea cucullata*	108	38	46
	G	*Monodonta labio*	54	19	9

Bi = Bivalve, G = Gastropod

Table 3.6(Cont'd) *The abundant species (relative abundance >10%) in every sampling zone*

Sampling zone TC3	Group	Species	Mean density (ind. m^{-2})	Relative abundance (%)	Cumulative relative abundance (%)
High	Bi	*Saccostrea cucullata*	134	47	8
	G	*Monodonta labio*	52	18	2
Mid	Bi	*Saccostrea cucullata*	126	29	9
	G	*Monodonta labio*	59	14	5
Low	Bi	*Saccostrea cucullata*	141	43	38
	G	*Monodonta labio*	40	12	1

Bi = Bivalve, G = Gastropod

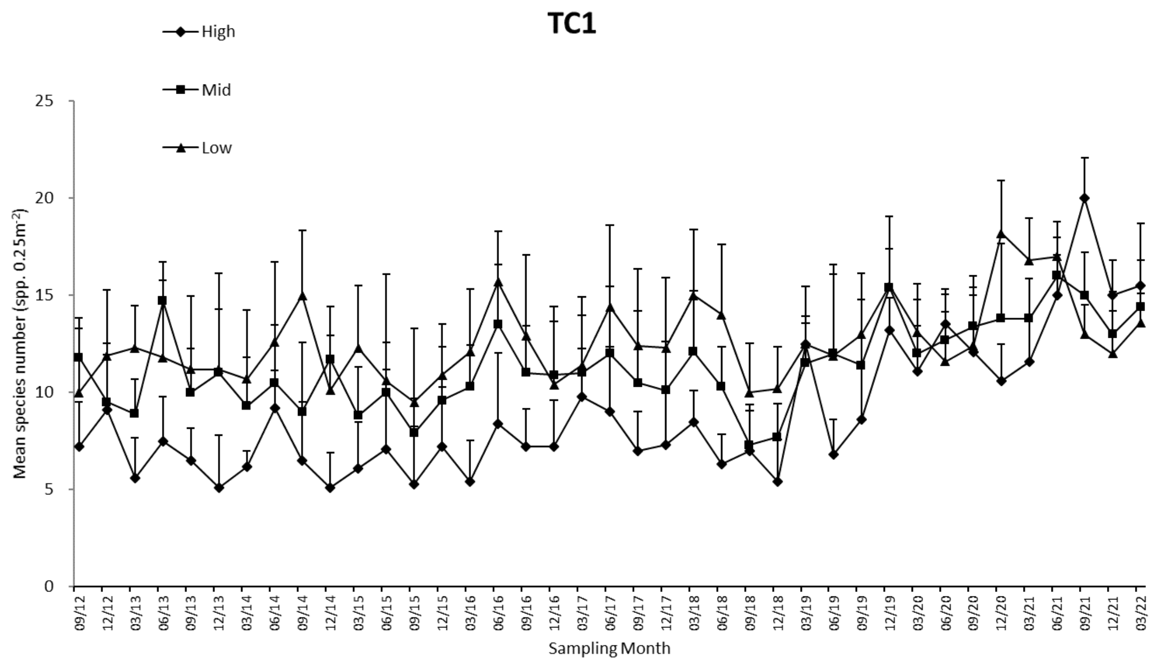
Table 3.6(Cont'd) *The abundant species (relative abundance >10%) in every sampling zone*

Sampling zone ST	Group	Species	Mean density (ind. m^{-2})	Relative abundance (%)	Cumulative relative abundance (%)
High	Bi	*Saccostrea cucullata*	116	39	16
	G	*Batillaria multiformis*	38	13	23
	G	*Monodonta labio*	48	16	39
Mid	Bi	Saccostrea cucullata	127	33	28
	G	Monodonta labio	72	19	45
Low	Bi	*Saccostrea cucullata*	94	34	25
	G	*Monodonta labio*	43	16	37

Bi = Bivalve, G = Gastropod

Table 3.7 *Mean values of species number, density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) at every tidal level and in every sampling zone*

Samling zone	Tidal	Mean species number (spp. 0.25m^{-2})	Mean species number across tidal levels	Mean density (ind. m^{-2})	Mean density across tidal levels	Mean H'	Mean H' across tidal levels	Mean J	Mean J across tidal levels
TC1	H	16		318		2.1		0.8	
	M	14	15	279	279	1.8	1.90	0.7	0.73
	L	14		241		1.8		0.7	
TC2	H	20		393		2.3		0.8	
	M	16	17	393	356	2.1	2.13	0.8	0.80
	L	14		283		2.0		0.8	
TC3	H	12		287		1.7		0.7	
	M	20	16	430	349	2.3	2.00	0.8	0.77
	L	15		331		2.0		0.8	
ST	H	15		299		2.0		0.7	
	M	17	15	390	322	2.2	2.00	0.8	0.73
	L	14		277		1.8		0.7	



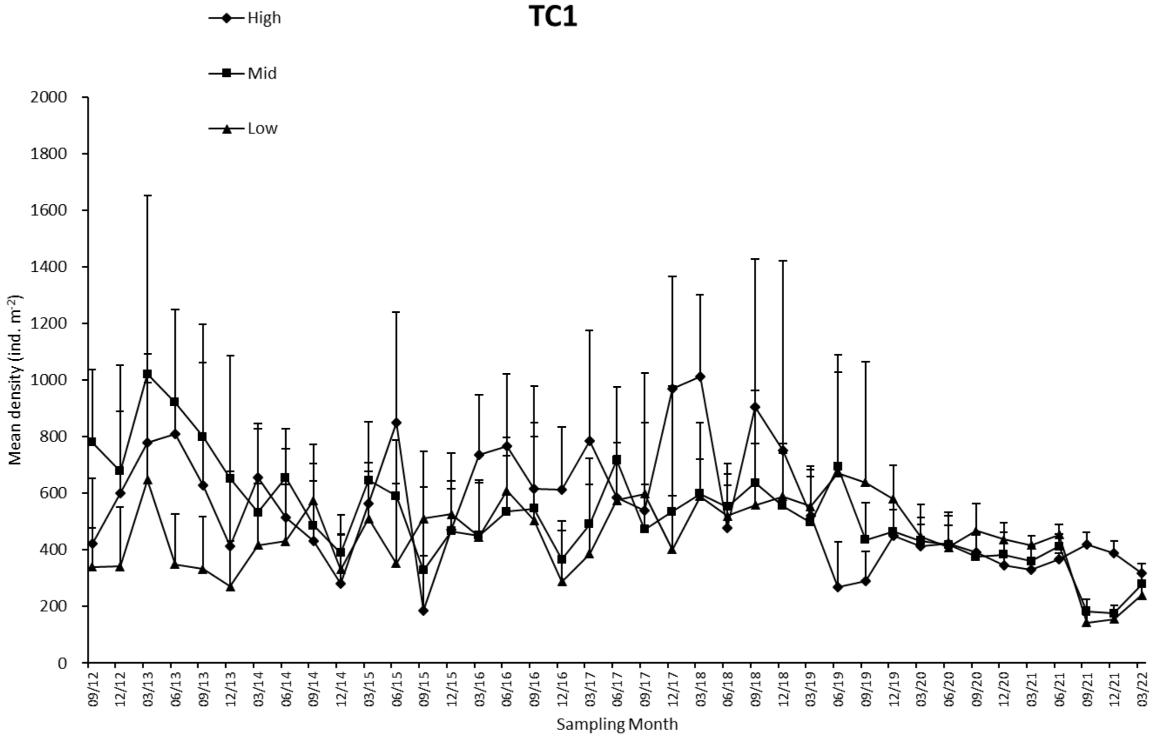
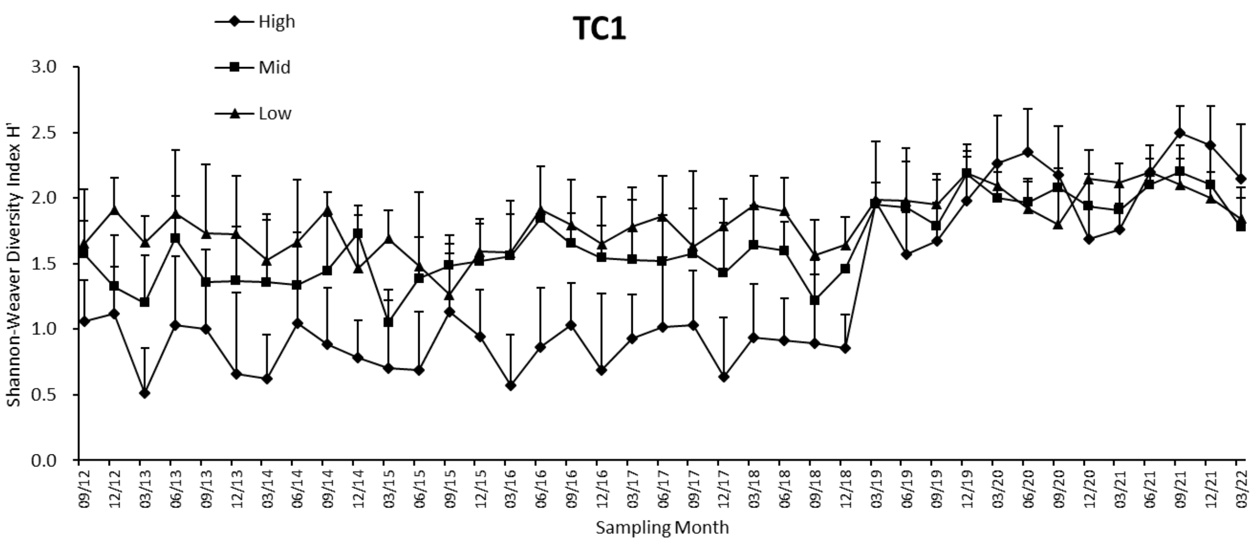


Figure 3.14 *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD)at every tidal level in sampling zone TC1*



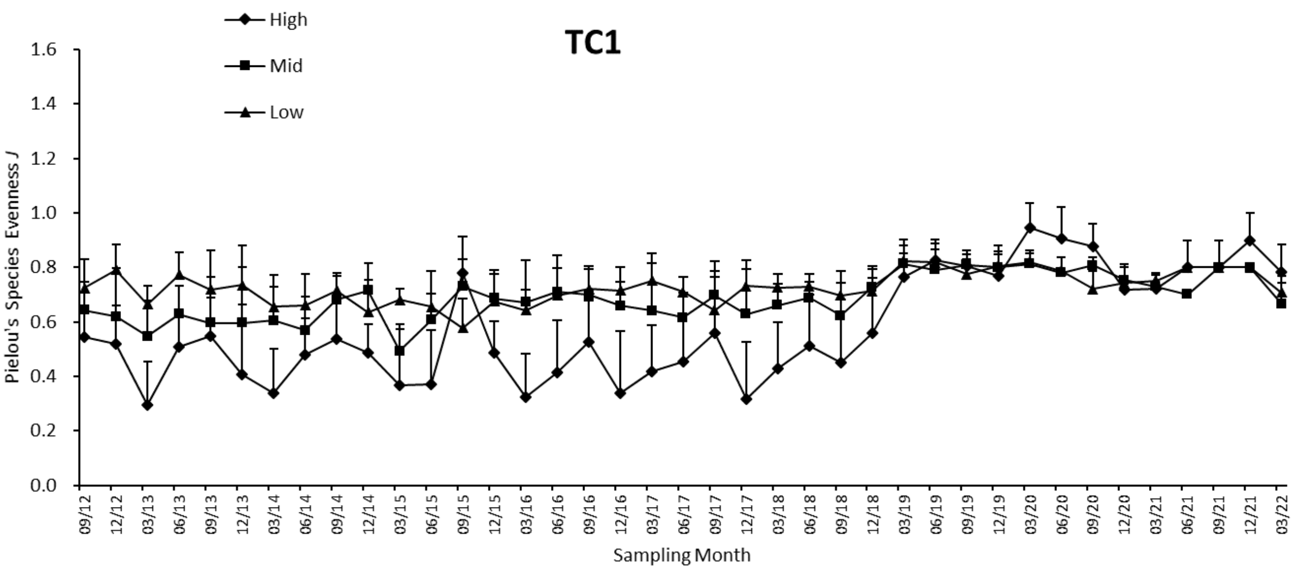
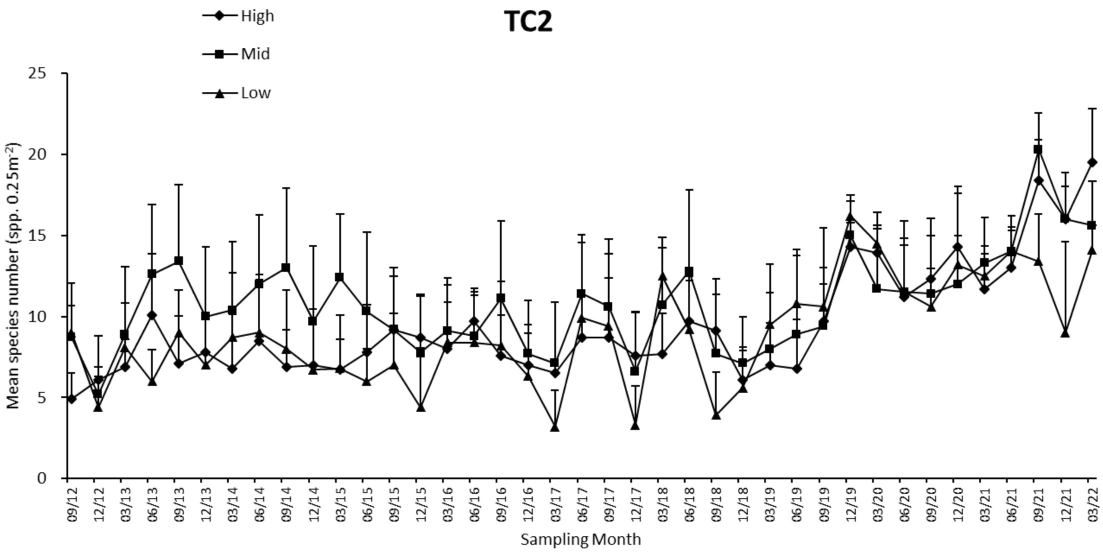


Figure 3.14(Cont'd) *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD)at every tidal level in sampling zone TC1*



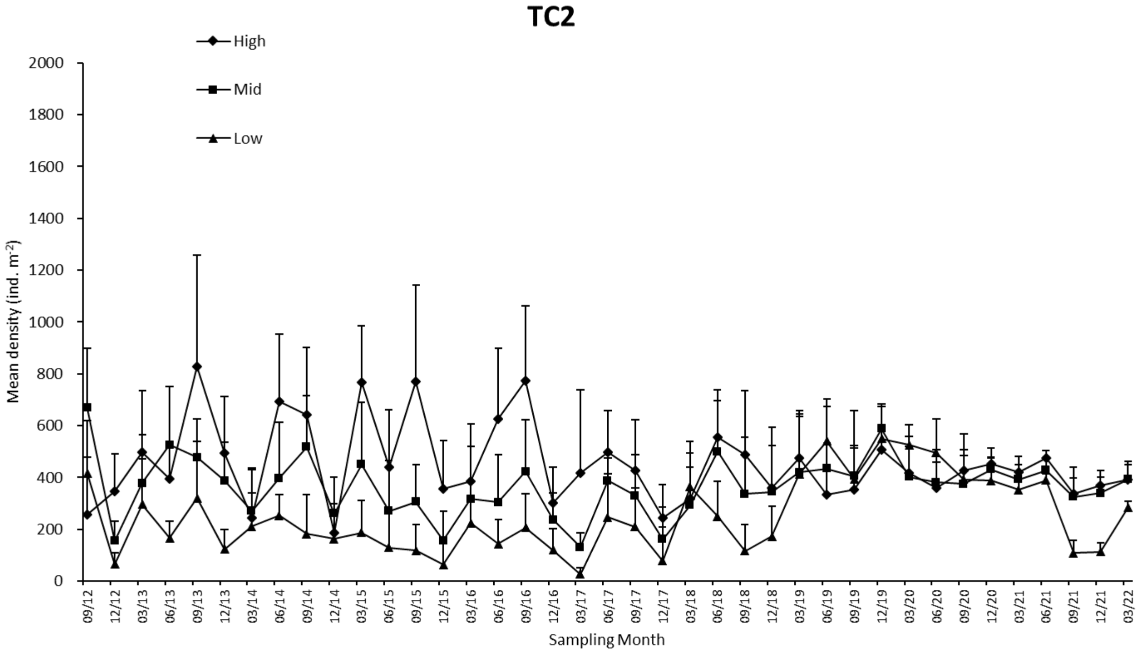
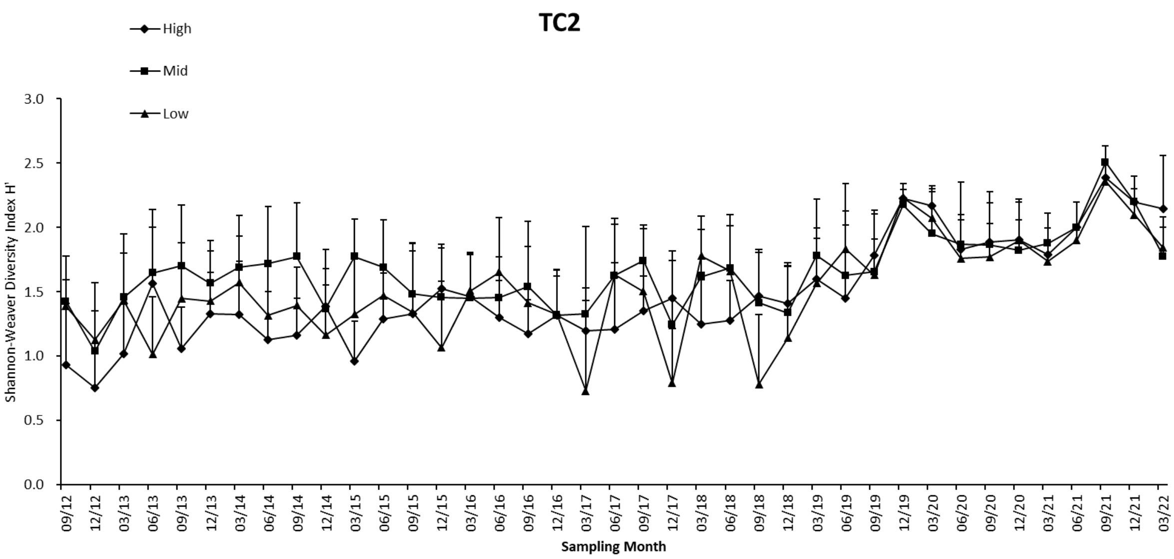


Figure 3.15 *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone TC2*



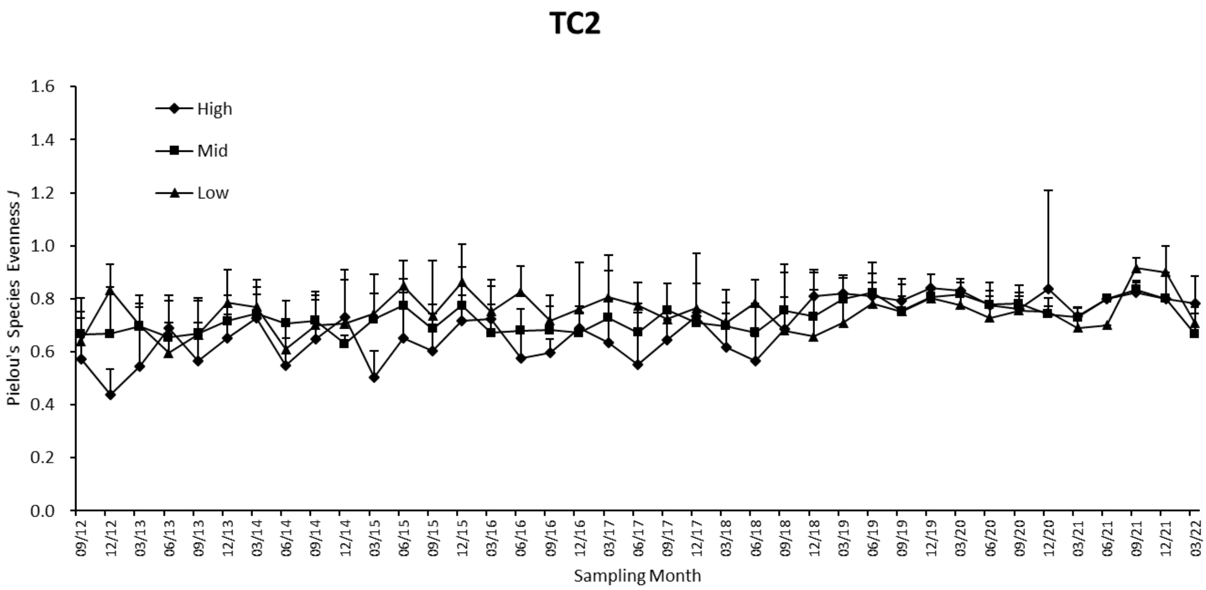
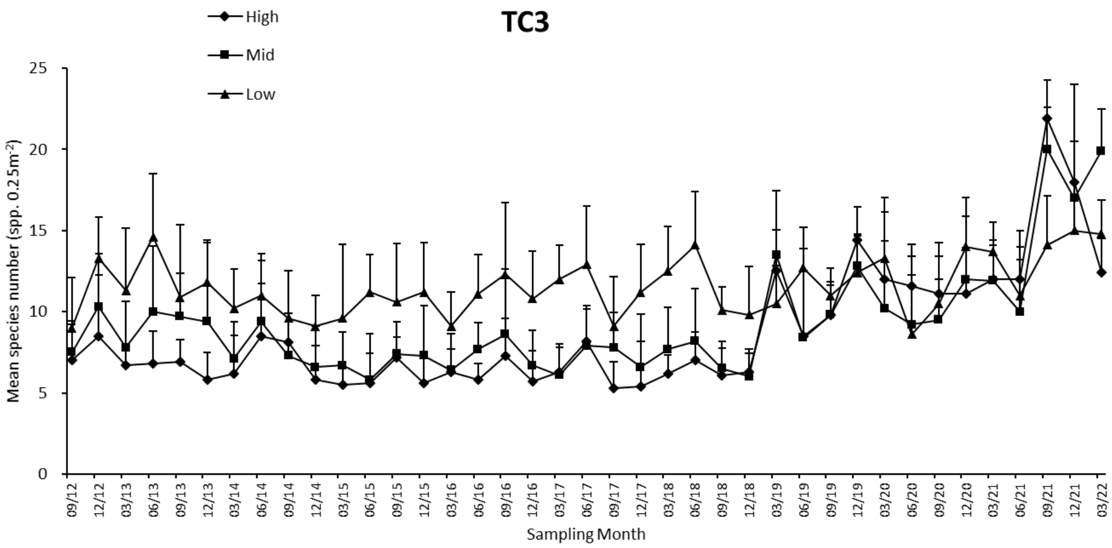


Figure3.15(Cont'd) *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone TC2*



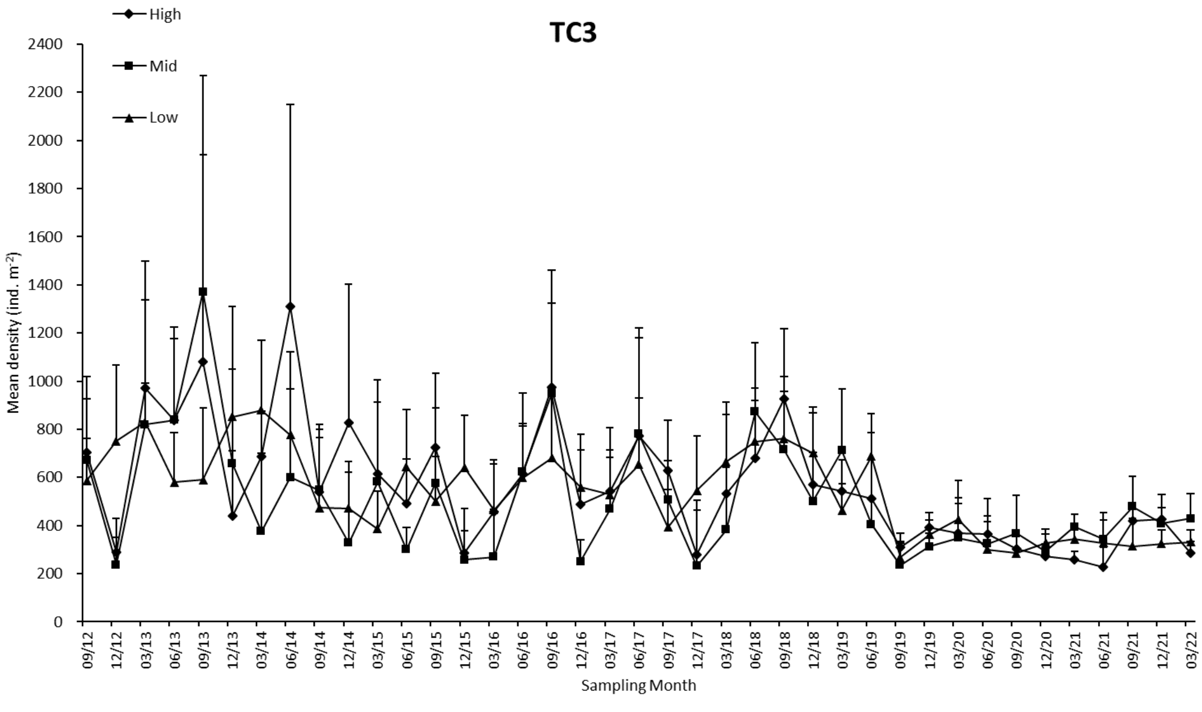
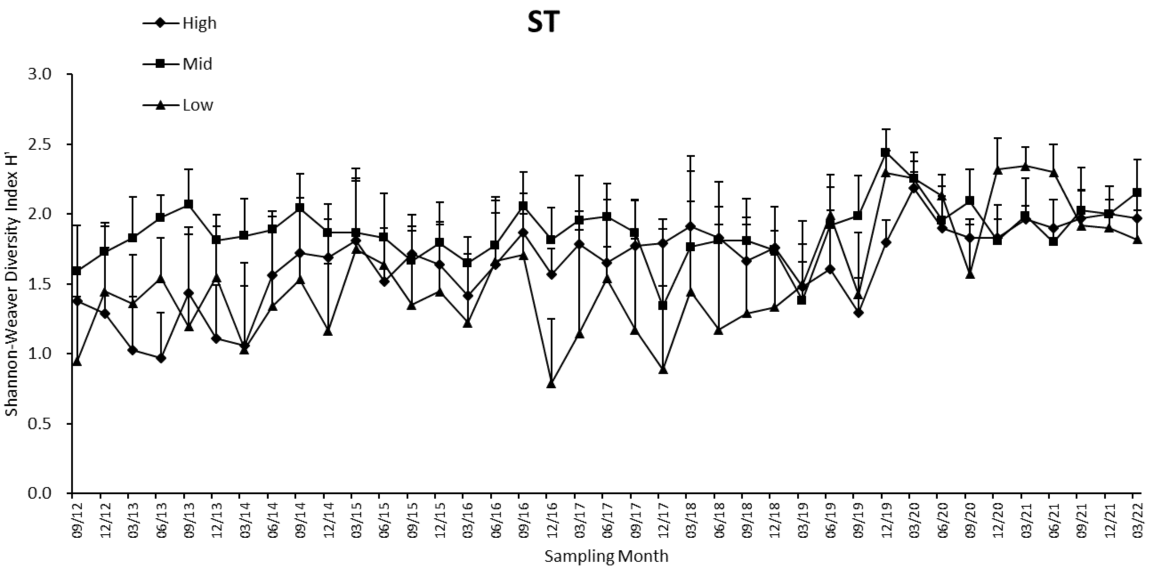


Figure 3.16 *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone TC3*



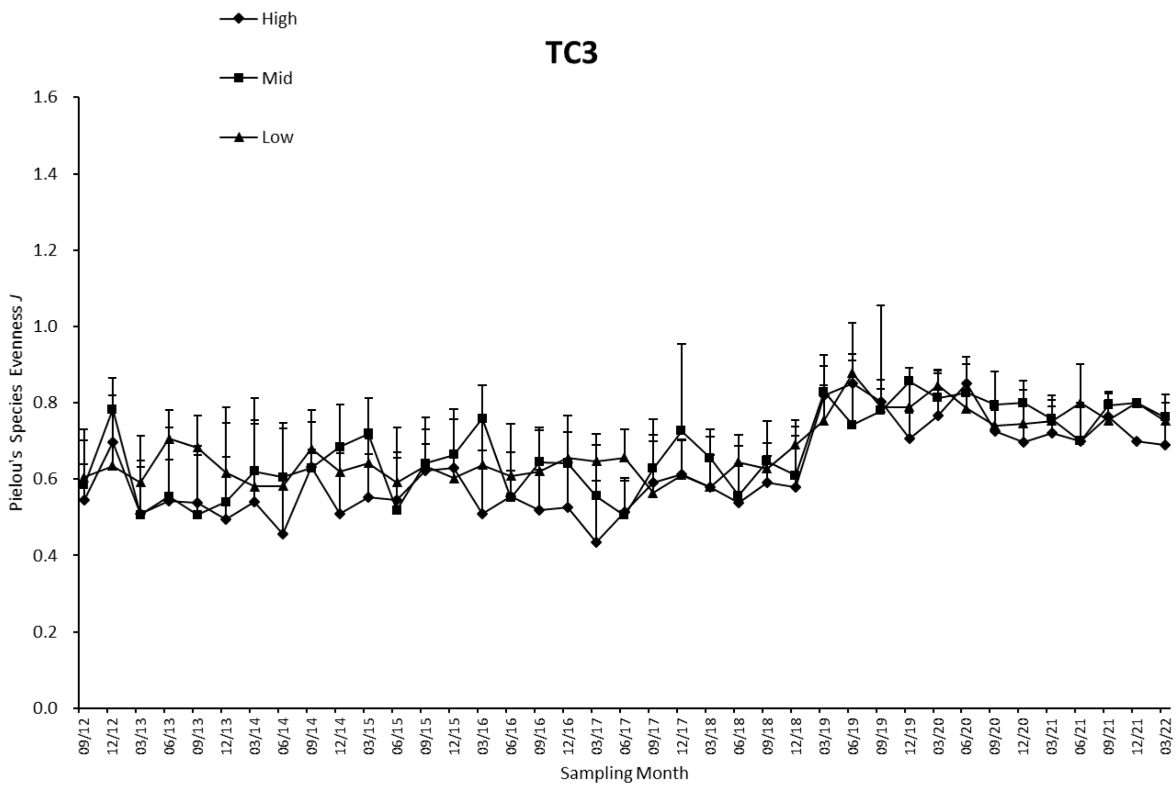
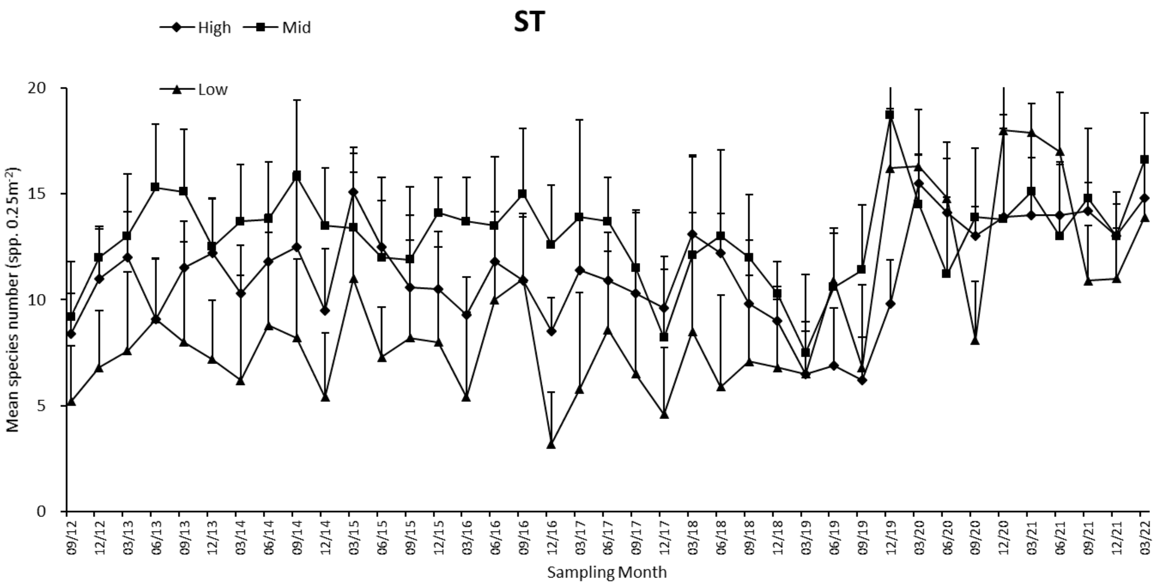


Figure 3.16(Cont'd) *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone TC3*



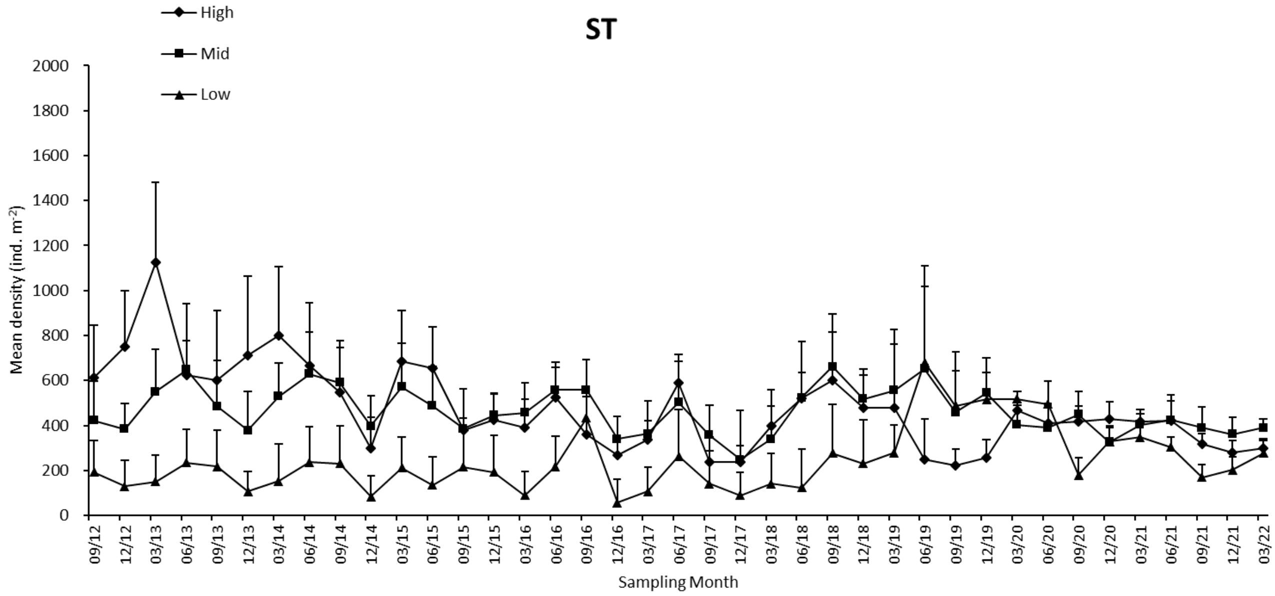
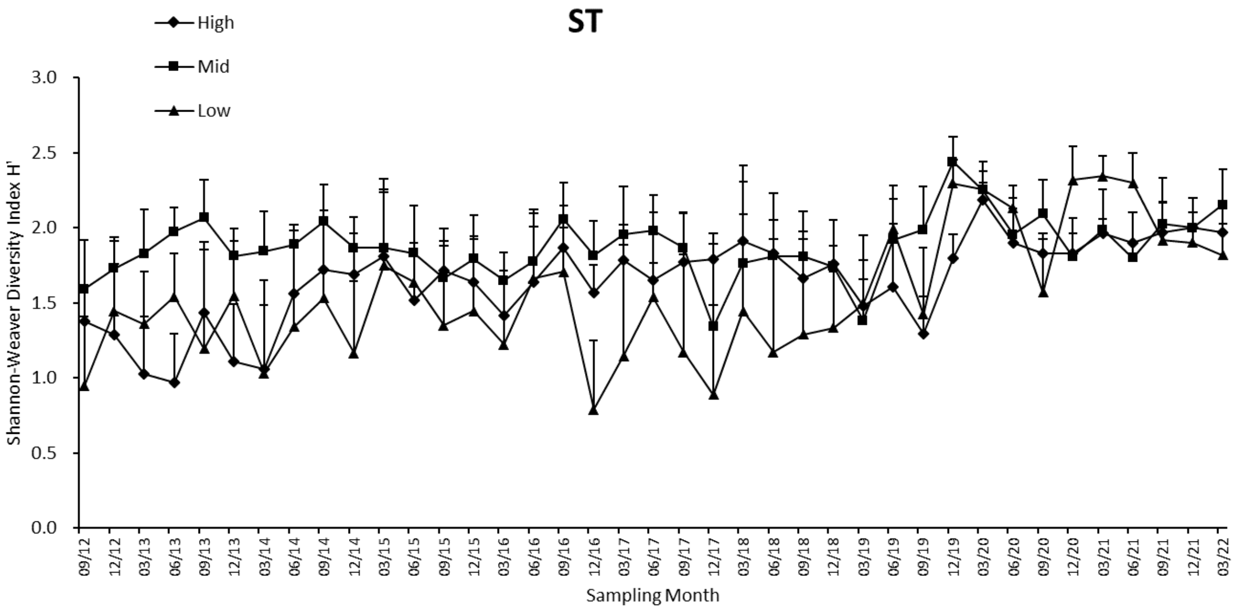


Figure 3.17 *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone S*



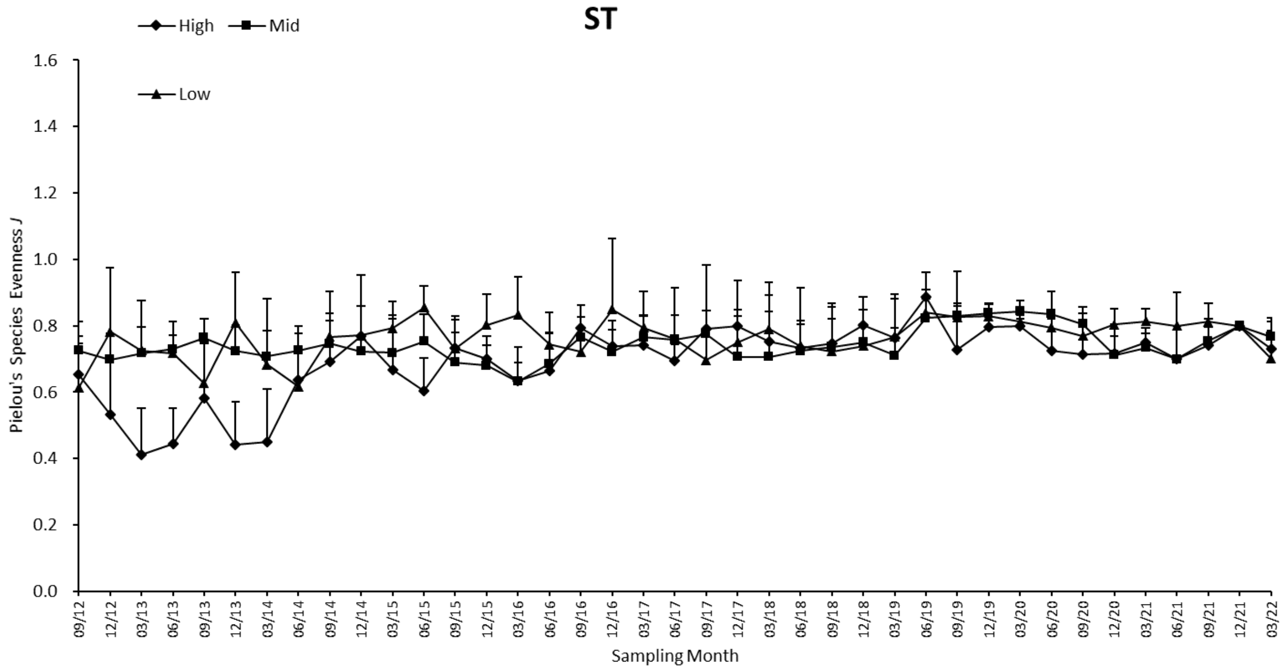


Figure 3.17(Cont'd) *Temporal changes of mean number of species, mean density, Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) (mean + SD) at every tidal level in sampling zone ST*

4 REFERENCES

AFCD, 2018. Potamidid Snails in Hong Kong Mangrove. Agriculture, Fisheries and Conservation Department Newsletter - Hong Kong Biodiversity Issue #25, 2-11.

Chan, K.K., Caley, K.J., 2003. Sandy Shores, Hong Kong Field Guides 4. The Department of Ecology & Biodiversity, The University of Hong Kong. pp 117.

Dai, A.Y., Yang, S.L., 1991. Crabs of the China Seas. China Ocean Press. Beijing.

Dong, Y.M., 1991. Fauna of Zhe Jiang Crustacea. Zhejiang Science and Technology Publishing House. ZheJiang.

EPD, 1997.Technical Memorandum on Environmental Impact Assessment Process (1st edition). Environmental Protection Department, HKSAR Government.

Fauchald, K., 1977. The polychaete worms.Definitions and keys to the orders, families and genera. Natural History Museum of Los Angeles County, Science Series 28. Los Angeles, U.S.A.

Fong, C.W., 1998. Distribution of Hong Kong seagrasses. In: *Porcupine!*No. 18. The School of Biological Sciences, The University of Hong Kong, in collaboration with Kadoorie Farm & Botanic Garden Fauna Conservation Department, p10-12.

Li, H.Y., 2008. The Conservation of Horseshoe Crabs in Hong Kong.MPhil Thesis, City University of Hong Kong, pp 277.

Longstaff, B.J., Dennison, W.C., 1999. Seagrass survival during pulsed turbidity events: the effects of light deprivation on the seagrasses *Halodule pinifolia* and *Halophila ovalis*. Aquatic Botany 65 (1-4), 105-121.

Longstaff, B.J., Loneragan, N.R., O'Donohue, M.J., Dennison, W.C., 1999. Effects of light deprivation on the survival and recovery of the seagrass *Halophila ovalis* (R. Br.) Hook. Journal of Experimental Marine Biology and Ecology 234 (1), 1-27.

Nakaoka, M., Aioi, K., 1999.Growth of seagrass *Halophila ovalis* at dugong trails compared to existing within-patch variation in a Thailand intertidal flat. Marine Ecology Progress Series 184, 97-103.

Pielou, E.C., 1966. Shannon's formula as a measure of species diversity: its use and misuse. American Naturalist 100, 463-465.

Qi, Z.Y., 2004. Sea shells of China.China Ocean Press. Beijing, China.

Qin, H., Chiu, H., Morton, B., 1998. Nursery beaches for Horseshoe Crabs in Hong Kong. In: *Porcupine!* No. 18. The School of Biological Sciences, The University of Hong Kong, in collaboration with Kadoorie Farm & Botanic Garden Fauna Conservation Department, p9-10.

Shannon, C.E., Weaver, W., 1963. The Mathematical Theory of Communication. Urbana: University of Illinois Press, USA.

Shin, P.K.S., Li, H.Y., Cheung, S.G., 2009.Horseshoe Crabs in Hong Kong: Current Population Status and Human Exploitation. Biology and Conservation of Horseshoe Crabs (part 2), 347-360.

Supanwanid, C., 1996. Recovery of the seagrass *Halophila ovalis* after grazing by dugong. In: Kuo, J., Philips, R.C., Walker, D.I., Kirkman, H. (eds), Seagrass biology: Proc Int workshop, Rottenest Island, Western Australia. Faculty of Science, The University of Western Australia, Nedlands, 315-318.

Vermaat, J.E., Agawin, N.S.R., Duarte, C.M., Fortes, M.D., Marba. N., Uri, J.S., 1995. Meadow maintenance, growth and productivity of a mixed Philippine seagrass bed. Marine Ecology Progress Series 124, 215-225.

Yang, D.J, Sun, R.P., 1988.Polychaetous annelids commonly seen from the Chinese waters (Chinese version).China Agriculture Press, China.

Annex I. Location of sampling zones (map from ATKINS China Ltd.)

Annex II *Record of horseshoe crab survey in every sampling zone.*

No.	Sub.	GPS coordinate		Record of prosomal width (mm)		
Sampling site TC1 (Search hour = 2 hrs)				*Carcinoscorpius rotundicauda*		*Tachypleus tridentatus*
		No record				
		No. of ind.		**0**		**0**
Sampling site TC2 (Search hour = 2 hrs)				*Carcinoscorpius rotundicauda*		*Tachypleus tridentatus*
		No record				
		No. of ind.		**0**		**0**
Sampling site TC3 (Search hour = 3 hrs)				*Carcinoscorpius rotundicauda*		*Tachypleus tridentatus*
1	M	22°17'08"N	113°55'34"E	52.21	54.63	
		No. of ind.		**2**		**0**

Ind. #: number of Individuals (individuals in a group are shown at the same row)

Underlined: size of mating pair or large individual (excluded from data analysis)

Sub.: Substratum type; G = Gravel and Boulders, M = Soft mud, S = Sand

Annex II (Cont'd) *Record of horseshoe crab survey in every sampling zone.*

No.	Sub.	GPS coordinate		Record of prosomal width (mm)	
Sampling site ST (Search hour = 3 hrs)				*Carcinoscorpius rotundicauda*	*Tachypleus tridentatus*
1	M	22°17'16"N	113°55'31"E	51.22 52.15 56.66	
2	M	22°17'16"N	113°55'29"E	53.63 55.81	78.86 76.32
		No. of ind.		**5**	**2**

Ind. #: number of Individuals (individuals in a group are shown at the same row)

Underlined: size of mating pair or large individual (excluded from data analysis)

Sub.: Substratum type; G = Gravel and Boulders, M = Soft mud, S = Sand

Annex III *Record of seagrass beds survey in every sampling zone*

Estimated area (m^2)	Estimated coverage (%)		GPS coordinate		Remark
TC1& TC2 (search hour = 2 hrs)					
No record					
TC3 *Halophila ovalis* **(search hour = 3 hrs)**					
460	40-70	horizontal	22°17'007"N	113°55'033"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove
		line	22°17'007"N	113°55'033"E	area at tidal level 1.5 m above C.D.
80	40-70	horizontal	22°17'001"N	113°55'038"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove
		line	22°17'001"N	113°55'038"E	area at tidal level 1.5m above C.D.
20	40-50	horizontal	22°17'007"N	113°55'034"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove
		line	22°17'007"N	113°55'034"E	area at tidal level 1.5m above C.D.
ST *Zostera Japonica* **(search hour = 3 hrs)**					
10	30-60	horizontal	22°17'012"N	113°55'029"E	A horizontal strand of seagrass bed nearby the seaward side of
		line	22°17'012"N	113°55'029"E	mangrove area at tidal level 2.0 m above C.D.
ST *Halophila ovalis* **(search hour = 3 hrs)**					
2	50-70	horizontal	22°17'018"N	113°55'030"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove
		line	22°17'018"N	113°55'030"E	area at tidal level 1.5 m above C.D.

8	40-60	horizontal line	22°17'017"N 22°17'017"N	113°55'031"E 113°55'031"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove area at tidal level 1.5 m above C.D.
30	40-70	horizontal line	22°17'015"N 22°17'015"N	113°55'030"E 113°55'030"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove area at tidal level 1.5 m above C.D.
680	40-70	horizontal line	22°17'013"N 22°17'013"N	113°55'029"E 113°55'029"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove area at tidal level 1.5 m above C.D.
480	40-70	horizontal line	22°17'012"N 22°17'012"N	113°55'032"E 113°55'032"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove area at tidal level 1.5 m above C.D.
840	40-80	horizontal line	22°17'010"N 22°17'010"N	113°55'032"E 113°55'032"E	A horizontal strand of seagrass bed nearby the seaward side of mangrove area at tidal level 1.5 m above C.D.

Annex IV. *Taxonomic resolution of every recorded species of intertidal soft shore community survey*

Kingdom	Phylum	Class	Order	Family	Species
Animalia	Annelida	Polycheata	Phyllodocida	Nereididae	*Nereididae spp.*
Animalia	Annelida	Polycheata	Sabellida	Sabellidae	*Sabellidae imbricatus*
Animalia	Arthropoda	Malacostraca	Decapoda	Grapsidae	*Gaetice depressus*
Animalia	Arthropoda	Malacostraca	Decapoda	Grapsidae	*Metopograpsus latifrons*
Animalia	Arthropoda	Malacostraca	Decapoda	Grapsidae	*Metopograpsus quadridentatus*
Animalia	Arthropoda	Malacostraca	Decapoda	Paguridae	*Pagurus dubius*
Animalia	Arthropoda	Malacostraca	Decapoda	Varuniae	*Hemigrapsus penicillatus*
Animalia	Arthropoda	Maxillopoda	Sessilia	Balanidae	*Balanus amphitrite*
Animalia	Cnidaria	Anthozoa	Actiniaria	Diadumenidae	*Diadumene lineata*
Animalia	Mollusca	Bivalvia	Arcoida	Arcidae	*Barbatia virescens*
Animalia	Mollusca	Bivalvia	Mytioida	Mytilidae	*Brachidontes variabilis*
Animalia	Mollusca	Bivalvia	Mytioida	Mytilidae	*Xenostrobus atratus*
Animalia	Mollusca	Bivalvia	Ostreoida	Ostreidae	*Saccostrea cucullata*
Animalia	Mollusca	Bivalvia	Venerida	Veneridae	*Ruditapes philippinarum*
Animalia	Mollusca	Bivalvia	Venerida	Glauconomidae	*Glauconome chinensis*
Animalia	Mollusca	Bivalvia	Venerida	Veneridae	*Anomalocardia squamosa*
Animalia	Mollusca	Gastropoda	Archaeogastropoda	Trochidae	*Monodonta labio*
Animalia	Mollusca	Gastropoda	Archaeogastropoda	Turbinidae	*Lunella coronata*
Animalia	Mollusca	Gastropoda	Archaeogastropoda	Turbinidae	*Lunella granulata*
Animalia	Mollusca	Gastropoda	Caenogastropoda	Batillariidae	*Batillaria multiformis*
Animalia	Mollusca	Gastropoda	Caenogastropoda	Batillariidae	*Batillaria zonalis*
Animalia	Mollusca	Gastropoda	Caenogastropoda	Potamididae	*Pirenella asiatica*
Animalia	Mollusca	Gastropoda	Caenogastropoda	Potamididae	*Pirenella incisa*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Clithon faba*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Clithon retropictus*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Nerita chamaeleon*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Nerita lineata*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Nerita polita*
Animalia	Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Nerita squamulata*
Animalia	Mollusca	Gastropoda	Littorinimorpha	Littorinidae	*Littoraria articulata*
Animalia	Mollusca	Gastropoda	Neogastropoda	Muricidae	*Thais clavigera*
Animalia	Mollusca	Gastropoda	Neotaenioglossa	Littorinidae	*Nodilittorina radiata*
Animalia	Mollusca	Gastropoda	Patellogastropoda	Lottiidae	*Lottia dorsuosa*
Animalia	Mollusca	Gastropoda	Patellogastropoda	Lottiidae	*Lottia luchuana*

Animalia	Mollusca	Gastropoda	Patellogastropoda	Lottiidae	*Nipponacmea concinna*
Animalia	Mollusca	Gastropoda	Trochida	Tegulidae	*Chlorostoma argyrostomum*
Animalia	Mollusca	Gastropoda		Lottiidae	*Patelloida pygmaea*
Animalia	Mollusca	Polyplacophora	Chitonida	Ischnochitonidae	*Lepidozona spp.*
Animalia	Nemertea				*Nemertea spp.*
Animalia	Platyhelminthes				*Platyhelminthes sp.*
Animalia	Sipuncula	Sipunculidae	Golfingiida	Sipunculidae	*Siphonosoma sp.*
Animalia	Sipuncula	Sipunculidae	Golfingiida	Sipunculidae	*Sipunculus nudus*

Annex V. *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2021 Sampling Zone TC1 High tidal level (2.0 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*	2						2				2		3				4				13
Bi	*Barbatia virescens*	1						1				2				1		1				6
Bi	*Brachidontes variabilis*	1				3				2						0				1		7
Bi	*Glauconome chinensis*	2							1	4				1		1		1				10
Bi	*Saccostrea cucullata*	36		32		26		24		31		27		17		27		29		23		272
Bi	*Xenostrobus atratus*			2		4		3		2		5		6		6		2		3		33
C	*Gaetice depressus*					1		1							1	3		2				8
C	*Metopograpsus latifrons*															2				2		4
C	*Pagurus dubius*	2										3		3		3		2		1		14
G	*Batillaria multiformis*	0				2		6		6		4		8		10		6		7		49
G	*Batillaria zonalis*	1				7		3		6		2		8		3		8		4		42
Cn	*Diadumene lineata*			2																		2
G	*Cellana toreuma*	3				1		2						1				1				8
G	*Chlorostoma argyrostomum*											2				1				1		4
G	*Clithon faba*									2				2				3				7
G	*Littoraria articulata*			3		2		4		5		6		3		1		2		2		28
G	*Lottia dorsuosa*					3		3				3		1		3				1		14

G	*Lottia luchuana*	2		1							2		1			3	1		10
G	*Lunella coronata*	1		4		1		1		2	3		3	4		2	5		26
G	*Lunella granulata*			3		2					1		2	1		1	1		11
G	*Monodonta labio*	18		13		18		28		16	18		17	20		14	24		186
G	*Nipponacmea concinna*	1								3				2		2	0		8
G	*Nodilittorina radiata*	1		1				2					6				2		12
G	*Patelloida pygmaea*					1					1		2	1			4		9
P	*Nereididae spp.*														1	1		1	3
G	*Pirenella asiatica*							*1*					*2*						3
P	*Sabellidae imbricatus*				1							1							2
Po	*Lepidozona spp.*															1			1
Sp	*Siphonosoma sp.*		1				1		1						0			1	4
																		Total	**796**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022 Sampling Zone TC1 Mid tidal level (1.5 m above C.D.)

Gp	Taxon	1		2		3		4		5		6		7		8		9		10		Sub-total
		Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	
Ba	*Balanus amphitrite*			1				3		4		5				1				0		14
Bi	*Barbatia virescens*					1		1		1		2				2		3				10
Bi	*Brachidontes variabilis*																					0
Bi	*Glauconome chinensis*			2		2	1	1							3	2		1			1	13
Bi	*Saccostrea cucullata*	30		24		38		34		30		27		38		27		19		27		294
Bi	*Xenostrobus atratus*	4				2		2				2		3		2		5		3		23
C	*Gaetice depressus*			3				1				1				2				1		8
C	*Hemigrapsus penicillatus*													1								1
C	*Metopograpsus latifrons*			2												1		1				4
G	*Batillaria multiformis*	6		5		2		6		3		4		2		2		6		3		39
G	*Batillaria zonalis*	8		2				4		6				2		1		1				24
G	*Chlorostoma argyrostomum*	1								2						1		1		1		6
G	*Clithon faba*	2						1				1		1				3				8
G	*Clithon retropictus*									2						2						4
G	*Littoraria articulata*	2		2						2		2		1		2				2		13
G	*Lottia dorsuosa*	3						1		4		3		1		1		2		1		16
G	*Lunella coronata*	4		5		1				5		1		1				3		1		21
G	*Lunella granulata*	3		2		2		2		5		1		2		1		1		1		20
G	*Monodonta labio*	16		9		18		13		16		19		12		11		13		16		143

G	*Nerita squamulata*	5		1							1							7
G	*Nipponacmea concinna*	4									2			1				7
G	*Nodilittorina radiata*					1			2				1	1		1		6
G	*Patelloida pygmaea*						1							1		1		3
G	*Pirenella asiatica*			1											1			2
P	*Nereididae spp.*		1		1					1							1	4
Po	*Lepidozona spp.*															1		1
Sp	*Siphonosoma sp.*											1						1
Sp	*Sipunculus nudus*		1		1			1		1				1				5
																	Total	**697**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022	Sampling Zone TC1	Low tidal level (0.5 m above C.D.)																				
		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*			2								3		2								7
Bi	*Barbatia virescens*	2						2				1						1				6
Bi	*Anomalocardiasquamosa*																		1			1
Bi	*Brachidontes variabilis*	1								1						1						3
Bi	*Glauconome chinensis*				1	1			3			1		1	1		1		1	1	1	12
Bi	*Saccostrea cucullata*	26		27		26		34		21		27		19		28		25		21		254
Bi	*Xenostrobus atratus*	6		2		2				3				2		4		3				22
C	*Gaetice depressus*						1					1					1	1		1		5
C	*Hemigrapsus penicillatus*		1															1				2
C	*Metopograpsus latifrons*							1						1		1						3
C	*Pagurus dubius*			2								1				2				1		6
Cn	*Diadumene lineata*	3								1				1								5
G	*Batillaria multiformis*					2		4		4		1		2		1		1		3		18
G	*Batillaria zonalis*			2		3		1		3		2		2		2		3		2		20
G	*Chlorostoma argyrostomum*							1						1								2
G	*Clithon retropictus*			3		3														1		7
G	*Littoraria articulata*	6		6		7		4		2		1		2		4		5		6		43
G	*Lottia dorsuosa*	2				4		5		3												14

G	*Lottia luchuana*		2				1					3
G	*Lunella coronata*	1	2		1	2	1	1	1	2	1	12
G	*Lunella granulata*	3	1				2	1		2		9
G	*Monodonta labio*	10	18	15	10	6	8	19	12	14	12	124
G	*Nerita lineata*			1				2				3
G	*Nerita polita*	1										1
G	*Nerita squamulata*					1	1					2
G	*Nipponacmea concinna*	1			1							2
G	*Nodilittorina radiata*		1			2		1	2			6
P	*Nereididae spp.*			1		1				1	1	4
P	*Sabellidae imbricatus*		1					1				2
Po	*Lepidozona spp.*						1					1
Sp	*Siphonosoma sp.*		1		1							2
Sp	*Sipunculus nudus*					1						1
											Total	**602**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2021	Sampling Zone TC2	High tidal level (2.0 m above C.D.)																				
		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*	3		4		1		2		1		2		5		4		6		3		31
Bi	*Barbatia virescens*	2		1		3		4		1		1		1		2		0				15
Bi	*Brachidontes variabilis*	1		1		5		2						1		2		1		1		14
Bi	*Glauconome chinensis*		1	0		2				0	1		1	1			1					7
Bi	*Saccostrea cucullata*	28		30		36		25		28		17		32		39		33		31		299
Bi	*Xenostrobus atratus*	4		4		1		5		3		2		1		2		2		1		25
C	*Gaetice depressus*	1		2		1	1			1			2	1	1			1		1	1	13
C	*Hemigrapsus penicillatus*			1		1		1								1						4
C	*Metopograpsus latifrons*	1				1				1						1		1				5
C	*Metopograpsus quadridentatus*			1														1		1		3
Cn	*Diadumene lineata*						1	1												1		3
G	*Batillaria multiformis*	9		11		5	0	14		11		17		12		17		18		9		123
G	*Batillaria zonalis*	5		7		3		5		8		6		7		4		9		4		58
G	*Chlorostoma argyrostomum*			1		2		2								1		2		1		9
G	*Clithon retropictus*					3		4		4		2		4				1		3		21
G	*Littoraria articulata*			5		8		10		8				13		5		3				52
G	*Lottia dorsuosa*	4		2		2		1		4				2		3		2				20
G	*Lunella coronata*	4		2		5		3		2		1		4		5		2				28

G	*Lunella granulata*	3	3	3	3			3	1	3		19
G	*Monodonta labio*	15	17	20	8	26	10	22	12	16	8	154
G	*Nerita squamulata*	2		5		1		5	1		1	15
G	*Nipponacmea concinna*	5	3	2	2	4			3		1	20
G	*Nodilittorina radiata*	3	3	1	3	1				1	1	13
G	*Patelloida pygmaea*	2	1	1					1	2	1	8
G	*Pirenella asiatica*	1	1	2		1						5
G	*Pirenella incisa*											0
Ne	*Nemertea sp.*	1		1		1	1	1	1	1	2	9
Po	*Lepidozona spp.*	1	1	1						2		5
Sp	*Siphonosoma sp.*				1		1		1		1	4
											Total	**982**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022 Sampling Zone TC2 Mid tidal level (1.5 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*	4								3		3		1		2		1		1		15
Bi	*Barbatia virescens*	2		3		1		3		1		1				2						13
Bi	*Brachidontes variabilis*	2				3		2		4								3		1		15
Bi	*Glauconome chinensis*		1	1			1	2		3		1				1						10
Bi	*Saccostrea cucullata*	19		30		21		29		36		45		39		35		36		33		323
Bi	*Xenostrobus atratus*	3		1		4		7		4		3				5		3		1		31
C	*Gaetice depressus*	1			1			1		2				1		1						7
C	*Metopograpsus latifrons*	1				1		1				1								1		5
C	*Pagurus dubius*			2		1										1				2		6
Cn	*Diadumene lineata*	1		1																		2
G	*Batillaria multiformis*			5		5		10		11		7		9		7		13		11		78
G	*Batillaria zonalis*	5				16		18		16		22		20		17		10		12		136
G	*Clithon faba*	2		4												1		2				9
G	*Clithon retropictus*	0		5				5		4		4		3						4		25
G	*Littoraria articulata*	12		6						2		1		5				1				27
G	*Lottia dorsuosa*			2		3				2						3		3		2		15
G	*Lunella coronata*	2		2		5						2		3		2		3		1		20

G	*Lunella granulata*	1	2	3		3	4	3				16
G	*Monodonta labio*	21	23	11	21	23	17	18	16	16	11	177
G	*Nipponacmea concinna*	2	3		2	2	2	4	1	2		18
G	*Nodilittorina radiata*	1	2	1	1	2					3	10
G	*Patelloida pygmaea*	2	2	2	3	4						13
G	*Pirenella incisa*			1								1
Ne	*Nemertea spp.*		1	1		2			1			5
Po	*Lepidozona spp.*				1				2			3
Sp	*Sipunculus nudus*	1					1				1	3
											Total	**983**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Dec 2021 Sampling Zone TC2 Low tidal level (0.5 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*					1		0		2				1				2		1		7
Bi	*Anomalocardia squamosa*	1				1		1								2						5
Bi	*Barbatia virescens*	2				2		1		2		3		4		2		2		1		19
Bi	*Brachidontes variabilis*	2		2		2		3		1								1				11
Bi	*Glauconome chinensis*									1				1		2		1		1		6
Bi	*Isognomon isognomum*			1		1		1				3		2				1				9
Bi	*Saccostrea cucullata*	26		22		28		27		21		34		25		23		33		32		271
Bi	*Xenostrobus atratus*			3		3		5		1		5		4				1		3		25
C	*Gaetice depressus*	1				1						2								2		6
C	*Hemigrapsus penicillatus*			1								1										2
C	*Metopograpsus latifrons*	1		1												1						3
C	*Pagurus dubius*									1		1										2
Cn	*Diadumene lineata*													1						1		2
G	*Batillaria multiformis*	9		4		5		6		4		2		2		4		4		2		42
G	*Batillaria zonalis*	2				7		3		10				3		5		4		2		36
G	*Clithon retropictus*	3						3						4		3		4				17
G	*Littoraria articulata*	3		4		2						3						2				14

G	*Lottia dorsuosa*	4	4		5				4	4	3	24
G	*Lunella coronata*			4	2	3	4		2		3	18
G	*Lunella granulata*			3	4	3	5		3		5	23
G	*Monodonta labio*	10	9	11	15	17	13	13	16	16	14	134
G	*Nipponacmea concinna*	5	5								1	11
G	*Nodilittorina radiata*							3		1		4
G	*Patelloida pygmaea*				2			3		1		6
G	*Pirenella incisa*		1	1	1			1		1		5
Po	*Lepidozona spp.*						1					1
Sp	*Siphonosoma sp.*	1	1	1							1	4
Sp	*Sipunculus nudus*							1				1
											Total	**708**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete, P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022 Sampling Zone TC3 High tidal level (2.0 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Bi	*Barbatia virescens*	1		1		4				2		1		3				4				16
Bi	*Brachidontes variabilis*			1		1		2						1				2		2		9
Bi	*Glauconome chinensis*		3							2							1				1	7
Bi	*Saccostrea cucullata*	31		36		37		44		36		21		39		36		29		25		334
Bi	*Xenostrobus atratus*	3				8												6				17
C	*Gaetice depressus*			1		1		2														4
C	*Metopograpsus latifrons*							6		2										1		9
C	*Pagurus dubius*							2				1					1			2		6
G	*Batillaria multiformis*	6				4		2		2		3		3				1		5		26
G	*Batillaria zonalis*	1		3		1		1						2		9				3		20
G	*Clithon oualaniensis*									4		1						4				9
G	*Clithon retropictus*			1		2						3		2				1				9
G	*Littoraria articulata*	5		7										3		3		5		6		29
G	*Lunella coronata*	2				2		3		7				3		3		6		2		28
G	*Lunella granulata*			2		1		1		3		3				3				1		14
G	*Monodonta labio*	13		13		27		16		11		9		13		9		8		11		130

G	*Nerita chamaeleon*												3			1		4
G	*Nerita polita*	1										2						3
G	*Nerita squamulata*								1									1
G	*Nipponacmea concinna*	3				1					3							7
G	*Nodilittorina radiata*												1					1
G	*Patelloida pygmaea*	3		4		2		2				1	4			1		17
G	*Pirenella incisa*														4			4
G	*Thais clavigera*	1										1				1		3
P	*Nereididae spp.*				1									2				3
P	*Perinereis sp.*	1					1							1			1	4
P	*Sabellidae imbricatus*		1							1							1	3
Pl	*Platyhelminthes*														1			1
																	Total	**718**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022 Sampling Zone TC3 Mid tidal level (1.5 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	Balanus amphitrite											2		1						2		5
Bi	Barbatia virescens	3		2		4		1		2		3		4		1		2				22
Bi	Brachidontes variabilis	3		2				3		2		4		1		2		2		5		24
Bi	Glauconome chinensis	2		1		2				2								8		3		18
Bi	Saccostrea cucullata	13		26		45		23		36		48		20		21		38		44		314
Bi	Xenostrobus atratus							11		8		7		3		7		6		2		44
C	Gaetice depressus	1				2				1		2				4		1		1		12
C	Metopograpsus latifrons			1		1				3		1		1				2		3		12
G	Batillaria multiformis	21		11		6		12		7		11		11		7		5		2		93
G	Batillaria zonalis	12		6		1		20		3		12		6		1				2		63
G	Clithon faba					1		2								2		7				12
G	Clithon oualaniense					1		5		10		2				7		2		3		30
G	Clithon retropictus							8												2		10
G	Littoraria articulata			2		2				3						1		3				11
G	Lottia dorsuosa							2				2								3		7
G	Lunella coronata	1		3		3						7		10		1						25

G	Lunella granulata	3		2		4				3		10		7		3		7		9		48
G	Monodonta labio	14		12		10		21		3		29		26		16		11		6		148
G	Nerita chamaeleon			1		3				5		1				1		2		2		15
G	Nerita lineata							3						1				1		6		11
G	Nerita polita											3										3
G	Nerita squamulata			3														3		1		7
G	Nipponacmea concinna							2		2		2		3		2				3		14
G	Nodilittorina radiata							3				7				1		2				13
G	Patelloida pygmaea					1						2		2		1				2		8
G	Pirenella asiatica	2		7				3		2		5										19
G	Pirenella incisa	1		5				2		8				2	3			5				26
Ne	Nemertea spp.		1	2	1				2				2	1	2		1				2	14
P	Sabellidae imbricatus	3		2		2		3		2		2								3		17
Po	Lepidozona spp.	3		1		1		2		1		2		1		1		1		2		15
Sp	Siphonosoma sp.		1		1	2			1		2		1				2					10
Sp	Sipunculus nudus				1		1						1								1	4
																					Total	**1074**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022	Sampling Zone TC3	Low tidal level (0.5 m above C.D.)																				
		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	Balanus amphitrite			2		1		1		2				3						3		12
Bi	Barbatia virescens	3		3		2		2		3				2				3		1		19
Bi	Anomalocardia squamosa		1		1						2		2	3		3					1	13
Bi	Ruditapes philippinarum				2				1	3						3						9
Bi	Brachidontes variabilis	3								3				6		1						13
Bi	Glauconome chinensis			5		1		2						2								10
Bi	Saccostrea cucullata	37		37		41		28		34		35		31		31		35		43		352
Bi	Xenostrobus atratus	3		11		2	1	2		2		5		8		4		4		3		45
C	Gaetice depressus	2		3		4		2		1		4		3		4		1				24
C	Metopograpsus latifrons	1				5		3				3				2		3				17
C	Pagurus dubius																					0
G	Batillaria multiformis	1		7				2						2				5		12		29
G	Batillaria zonalis	3		8				1		2		2		2				3		3		24
G	Clithon oualaniensis	2														1		2				5
G	Littoraria articulata	6				4								4						2		16
G	Lottia dorsuosa					6																6
G	Lunella coronata	4		4		3				2		2		3		2		5		5		30
G	Lunella granulata	7		3		4		3		5				2		4		5		4		37
G	Monodonta labio	8		14		13		12		9		6		7		15		11		6		101

G	Nipponacmea concinna	3		2				2		2						3		3		1		16
G	Patelloida pygmaea																			2		2
G	Pirenella incisa																			2		2
P	Nereididae spp.				3		1						3									7
P	Sabellidae imbricatus	3		1			2	2	2	1	1	3		4		2		5				26
Sp	Siphonosoma sp.		1				1		1					2	2		2				1	10
Sp	*Sipunculus nudus*				1				1								1					3
																			Total	**828**		

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022	Sampling Zone ST	High tidal level (2.0 m above C.D.)																				
		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*	1		1				3														5
Bi	*Barbatia virescens*					2						1				3						6
Bi	*Brachidontes variabilis*			1						3		1		3		1		2		3		14
Bi	*Glauconome chinensis*							2		1		2				5		3		1		14
Bi	*Saccostrea cucullata*	33		35		31		28		33		41		21		12		28		29		291
Bi	*Xenostrobus atratus*	2		4										3								9
C	*Gaetice depressus*	1		1		2												1				5
C	*Metopograpsus latifrons*	1		1				1				1		2		1		2		1		10
C	*Pagurus dubius*			1				2		1		1				2						7
Cn	*Diadumene lineata*							1														1
G	*Batillaria multiformis*	3		5		10		14		13		11		8		15		8		7		94
G	*Batillaria zonalis*					2		3				3		3		3				3		17
G	*Cellana toreuma*	2		2				1						2								7
G	*Clithon faba*					1				2		1										4
G	*Clithon retropictus*	3						1		3						1		2				10

G	*Littoraria articulata*												2								2
G	*Lottia dorsuosa*					2															2
G	*Lunella coronata*	1				3		2					1		1		3				11
G	*Lunella granulata*			1		2		1		4		4	2		3		5		3		25
G	*Monodonta labio*	11		21		18		11		8		10	13		16				13		121
G	*Nerita chamaeleon*			2		3				1											6
G	*Nerita polita*									2					2						4
G	*Nipponacmea concinna*					2							1				1		2		6
G	*Nodilittorina radiata*	3		4		1		9				1			1						19
G	*Patelloida pygmaea*	1		4		1							2				1				9
G	*Pirenella incisa*			2		3					2					1					8
P	*Sabellidae imbricatus*	6		3				2	1	5		3	3				1		2		26
Po	*Lepidozona spp.*									2									1		3
Sp	*Sipunculus nudus*				1													1			2
Sp	*Siphonosoma sp.*		1		1		1		2					1	1	1		1		1	10
																			Total		**748**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022	Sampling Zone ST	Mid tidal level (1.5 m above C.D.)																				
		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Bi	*Barbatia virescens*			1				4		1		1		1		2		1		2		13
Bi	*Glauconome chinensis*			1		2				1						1				2		7
Bi	*Brachidontes variabilis*									1		2		4		7		4		3		21
Bi	*Saccostrea cucullata*	27		27		38		33		31		47		31		21		35		27		317
Bi	*Xenostrobus atratus*			4		8		6						4		2		2		2		28
C	*Gaetice depressus*					3		2						2								7
C	*Metopograpsus latifrons*			2		2				1				1		2		2				10
C	*Pagurus dubius*													2								2
G	*Batillaria multiformis*	23		4		2		3		2		3				8		2		1		48
G	*Batillaria zonalis*	6		9		11		13		9		6		2		6		6		11		79
G	*Chlorostoma argyrostomum*	3				4		3												3		13
G	*Clithon faba*	1		2						2						4		2				11
G	*Clithon oualaniense*													3				1		2		6
G	*Clithon retropictus*					1										2				1		4
G	*Littoraria articulata*			7		2		5						2		2		8		8		34
G	*Lottia dorsuosa*																			1		1
G	*Lunella coronata*			1		2		2		4		7		7		4		2		5		34

G	*Lunella granulata*	4				4		8		6	7		6		6		4		7		52
G	*Monodonta labio*	19		21		14		21		15	10		35		10		15		21		181
G	*Nerita chamaeleon*																1				1
G	*Nerita lineata*	1		1											2						4
G	*Nerita squamulata*	2		2		1				2			3								10
G	*Nipponacmea concinna*			1		1		3					2		5						12
G	*Nodilittorina radiata*	2		4		3		1		5			5								20
G	*Patelloida pygmaea*							1		1	1				3				3		9
G	*Pirenella incisa*	3												1							4
Ne	*Nemertea spp.*	5	1	1								2						2			11
P	*Sabellidae imbricatus*	2				1	1	3	1	2	3					2	3				18
Po	*Lepidozona spp.*									1	2		2						2		7
Sp	*Siphonosoma sp.*		*2*										1	1				1		1	6
Sp	*Sipunculus nudus*				1		1		1							2					5
																			Total		**975**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete, P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

Annex V (Cont'd). *List of recorded fauna of intertidal soft shore community survey in every sampling zone*

Mar 2022 Sampling Zone ST Low tidal level (0.5 m above C.D.)

		1		2		3		4		5		6		7		8		9		10		
Gp	Taxon	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Q	C	Sub-total
Ba	*Balanus amphitrite*	2				1		2		1		1		1		2		1		1		12
Bi	*Anomalocardia squamosa*	2		3		2							1				1	2			1	12
Bi	*Barbatia virescens*	1				2						3		2				1		2		11
Bi	*Brachidontes variabilis*															3				1		4
Bi	*Glauconome chinensis*					2				2						4		2				10
Bi	*Saccostrea cucullata*	23		14		25		26		22		27		18		28		27		25		235
Bi	*Xenostrobus atratus*	2				1						8		2		5		3		8		29
C	*Gaetice depressus*	3		4	1					2				2								12
C	*Hemigrapsus penicillatus*																					0
C	*Metopograpsus latifrons*									1		2		3								6
C	*Metopograpsus quadridentatus*																			3		3
Cn	*Diadumene lineata*																					0
G	*Batillaria multiformis*	2		3		4		2		3		3		5		3		6		8		39
G	*Batillaria zonalis*	4		7		5		1		3		11		2		5		4				42
G	*Chlorostoma argyrostomum*																					0
G	*Clithon faba*	1																				1
G	*Lottia dorsuosa*	4						1		2		4				5				4		20
G	*Lunella coronata*							5		1		9		6		2		7				30

G	*Lunella granulata*			8		6		2		9						4		2		4		35
G	*Monodonta labio*	16		5		14		8		12		15		6		16		7		9		108
G	*Nerita lineata*																	1		2		3
G	*Nerita squamulata*	1																				1
G	*Nipponacmea concinna*			3				3		2		1		2		1		5				17
G	*Nodilittorina radiata*			1										2				1		6		10
G	*Patelloida pygmaea*	3						3				5						8				19
G	*Pirenella incisa*				2														1			3
Ne	*Nemertea spp.*														2						1	3
P	*Sabellidae imbricatus*	3					3			2	2	3			1	2		2			1	19
Po	*Lepidozona spp.*					2								1								3
Sp	*Siphonosoma sp.*		1														2		1			4
Sp	*Sipunculus nudus*		1										1									2
																				Total		**693**

Key for faunal groups (Gp):

Ba: Barnacle, Bi: Bivalve, C: Crab, Cn: Cnidarin, Eh: Echiuran, F: Fish, G: Gastropod, Hc: Hermit crab, Ne: Nemertean, Ol: Oligochaete,

P: Polychaete, Pl: Platyhelminthes, Po: Polyplacophores, S: Shrimp, Sc: Scaphopods, Sp: Sipunculan

End of the report