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Original Article

Evaluation of the fisheries and resource of sea cucumbers in the coastal waters of Trincomalee district, Eastern Sri Lanka

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Abstract: Though sea cucumber is one of the key export-oriented fishery resources in Sri Lanka, there is some evidence for the population depletion of most of the sea cucumber species in the shallow coastal waters. The present study was aimed to study the status of the sea cucumber fishery in the Irrakkakandi coastal area, eastern Sri Lanka, and carry out a stock assessment on the critical sea cucumber species presently harvested in this area. In order to achieve the objectives, logbook records based survey was conducted to cover the fishing season in 2019, from late February to the end of September. The harvest was collected by skin diving from shallow nearshore waters and Scuba diving from distal coastal waters about 5 km away from the shore. *Thelenota anax* was the dominant species in the catch from both fishing grounds, with a relative abundance of 86.82% in shallow waters and 91.30% in distal waters. The average Catch Per Unit Effort (CPUE) during the fishing season in 2019 for SCUBA diving and skin diving was 50±8.59 individuals /boat/day and 8±1.12 individuals /diver/day, respectively. The dominant stock of the *T. anax* in the distal fishing ground was assessed using the depletion method. The initial stock size of *T. anax* at the onset of the fishing season was estimated at 112,067 individuals, and about 25% of the initial stock had been fished by the end of the fishing season in 2019. The estimated catchability coefficient (q) was 0.00046. The study revealed that the stock of *T. anax* along with other recorded threatened species in the Irrakkakandi coastal waters might be led towards extinction if the fishery prevails without proper management.

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Introduction

Sri Lanka is an island nation located in between 5°55' and 9°55'N and 72°42' and 81°52'E, south of the Indian subcontinent. It has a total land area of 65,000 km^2 and a coastline of 1,770 km in length, containing several bays and shallow inlets (Kumara et al., 2005; Dissanayake et al., 2010). The continental shelf area is 30,000 km^2, which is relatively narrow and small in the area when compared with other island nations (Kumara et al., 2005). Fishing activities are carried out all around the coast, but primarily within the continental shelf, which rarely extends more than 40 km and averages 25 km (Dissanayake et al., 2010).

Though there are nearly 200 known species of sea cucumbers found in the waters around Sri Lanka, about 75 species inhabit shallow coastal waters, while nearly 50 species are abundant in intertidal areas (Kumara et al., 2005). Among them, 21 species are considered commercially important (Dissanayake and Athukoorala, 2010; Dissanayake and Stefanson, 2010). As in many Asian countries, the sea cucumber fishery in Sri Lanka is an artisanal fishery confined to the shallow coastal waters (Dissanayake et al., 2010; Dissanayake and Stefanson, 2012). At the present, the sea cucumber fishery is confined to the north-western (Puttlam and Mannar districts), eastern (Trincomalee to Ampara districts), northern (Jaffna district) and north-eastern (Mullaitivu district) coastal areas of the island. Sea cucumbers were initially harvested by hand picking along the coast during the low tide period, and since the 1980's fishers moved further offshore using snorkelling and at present by scuba diving as stock became depleted in shallow waters (Kumara et al., 2005). Fishing activities for sea cucumbers in Sri Lanka are highly seasonal which affected by the monsoon wind patterns. Generally, the

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fishery for sea cucumbers in north-eastern and eastern coastal areas are carried out from the end of March to the end of September, while in north-western coastal areas, those prevail from the onset of October to onset March. As in the many parts of the Asia region, all the harvest is exported as the 'Beche-de-mer', mainly to Singapore, Hong Kong and China (Dissanayake et al., 2010; Dissanayake and Stefanson, 2010).

Holothurians are now considered valuable species worldwide (Conand, 2008), and the recovery of depleted populations are slow and sporadic (Kinch, 2002). Even though there is a long history of sea cucumber fishery in Sri Lanka which dated back to about 1000 years back (Dissanayake and Wijeyaratne, 2007; Dissanayake and Stefanson, 2010), baseline data on the species composition, stock status, catch, effort etc. are very scarce. Thus, the fishery for sea cucumbers in Sri Lanka has developed neither regulations nor precautionary approaches except diving and transportation licenses (Dissanayake and Wijeyaratne, 2007; Dissanayake and Athukoorala, 2010; Dissanayake and Stefanson, 2010, 2012). Furthermore, some of the biological characteristics of the sea cucumbers, such as their lack of hard parts for ageing, difficulty in marking them, and plastic size and shape, may cause difficulties in conventional stock assessment methods (Perry et al., 1999; Uthicke, 2004). Making the situation worse, due to the less availability of facilities for conducting the fishery-independent surveys of resources, no one has attempted to carry out a stock assessment for sea cucumber resources in the Trincomalee district, eastern Sri Lanka, via such method.

Based on the observations, it is evident that intense exploitation rates generally induce sharp depletions in abundance after the main recruitment within a year. The depletion model is designed to capture such within-season dynamics and can be used to track in real-time the depletions in abundance under fishing pressure, allowing in-season adaptations of management measures (Pierce and Guerra, 1994; Agnew et al., 1998). Thus depletion models (Leslie and Davis, 1939; De Lury, 1947) are good candidates for in-season monitoring and management of invertebrate fisheries such as sea cucumbers (Trianni, 2000; Hoggarth et al., 2006; Prescott et al., 2013). Therefore, in this study, the present status of the sea cucumber fishery in the Trincomalee District, eastern Sri Lanka, was assessed. Further, the stock of dominant sea cumber species in the commercial catch was assessed by the depletion method. To my knowledge, this is the first effort to assess the sea cucumber fishery and the application of depletion methods for sea cucumber stock assessment in the Trincomalee district, eastern Sri Lanka. The findings of this study will help to understand the sea cucumber fishery and the current status, and the exploitation rates of the sea cucumbers in the region. The results will be beneficial for the preparation and implementation of appropriate management strategies for a sustainable fishery for sea cucumbers in the region.

Materials and Methods

Study area: A fisheries dependent survey of fisheries logbook records was carried out in 2019 in Irrakkakandi coastal area, Trincomalee district, eastern Sri Lanka. A single collector was responsible for carrying out the fishery for sea cucumbers in the Irrakkakandi coastal area (Fig. 1).

Data collection: The fishing season for sea cucumbers in the Trincomalee district was initiated in late February till September 2019. Thus the logbook data collection was carried out during this period. Sea cucumber collectors typically maintain their logbooks in which they record daily species wise catch per boat. Accordingly, data on the total landed catch per boat by species in terms of the number of individuals and the total number of boats operated each day was extracted from the daily logbook records of the collector. In addition, some of the fishers had involved in skin diving for collecting sea cucumbers in near shore shallow waters. The collector had recorded the daily species wise catch per each skin diver. Those data were also available separately in the logbook records, which was used to assess the nearshore stocks of the dominant sea cucumber species. As the collector had recorded the species by their local names, scientific

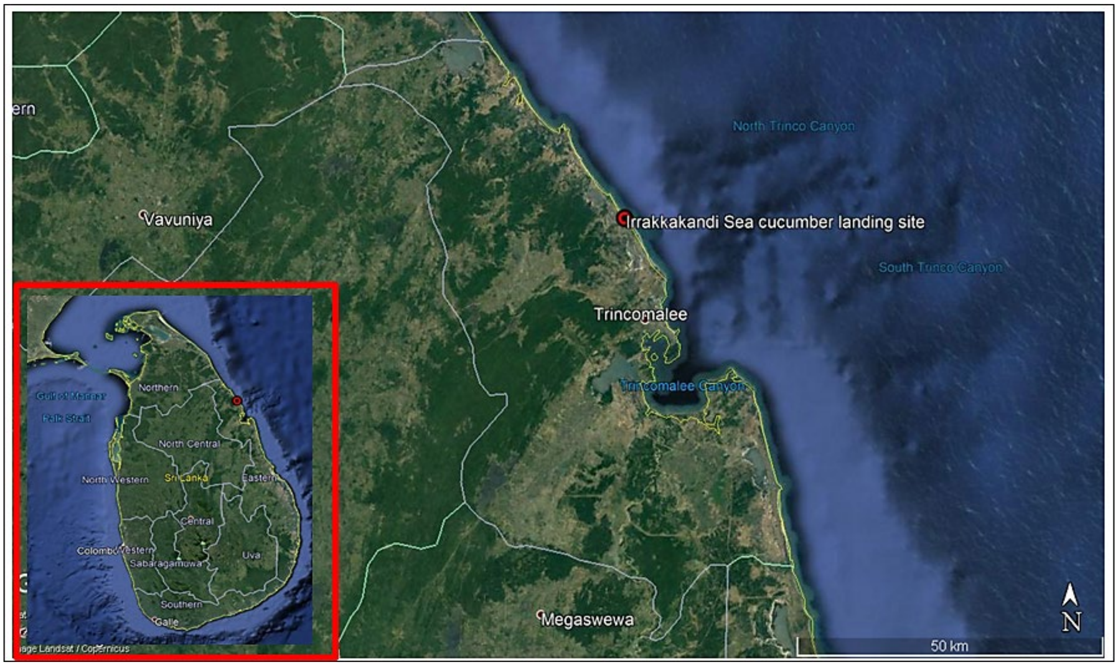

Figure 1. Sea cucumber landing site in Irrakkakandi area, Trincomalee district, eastern Sri Lanka (Sri Lankan map inset).

identification of the species was made in the field using available published literature and species identification guides (Conand, 1998; Dissanayake and Athukoorala, 2010; Purcell et al., 2012; Dissanayake and Nishanthan, 2016). Further information was gathered via interviewing the divers and boat skippers.

Total monthly catch estimate by species

For scuba diving: For the present study, a single fishing trip was considered as one unit of effort. Therefore, for each sea cucumber species, the monthly mean Catch Per Unit Effort (CPUE) in terms of catch in the number of individuals per boat per day was estimated based on the logbook data. Accordingly, the total monthly collection of sea cucumber species by scuba diving was estimated by summing up the daily catch records of the particular month.

For skin diving: The total effort of a skin diver in a single day was considered one unit of effort. For each sea cucumber species, the monthly mean CPUE in terms of catch in the number of individuals per diver per day was estimated based on the logbook data. Accordingly, the total monthly collection of sea cucumber species by skin diving was estimated by summing up the daily catch records of the particular month.

Stock assessment by depletion method: The depletion method consisted of modelling the depletion of stock during the main fishing season and analysing the influence of cumulative effort on an abundance index (Royer et al., 2002). This method allows interpolation of the total initial stock size during each fishing season (Leslie and Davis, 1939; De Lury, 1947). Models were based on a biological understanding of the fishery. Although not optimal, this was the best compromise between using the high resolution of the catch data and the lower resolution of the biological data (Keller et al., 2015). The model estimates the following parameters: the initial population (*N1*) and the current stock size, the expected catches for each time step during the depletion event (all in numbers), the catchability coefficient (*q*) and the goodness of fit measure (*Rt*). It was assumed that the population was a closed one because natural mortality would be low in the relatively short fishing season (Gould and Pollock, 1997). Further, the catchability coefficient (*q*) was assumed to be constant during the study period.

The assessments were conducted using the Leslie-DeLury DMs with the Catch and Effort Data Analysis (CEDA) Version 3.0 software package (Kirkwood et al., 2001). The CEDA software package assumes that the index (e.g. CPUE) is simply proportional to the stock size (Hoggarth et al., 2006). For the analysis, '*No recruitment*' model type was used as per availability of the data over a short period, certainly less than one year, and based on the assumption of the closed stock (Trianni, 2000; Kirkwood et al., 2001; Hoggarth et al., 2006). Thus it was assumed that there is no recruitment to the stock after the first data point but a constant natural mortality rate 'M' (Kirkwood et al., 2001; Hoggarth et al., 2006). For the analysis, 'M' was assumed to be not significantly different from zero over the period for which the model was fitted, which was generally of the order of about seven days (Parkes et al., 1996; Hoggarth et al., 2006; Prescott et al., 2013). The depletion model is as follows:

$$N_{t+1} = N_t\, e^{-M} - C_t\, e^{-\frac{1}{2}M}$$

Where N_t is the abundance in terms of numbers of sea cucumber at the start of time *t,* C is total catch taken over time *t,* and M is natural mortality. The '*No recruitment*' model type is as follows (Kirkwood et al., 2001):

$$N_{t+1} = e^{-M} N_t - e^{-\frac{1}{2}M}\, C_t$$

$$N_{t+\frac{1}{2}} = e^{-\frac{1}{2}M}\, N_t - \frac{1}{2} C_t$$

Where N_t is the abundance in terms of numbers of sea cucumber at the start of time *t,* C, is total catch taken over time *t,* and M is natural mortality.

There are three error models in the CEDA software package; least squares, gamma, log transform, deal with the measurement errors in the catch component of CPUE, or, if a single abundance index is being used, in the abundance index itself (Kirkwood et al., 2001), to achieve the best model fit (Keller et al., 2015). Considering the three error models in the CEDA software package, a preliminary analysis was conducted to understand the effect of each error model on the results and determine the most suitable one. The best error model for the analysis with the available data set was decided after analysing the "residuals" graphs of the observed and expected values of catch and CPUE (Kirkwood et al., 2001; Hoggarth et al., 2006). Further within the selected error model, Numerical measures of goodness of fit (R^2) was used to decide how well the model fits (Kirkwood et al., 2001; Hoggarth et al., 2006; Keller et al., 2015).

Results

Fishery, fishing season and fishing methods: The fishing season for the sea cucumbers in the Trincomalee district was from February to the end of September 2019. After that, fishing for sea cucumbers could be carried out day and night. However, since a complete ban on night diving activities in sea cucumber fishery has been executed by the Department of Fisheries and Aquatic Resources (DFAR) of Sri Lanka since April 2019, all fishing operations conducted targeting sea cucumber were confined to the daytime. Fishing operations were usually carried out by 6 to 7 m long outboard motor Fibre Reinforced Plastic (OFRP) boats. Under the collector in the Irrakkakandi area, there were 15 OFRP boats available for sea cucumber fishery though all of them had not operated in a single day. The collector used his boats interchangeably for the ease of service and repairs of the boats and engines. The catch had collected mainly by scuba divers by the method of hand-picking. According to the regulations implemented by the Department of Fisheries and Aquatic Resources (DFAR), Sri Lanka, two scuba divers and the boat operator were allowed to participate in one fishing operation by scuba diving. Furthermore, a boat could carry a maximum of 10 oxygen cylinders per single fishing operation. Usually, boats left from the landing site around 7.00 am and reached the landing site with the catch by around 2.00 pm. The fishing ground for scuba diving was about 5 km away from the shore, about 20 m depth.

In addition, few skin divers had engaged in sea cucumber collection in shallow waters on a more or less daily basis. There was no specific time for skin diving; thus, they had carried out the skin diving in search of sea cucumbers when the near shore waters got calm. Those skin divers just swam towards the fishing ground, located within 1 km distance from the shore and collected the catch. Then the catch was sold to the collector. The sea cucumber catch was processed at the collection centre to produce beach-

Table 1. Species composition of the sea cucumber fishery based on the landed catch from in Irrakkakandi area in 2019.

Family	Species	Common name	Local name	% in the catch		Global conservation status
				Scuba diving	Skin diving	
Stichopodidae	*Thelenota anax* Clark, 1921	Amber fish	Poona attaya	91.30	86.82	DD (Conand et al., 2013a)
	Stichopus chloronotus Brandt, 1835	Greenfish	Dambala Attaya	0.85	0.17	LC (Conand et al., 2013c)
Holothuriidae	*Actinopyga miliaris* (Quoy & Gaimard, 1834)	Hairy blackfish	Kalu gal attaya	3.20	4.74	VU (Conand et al., 2013b)
	Bohadschia sp.	Sandfish	Nool attaya	4.51	7.79	
	Holothuria atra Jaeger, 1833	Lollyfish	Nari Attaya	0.14	0.48	LC (Conand et al., 2013d)

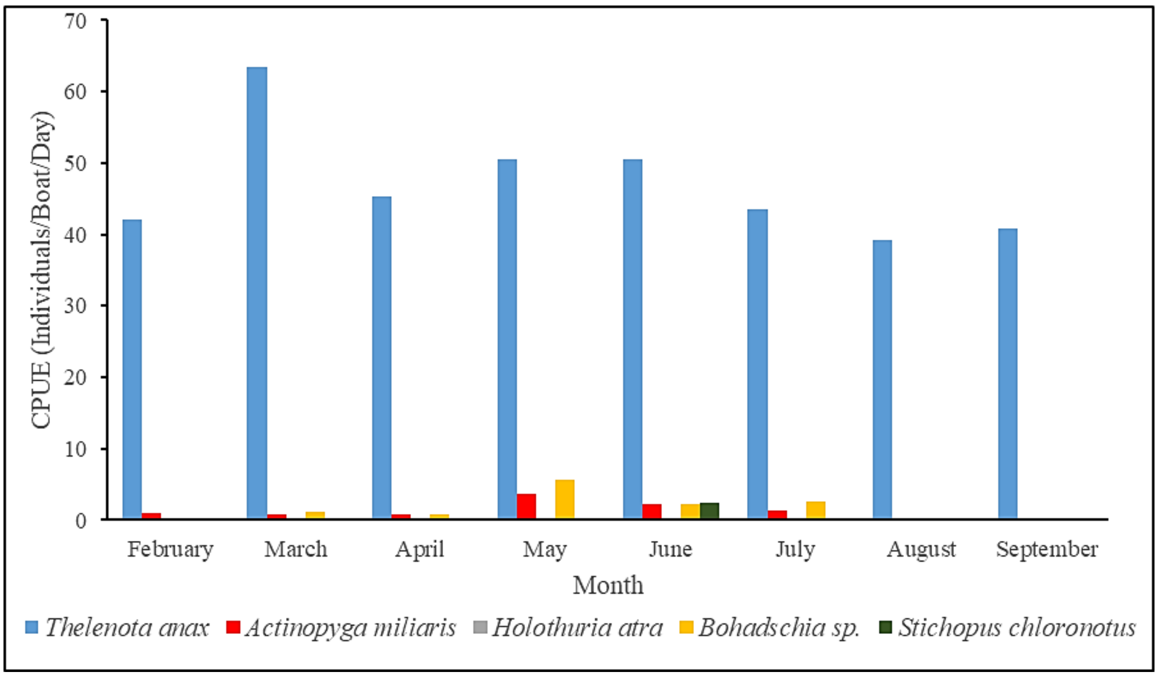

Figure 2. The monthly variation of the average Catch per Unit Effort (CPUE) in 2019 in the sea cucumber fishery by scuba diving in the Irrakkakandi area.

de-mer.

Species composition in the present catch in Irrakkakandi area: Five species belonged to two families were recorded from the catch of the Irrakkakandi waters on the eastern coast of Sri Lanka. Considering the fishery by scuba diving, *Thelenota anax* Clark, 1921, was the dominant species with 91.30% relative abundance in terms of the number of individuals (Table 1). *Holothuria atra* Jaeger, 1833 was recorded the lowest abundance with 0.14% representation in the catch in 2019. In addition, *Actinopyga miliaris* (Quoy & Gaimard, 1834), *Bohadschia* sp. and *Stichopus chloronotus* Brandt, 1835, had contributed to the rest of the catch (Table 1).

The catch of skin divers was composed of the same species as in the scuba diving but with different relative abundances. *Thelenota anax* was the dominant species with 86.82% relative abundance in terms of the number of individuals and *S. chloronotus* recorded the lowest abundance with 0.17% relative abundance in 2019 (Table 1).

The fishing effort, CPUE and production in the sea cucumber fishery

Scuba diving: The average effort during the fishing season in 2019 was estimated at 3.37±2.07 boat days.

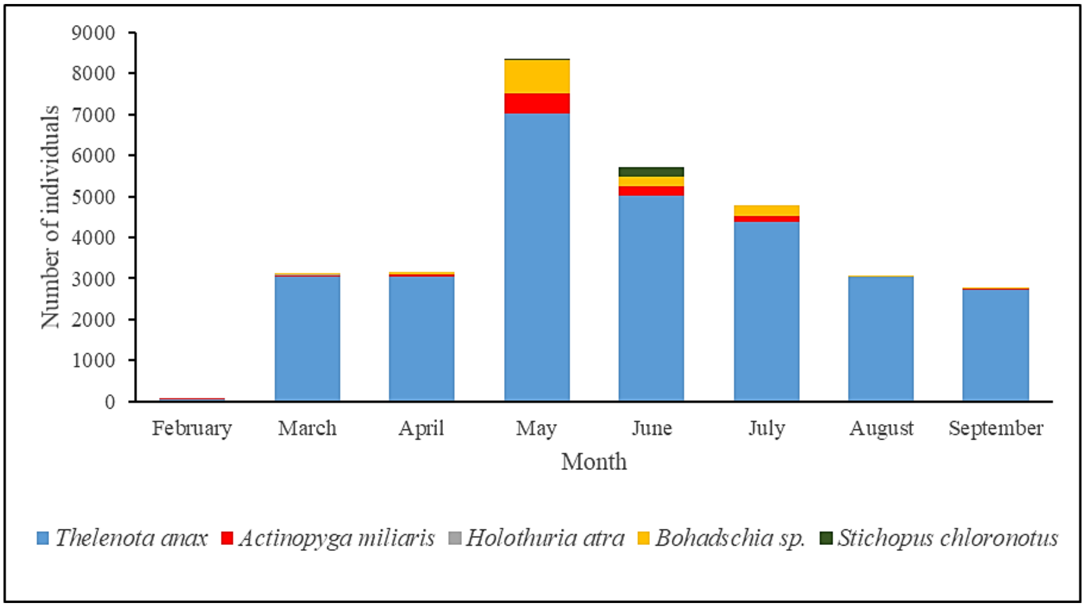

Figure 3. The monthly production of sea cumber fishery by SCUBA diving in the Irrakkakandi area in 2019.

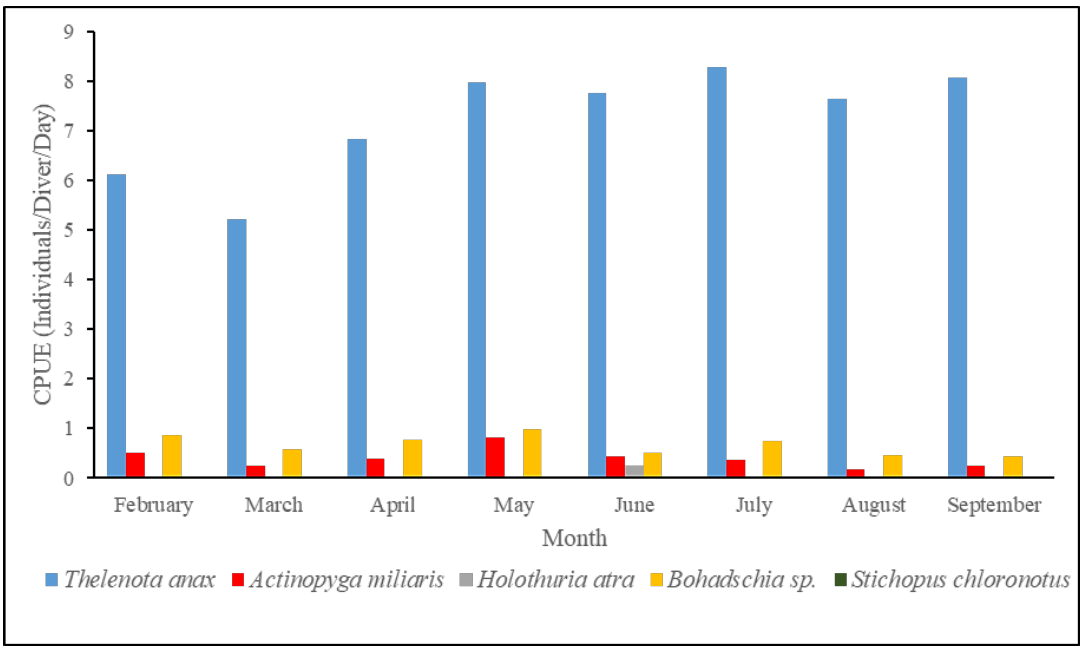

Figure 4. The monthly variation of the average Catch per Unit Effort (CPUE) in 2019 in the sea cucumber fishery by skin diving in the Irrakkakandi area.

The average CPUE in the sea cucumber fishery was 50±8.59 individuals /boat/day. Considering the CPUE for the species caught by Scuba diving, a gradual declining trend could be identified for *T. anax* from March towards the end of the season. A gradual incline till May and then after a declining trend towards the end of the season in the CPUE was observed for *A. miliaris* and *Bohadschia* sp. (Fig. 2).

The total production from the fishing ground for scuba diving in the Irrakkakandi area was estimated at 31,014 individuals of sea cucumber species in 2019. Among them, 28,317 individuals were represented by *T. anax.* Considering monthly variations in the total production by scuba diving, a sharp increment in the catch till May then gradually decreased towards the end of the fishing season (Fig. 3). The highest production was recorded in May 2019. The three most dominant species in the catch, *T. anax*, *A. miliaris* and *Bohadschia* sp. showed a similar production trend, which increased rapidly till May and then decreased

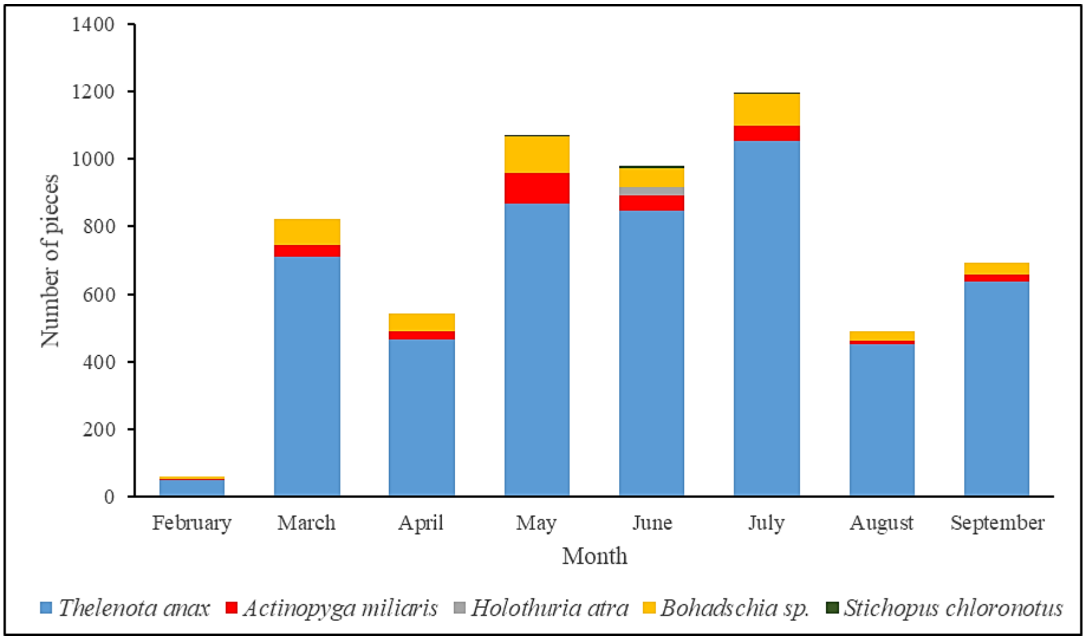

Figure 5. The monthly production of sea cumber fishery by skin diving in the Irrakkakandi area in 2019.

gradually to the end of the season in September. *Stichopus chloronotus* was recorded only in May and June.

Skin diving: The average effort for skin diving fishery during the fishing season in 2019 was estimated at 4.00±2.29 diver days. The average CPUE in the sea cucumber fishery by skin diving was estimated at 8±1.12 individuals /diver/ day. The highest average CPUE was recorded in May, and a gradual decline in the CPUE was observed then after towards the end of the fishing season for *A. miliaris* and *Bohadschia* sp. The average CPUE for *T. anax* remained almost constant from May to the end of the fishing season (Fig. 4).

The total production of sea cucumbers via skin diving in 2019 was estimated at 5,836 individuals, among which 5,067 individuals were represented by *T. anax*. Considering the monthly variation in the total production by skin diving, the total production was boosted from February to March, and then a drop-down was observed in April. Then, it gradually increased till July and recorded the highest production in 2019. After that, it decreased steeply in August. The most dominant species, *T. anax,* followed a trend similar to the total production. Considering other species in the catch, the production of *Bohadschia* sp. and *A. miliaris* exhibited an increasing trend till May and then decreased gradually towards the end of the season (Fig. 5).

Stock assessment for *Thelenota anax* in deep water fishing ground (scuba diving) in the Irrakkakandi area: According to the results, the stock at the onset and end of the fishing season was estimated at N_1 = 112,067 and N_{30} = 83,750 (R^2 = 0.94). The estimated catchability coefficient (q) was 0.00046. Thus, 25.27% of the *T. anax* stock thrived in the distal waters fishing ground was harvested by the end of the fishing season in 2019 (Fig. 6). Log transforms error model assumptions frequently showed minimisation failure in the stock assessment process for the other species recorded in the catch by the CEDA software package.

Discussions

Harvesting and exporting coastal ecosystem associated organisms such as sea cucumbers have contributed substantially to the country's foreign exchange earnings while providing essential livelihood to the coastal fishing community (Choo, 2008; Kumara et al., 2008; Dissanayake and Stefansson, 2012). Considering the fishery for sea cumbers in the Irrakkakandi area, Trincomalee district, eastern Sri Lanka, hand-picking by scuba diving was the main fishing method while OFRP boats were used fishing craft. Those are the main fishing and

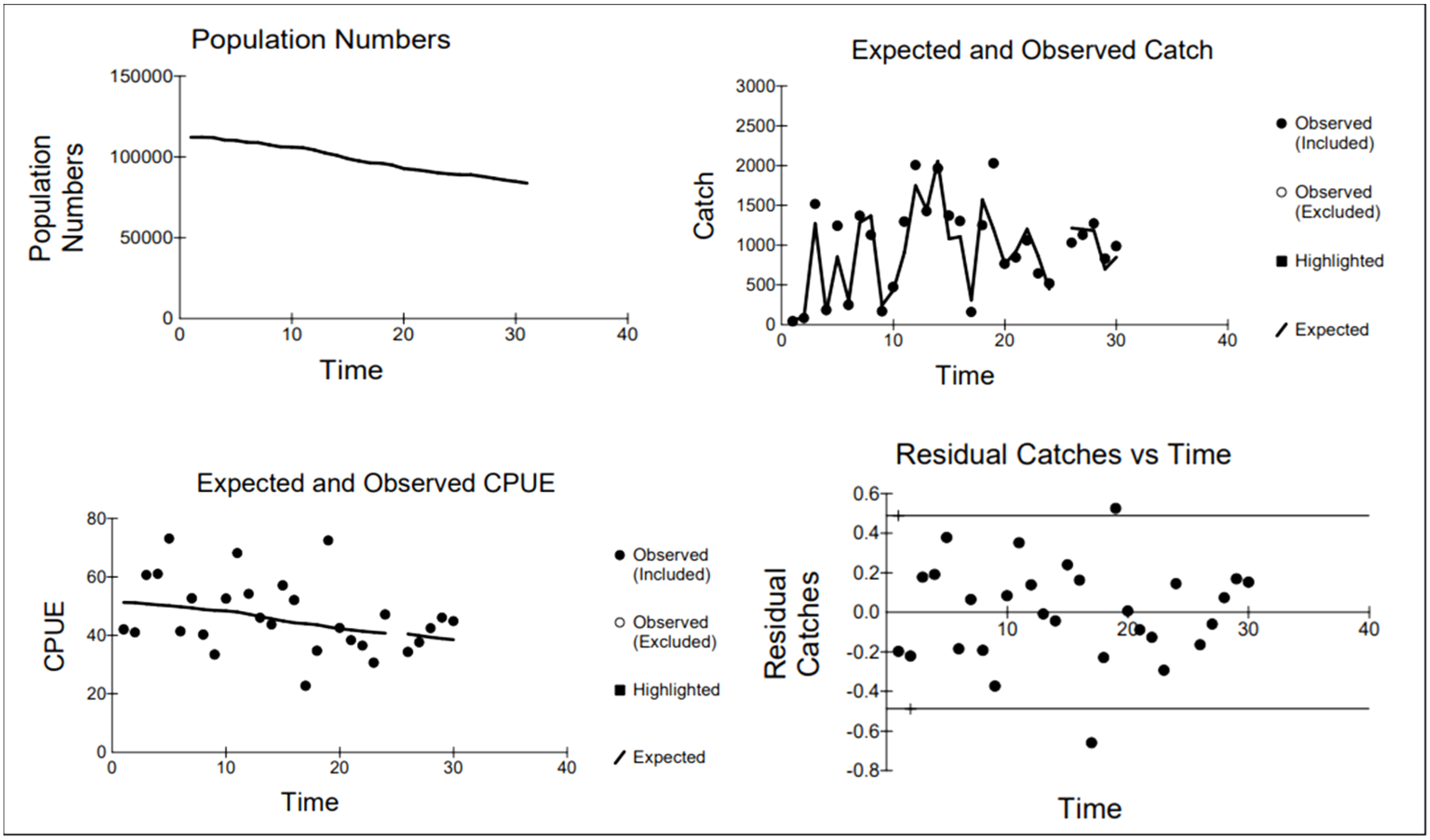

Figure 6. The results of the catch and effort data of *Thelenota anax* with the 'log transform error model' in CEDA software package version 3.0 for SCUBA diving fishery in the Irrakkakandi coastal waters in 2019.

craft types for sea cucumber fishery in Sri Lanka (Dissanayake and Athukoorala, 2010; Dissanayake and Stefansson, 2012). In addition to the hand-picking by scuba divers, some fishers involved in the hand-picking of sea cucumbers in nearshore shallow waters by skin diving. At the beginning of the sea cucumber fishery in Sri Lanka, hand-picking while wading or using snorkel gears were the main fishing methods (Kumara et al., 2005). However, due to the overexploitation of the nearshore sea cucumber resources, fishers had to exploit resources located in far deeper areas by scuba diving (Kumara et al., 2005; Dissanayake and Athukoorala, 2010). Therefore, it was evident that the sea cucumber resource in nearshore shallow waters in the Irrakkakandi area had not been over-exploited to date.

Though about 21 sea cucumber species are considered commercially important (Dissanayake and Stefanson, 2010) in Sri Lanka, only five species belonging to two families were recorded during this study. Among them, the representation of *Holothuria atra* in the catch from the deep distal waters was lower than that from the nearshore shallow waters. It may be attributed to the habitat preference of this species as it inhabits in aggregated populations in shallow waters where skin diving operated while it inhabits in more scatter in the deeper waters where the scuba diving operated (Conand, 1998). Further, this scattered nature of occupancy in the habitat may be the reason behind the lowest representation of *H. atra* in the catch from the scuba diving fishery. Furthermore, the lowest representation of *S. chloronotus* in the catch from the skin diving may also be attributed to its habitat preference. This species generally occurs on back reef hollows (Conand and Mangion, 2002) and in areas with boulders mixed with live corals (Choo, 2008), making it difficult to be spotted by the skin diver. However, due to the absence of scientific records of previous studies in sea cucumber fishery in Trincomalee district, Sri Lanka, it is challenging to state whether the relatively low abundance of *S. chloronotus*, *A. miliaris*, *H. atra* and *Bohadschia* sp. in the catch was due to depletion of the resources in the area or due to other factors such as the ecology of these species.

The lowest production from both fishing methods in February may be attributed to the lowest total fishing effort in February, as the fishing season started in the last week of the month. The Easter day terrorist attack in Sri Lanka on 21st April 2019 made a larger impact on Sri Lankan society, including the fishing community. It might be the reason behind the low production in April, as most of the fishing activities were seized for about two weeks due to security reasons. However, a continuous decline in the total monthly production was observed from May to September. The sharp decline in production could presumably be attributed to the depletion of the sea cucumber resource in the scuba fishing ground in the Irrakkakandi area. When considering the fishery for sea cucumbers by skin diving, the sudden drop of the production from July to August and also the comparatively low production in September may be due to either the depletion of the resources or unfavourable weather conditions for skin diving activities in rocky shore area in Irrakkakandi or due to the combination of both reasons. However, lacking historical data on the sea cucumber fishery in this area obstructed to conclude on either trend in the production or the fishing effort.

According to the collector in the Irrakkakandi area, the price paid for a diver per individual of different species in 2019 was 300-500 LKR (based on the size of the specimen) for *T. anax*; 400 LKR for *A. miliaris* and 200 LKR for *Bohadschia* sp. Therefore, when considering the species composition, production and CPUE for both harvesting methods, *T. anax* was dominated while *Bohadschia* sp. holds the second highest species in the catch. Though *A. miliaris* has higher economic value than *Bohadschia* sp, the higher percentage of *Bohadschia* sp in the catch probably explained by the fishers' behaviour which aims to catch valuable species first, and when such species are not abundant or not found, they attempt to harvest low-value species (Hasan, 2019).

Actinopyga miliaris was the third abundant species in the catch from both fishing methods in the Irrakkakandi area. According to the global conservation status of this species, it has been categorised under the 'Vulnerable' category, which is one of the 'threaten categories' in the IUCN criteria (Conand et al., 2013b). The price paid for an individual of *A. miliaris* was as same as for *T. anax*. Furthermore, unlike *T. anax*, *A. miliaris* can be easily collected from their habitats (Conand et al., 2013b). Therefore, the very low abundance in the catch most probably attributed to the very low stock abundance in the habitat. Thus prevailing fishing pressure may lead this species towards extinction from its local habitats. However, as there is a lack of historical data and unavailability of the stock assessment results from the present study for *A. miliaris*, it cannot be concluded on the present status of *A. miliaris* in the Irrakkakandi area.

Some studies (Purcell, 2010; Koike, 2017) have proven that the decreasing trend in the CPUE might indicate the decrease in the abundance of the target sea cucumber species in their habitat. However, the degree of confidence in CPUE as an index of species abundance varies with behavioural interactions between the harvested sea cucumber species and the collectors (Purcell, 2010; Dissanayake and Stefanson, 2012).

The stock assessment results revealed that around 25% of the stock of *T. anax* had been removed at the end of the fishing season via scuba diving. Though there might be other factors that affected the reduction of the stock, several studies have proven that the contribution of those factors on the decline in the abundance of sea cucumbers are probably negligible (Conand, 1990; Uthicke and Benzie, 2000; Hasan, 2019). Therefore, the marked reduction in the size of the stock could result from the high fishing mortality. Due to some of the biological traits of sea cucumbers such as late maturity, density-dependent reproduction, and low rate of recruitment of sea cucumbers (Dissanayake and Stefanson, 2012; Hasan and El-Rady, 2012), some studies have suggested maintaining the exploitable level at a lower rate such as around 5% of the initial stock size to avoid the collapse of the fishery due to overexploitation (Uthicke, 2004; Purcell, 2010). If the fishery collapses due to over-exploitation of the resources in the particular area, it will take several decades to regain the stocks to their original condition (Purcell, 2010; Hasan and El-Rady, 2012; Hasan, 2019). As the current exploitation level is higher than the recommended level in the scuba fishing ground, there is a high risk of extinction of the *T. anax* in the habitat susceptible to scuba diving fishing if the current exploitation level remains unchanged in future.

In this assessment, the Depletion Model used several assumptions. Sea cucumber species exhibit minimal movements and a slow growth rate (Conand, 1998; Trianni, 2000). Therefore, the *T. anax* population in the Irrakkakandi coastal area would probably not have experienced any significant immigration or emigration during the seven-month harvest period, thus validates the assumption of a closed population. One of the fundamental assumptions in this method is constant catchability (q) over time. The constant catchability assumption would depend upon weather and the management unit fished (Trianni, 2000). For sea cucumber fishing operations by scuba diving in Irrakkakandi coastal area, the environmental conditions remained unchanged to some extent during the fishing season in 2019, and fishers used their fishing locations within the same fishing ground for the collection of sea cucumbers. Moreover, the number of divers who were on-board for sea cucumber collection and the number of oxygen cylinders used for scuba diving per fishing operation also remained constant. Therefore, the magnitude of change in catchability is expected to be low.

However, it is imperative to formulate a proper management plan and implement appropriate management strategies to ascertain the sustainability of the sea cucumber fishery in the Trincomalee district, eastern Sri Lanka. The results of this study could be use of when preparing such a management plan. Further, it is highly recommended to implement a monitoring mechanism for the sea cucumber fishery in the Trincomalee district to understand its existing trend.

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