Rapid baseline assessment of crab abundance and species richness in mangroves using a video recording method

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Abstract. Crabs are among the most dominant macrofauna in mangrove ecosystems. Crabs play vital roles in maintaining the ecological functions of mangroves. However, there are limitations in assessing crab populations accurately. In previous studies crabs are caught or visually observed by researchers to obtain data on crab abundance and diversity. However, difficulties and biases arise due to complications in sighting crabs accurately and minimizing damage caused by intrusive methods used when attempts are made to capture crabs in situ. Therefore, more accurate observations, and less intrusive method should be implemented to identify crab populations. Two less destructive methods to investigate crab abundance were used in this study and compared to ascertain the efficiency of obtaining mangrove crab population data. Findings show that video recording method was more accurate compared with hand catch method in providing crab abundance data as hand catch method resulted in the under-sampling of crab abundance. This video recording method may be used: (1) to identify the abundance of crabs in a quadrat, (2) to provide crab population data as the quadrat is replicated in multiple sampling sites, and (3) to observe crab behaviour.

1. Introduction

Crabs play a vital role in the functioning of mangrove ecosystems [1]. Activities conducted by crabs form the basis of food supply and energy transfer in mangroves [2]. The leaves that are consumed by the crabs will be degraded and turned into partially digested faecal material that are more suitable for the consumption of detritivores [2]. Crab activity facilitates organic matter cycling in mangroves as these crabs bury the detrital matter in mangrove sediment, thus slowing down the export of detrital matter out of the mangrove ecosystem [3-5]. The burrowing activity of crabs, termed bioturbation modifies the physical structure of the sediment by redistributing particle size and improving drainage [6, 7] and promotes greater soil aeration [8]. This contributes to nutrient availability in sediment, influencing microbial activity involved in biogeochemical cycles [7] as well as redox sensitive processes [9]. Moreover, mangrove crabs also aid in bioremediation as wastewater enters the mangrove sediment through crab burrows [10], allowing the excess nutrients from the wastewater to be absorbed by mangrove trees [11]. Therefore, identifying the abundance and diversity of crabs is important in monitoring the rate of mangrove productivity and ecosystem health.

Despite the crucial roles of crabs in mangrove as an ecosystem engineer as well as a bioindicator, there are limitations in obtaining accurate data on crab populations in mangroves. Crabs are very sensitive to the surrounding environment, as crabs would quickly retreat into the burrows at the first sign of vibration or danger [12]. Therefore, a less intrusive method of crab sampling should be
implemented in order to obtain more accurate data on crab populations. Abundance of crabs could be identified via video recording, which is a modification of visual observation method [13] that may provide more accurate data with less destructive effects [14, 15] compared with other methods such as burrow excavation [14], pitfall trap [3] and hand catch method [16].

Previous authors have noted that another important issue to consider is the reliability of crab capture methods. Most of sampling methods are destructive and less reliable [17] such as burrow excavation [14] and pitfall trap [3], which are destructive and time consuming [18]. Burrow excavation for example have been known to cause irreversible disturbances on mangrove crabs [19]. Pitfall traps may introduce bias sampling as there might be a species-specific response as some crabs may avoid themselves from falling into the traps [15, 19] while less intrusive remote photographic method by Vermeiren and Sheaves [15] may be limited to short time frame compared to video recording method where the camera can be left for adequate period of time. Furthermore, this method is only limited to the crab population that occupies bare, low intertidal banks. Thus, it is important to identify a new method via video recording that can be use in the mangroves.

Thus, a least intrusive, quick and reliable method, video recording, could improve the efficiency of recording crab abundance and richness [14, 15]. Video recording is a modification of visual observation [13], that can provide more accurate estimation of crab population density [14]. However, it is difficult to identify crab species via video recording or visual observation methods [20]. Therefore, it is practical to include the use of more than one method to account for biases that may occur if only one method was used.

In addition, difficulty in identifying crab species presents another problem in mangrove crab studies [21]. There are issues in mangrove crab taxonomic and nomenclature due to changes of genera [22] and insufficient taxonomic resolution [23]. Schubart et al. (2000) suggested reclassification of some genera and acknowledgement of new taxonomic units. Furthermore, there is no complete identification key for mangrove crabs of South East Asia [24]. Hence, a combination of video recording and hand catch methods may provide data for abundance as well as species richness in an area.

2. Materials and methods

2.1 Study Site

Sampling was conducted at mangroves of Merbok and Penang in 2016. Merbok and Penang mangroves are located at North-west Peninsular Malaysia [25]. Three forests were chosen in each area.

Figure 1. The map shows the location of the study sites 1) Merbok and 2) Penang
2.2 Sampling method
Three cameras were set up in a plot where a camera was placed near each quadrat (Figure 2). The camera was secured to a tripod stand that was adjusted to be 0.5 metre above the ground. The distance of the camera from the plot was 0.5 meters away. Each quadrat covers an area of 1 meter by 1 meter as the radius of crab activity ranged between 0 cm to 100 cm [12]. The quadrat was made by thin plastic rope to avoid disturbance to the crabs. Previously, thicker material (plastic rope and a metal quadrat) used to create a quadrat resulted in crabs staying longer in their burrows or crabs not appearing at all on the mangrove sediment surface. Furthermore, this study did not prevent the crabs from escaping the quadrat as only the crabs that emerge from burrows were taken into account [19]. The recordings spanned 20 minutes, with five minutes allowed for crabs to recover from stress introduced by setting up camera equipment, and 15 minutes of video recording adapted from Nobbs & McGuinness, [19].

Figure 2. Video recording comprising the use of a camera placed over a 1m² quadrat. Crab abundance was observed and counted for 15 minutes.

In addition to video recording, the crabs were also captured by hand for 15 minutes after the video recording ended [3]. Crabs were then examined under the microscope for further species identification. Samples collected were washed over 2 mm sieve then preserved in 70% ethanol for species identification.

The video recordings of the crabs were analysed to identify the abundance while the captured crabs were analysed for both abundance and species identification. For counting of crabs in the video, a transparent paper was used by placing the paper onto the laptop monitor while the video played, so that the crabs that came out from the burrows were marked with a marker pen. The movement of the crabs were monitored carefully to avoid double or triple counts. For quadrat with small number of crabs, the counting was done once for the whole 20 minutes while for quadrats with large number of crabs, the counting was done twice.

3. Results and Discussion
The data presented here is the abundance of crabs in mangrove sites in North Peninsular Malaysia obtained via video recording and hand catch methods respectively (Figure 3). Kuala Sg Pinang, Gurney, and Pulau Betong were located in the island of Penang, characterized by urbanization and proximity to anthropogenic activities. Sungai Batu, Sungai Bujang and Sungai Gelam were located in Merbok in the mainland of Northern Peninsular Malaysia, characterized by multispecies stands of less disturbed mangrove forests. A general linear model (ANOVA) was used to analyse the different methods used to identify crab abundance.
Crab abundance observed in video recordings was overall greater than crabs caught by hand for all sampling sites, except for Sungai Gelam (ANOVA Forest x Method: F5,432 = 14.82, p<0.05; Figure 3). The number of crabs recorded in this study based on video recordings was more comparable to the number of crabs recorded by MacDonald [26] in his study in Peninsular Malaysia. In this study, 0-70 crabs per square meter were observed via video recording, while MacDonald [26], obtained 0-92 crabs per square meter. In contrast, only 0-30 crabs were obtained via hand catch method in this present study.

The hand catch method could have introduced greater disturbance to crab assemblages during sampling activities compared with the video recording method, and may be considered as more intrusive [17]. This was evident as during the 15 minute hand catch timeframe, crabs were observed to scamper and quickly retreat into the burrows at the first sign of vibration, movement or danger [12]. Furthermore, some species of crabs were more cautious [27] and hid in their burrows throughout the hand catch session. This resulted in underestimation of crab counts, and introduces potential bias that is species specific, for example only active and less cautious crabs could be obtained in the dataset.

Visual count or visual observation used by MacDonald [26] which obtained comparable findings with this study indicate that the level of accuracy for both methods might be almost similar. In fact, the ability to conduct *in situ* behavioural observations is also another similar advantage of using both of these methods, which could not be done by other methods [15]. However, visual count is more labour intensive compared with video recording method as the observer has to stand at the same spot for at least 15 minutes to wait for the crabs to re-emerge from their burrows [13]. Furthermore, the observer has to stay still and silent for the whole allocated time to avoid disturbance that may cause the crabs to stay in their burrows [12]. High concentration is also required to ensure the accuracy of the crab counting activity, while the observer is more prone to making mistakes especially when considering the human error that may occur due to tiredness and exhaustion caused by continuous observation.

In comparison, cameras will accurately capture images and videos of crabs in the allocated time. More importantly, the recorded videos can be replayed to recheck crab counts and minimize error in assessing crab abundance. In fact, less labour intensive methods such as video recording might not only provide higher accuracy of crab abundance but also opens up possibilities for more standardized and greater number of replicates [15]. This can be compared with ecological techniques which employ the

**Figure 3.** Mean (+ Standard error of the mean (SEM)) of crab abundance per square meter based on different methods, video recording hand catch method in all mangrove forests (n=6) at all four sampling month July, September, November and December 2016. (Means were averaged across month (n=4) x treatments (n=3) x plots (n=4)).
use of camera technology, which relies on the accuracy of cameras capturing images and videos continuously with minimal interruptions and errors. In addition, cameras can be set up simultaneously with less disturbance compared with having more number of observers in the field [15].

Another advantage of using video recording method instead of visual count is the ability to identify both large adults or large crab species and the small and cryptic crab species such as *Paracleistostoma depressum* which is the most dominant species found in this study. This is because, one of the limitations of visual count stated by Kent and McGuinness [13], is in order to identify small crabs, the observer has to be 1 m from the quadrat however, the larger crabs or the adults crab will only emerge when the observer is at least 6 m from the quadrat as the adult crabs might be more sensitive in sensing the presence or vibration from any slight movement of the observer [13]. For video recording, the cameras can be set up as close as 0.5 m, as applied in this study, without intimidating the large or adult crabs and preventing them from emerging out of the burrows.

Furthermore, in this study, the overall pattern of crab abundance was also clearer when the video recording data was considered. Greater abundance of crabs was recorded in sites in Penang compared with sites in Merbok (Figure 2). This could indicate that more crabs were found in Penang, attributed to higher organic matter content found in mangrove sediments in these sites.

### 4. Conclusion

We suggest video recording to be a more accurate method to identify the abundance of crabs in mangroves [14, 17]. The video recording method provides a rapid assessment of crab abundance and can be utilized to observe crab behaviour. In cases where a quick estimate is needed to observe patterns in crab abundance in relation to environmental conditions, the video recording method may be more time, energy and cost efficient compared with other intrusive methods.

However, there were limitations to the video recording method. Based on the videos recorded in this present study, it was difficult to identify the crab to species level, as there were parts of crab morphology that required detailed observation to identify crab species. Ashton [20] stated in her study that the hand catch method might be a good method to measure crab richness but was only suitable to estimate crab abundance. Thus, both methods hand catch, and video recording were required to identify crab abundance and species richness.

The use of more advanced high resolution camera and visual recording equipment might be useful so that the crabs can be identified to species level, thus it would be unnecessary to complement the video recording method with other intrusive method such as hand catch method for species identification purposes.

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