Catch Composition, Size and CPUE of Spiny Lobsters in Bottom Gillnet Fisheries from Two Distinct Fishing Grounds in Koh Pu, Krabi Province, Southern Thailand

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ABSTRACT

This study aimed to assess the catch composition, size, and catch per unit effort (CPUE) of spiny lobsters in two distinct fishing grounds: a seagrass bed (FG1) and an artificial reef area (FG2), using bottom gillnets operated by small-scale fishers in Koh Pu, Krabi Province, Southern Thailand. Data were collected monthly from September 2022 to February 2023 through onboard surveys conducted with two study boats, one assigned to each fishing ground. Over the six-month period, bottom gillnet fishing was conducted 12.2±4.8 and 13.0±2.6 times per month in FG1 and FG2, respectively. The analysis revealed that two lobster species (*Panulirus polyphagus* and *P. ornatus*) were present in FG1, while three species (*P. polyphagus, P. ornatus*, and *P. versicolor*) were found in FG2. The mean caught weight and body weight (BW) of spiny lobsters were 1,400.0±1,106.8 g·month^{-1} and 538.5±150.2 g BW in FG1, and 3,033.3±665.8 g·month^{-1} and 650.0±165.3 g BW in FG2. No significant differences in lobster CPUE were observed between FG1 (58.3±46.1 g·h^{-1}) and FG2 (126.4±27.7 g·h^{-1}), and the water quality parameters (salinity, pH, dissolved oxygen, and water temperature) did not differ significantly between the two fishing grounds. This study indicated that neither fishing ground in the Koh Pu area significantly affected the monthly catch or CPUE of spiny lobsters. Additionally, these areas are considered important areas for spiny lobster fishing.

Keywords: Bottom gillnet fishing, Catch composition, Lobster CPUE, Spiny lobster fishery

INTRODUCTION

The spiny lobster (*Panulirus* spp.) is an important commercial marine crustacean species that is distributed throughout the tropical regions from the eastern Indian Ocean to the Pacific Ocean with high demand for both local consumption and export in many Asian countries (Wahyudin *et al*., 2017; Radhakrishnan *et al*., 2019). In 2020, fishery trends indicated that lobster catches remained at high levels, with total fisheries and aquaculture production reaching a record 214 million tonnes, driven largely by the growth of consumption, especially in Asia. The amount of seafood destined for human consumption was 20.2 kg per capita, more than double the average of 9.9 kg per capita in the 1960s (FAO, 2022). These trends reflect a significant increase in demand for seafood, even as natural marine resources decline due to overexploitation and habitat destruction, with spiny lobsters among the species considered to be under threat (Radhakrishnan *et al*., 2019; Chamnina *et al*., 2022). It has been reported that most (95.5%) of the spiny lobsters caught by trawling are dead or die while being caught (Nitiratsuwan *et al*., 2017).

Marine fisheries can be characterized as either commercial or small-scale, with the latter contributing about 15% of the total marine harvest in Thailand annually (Derrick *et al*., 2017; Jutagate

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and Sawusdee, 2022). Generally, in most lobster fisheries, the catch comes from traps, set gillnets, trawls, and divers using hooks or spears (Phillips and Smith, 2006; Spanier and Lavalli, 2007; Nitiratsuwan *et al*., 2017; Wang *et al*., 2022). Gillnets are distinctive fishing gear because their mesh size both captures and selectively targets specific species. They are deployed on the seabed to catch groundfish and other bottom-dwelling aquatic animals, or placed in midwater or near the surface to catch pelagic species. (He, 2006; Grimaldo *et al*., 2018). The minimum investment on nets and the requirement of a smaller number of crew are some of the reasons for gillnet fishing worldwide (Kumer *et al*., 2013; Fazrul *et al*., 2015; Li *et al*., 2017; Kim *et al*., 2021; Jutagate and Sawusdee, 2022).

In Thailand, spiny lobsters are one of the most expensive seafood in various southern tourist provinces of Thailand, such as Phuket, Krabi, Phang Nga, Surat Thani (Koh Samui) and Prachuap Khiri Khan (Hua Hin) provinces, as well as in Bangkok, with the current retail price from THB 1,000 to 3,000 per kg, depending on size and species. Spiny lobster fishing has been recorded in many fishing grounds in the Andaman Sea of Thailand (Nitiratsuwan *et al*., 2017; Chamnina *et al*., 2022; Oniam *et al*., 2024). In some areas, the gillnet catch by small-scale fishers has targeted only spiny lobsters, such as in the Koh Pu area.

Koh Pu is a large island located in southern Thailand in the Andaman Sea within the Koh Si Boya sub-district, Nuea Khlong district, Krabi province. It consists of three fishery villages: Ban Koh Pu, Ban Ting Rai, and Ban Ko Jum. Currently, spiny lobsters are an important component of fishing in this area, with three main fishers in the area specializing in their capture. Most of the lobsters caught are sold to middlemen or directly to lobster farmers who raise them in cages, a practice common in many parts of Thailand. Specifically, the mud spiny lobster (*P. polyphagus*), the ornate spiny lobster (*P. ornatus*), and the painted spiny lobster (*P. versicolor*) were in high demand for both farming and consumption (Oniam *et al*., 2024).

The spiny lobster fisheries in Koh Ph area use only bottom gillnets on a small-scale. The use of bottom gillnets in the shore area of Koh Pu is seasonal and depends on the availability of the resource. In addition, the habitat of spiny lobsters is common in the fishing grounds around Koh Pu. The characteristics of these fishing grounds can be divided into two ecosystems: seagrass and artificial reef ecosystems. The seagrass beds in the Koh Si Boya sub-district area are one of the important seagrass ecosystems in the country, covering an area of more than 10 km^2, including the area at Koh Pu distributed at depths of 4–12 m with a sandy mud bottom substrate (Department of Marine and Coastal Resources, 2020). The artificial reefs around Koh Pu were constructed under a Thai Government initiative using 500 concrete blocks (1.5×1.5×1.5 m) placed on the sandy mud sea bottom and shelves at depths of 15–20 m (DMCR, 2008; Kheawwongjan and Kim, 2012).

Knowledge of fishing grounds is also of interest regarding spiny lobster fishing as it influences the catch rate. Furthermore, no studies have been published on spiny lobster bottom gillnet fishing in the Koh Pu area. Therefore, the current study considered the catch of spiny lobsters from bottom gillnet fishing in each fishing ground of the Koh Pu area, using data obtained from accompanying fishing operations and examining the species, size, monthly catch, and catch per unit of effort (CPUE). The study results could be used to provide information for the improvement or conservation of the spiny lobster fishing grounds for better lobster resource management in Thailand.

MATERIALS AND METHODS

Study site

The study on spiny lobster fishery was conducted in Koh Pu, Krabi province in two fishing grounds: (1) the seagrass ecosystem situated 100–200 m offshore from the front of Koh Pu (7º50´–7º52´N, 98º56´–98º59´E), and (2) the artificial reef ecosystem located 15–20 km offshore from the behind of Koh Pu (7º46´–7º48´N, 98º49´–98º58´E) and at sea depths of about 4–12 m and 15–20 m, respectively (Figure 1). The fishing grounds in seagrass area and artificial reef area are referred to as FG1 and FG2, respectively.

Fishing gear and fishing method

The study used a wooden boat with a length of 7.2–7.9 m, a beam of 1.9–2.1 m and equipped with a 16–22 HP diesel engine. The small-scale gillnet was used in this study. The basic structure of the bottom gillnet is shown in Figure 2a, with one panel of a bottom gillnet having a total length of 900–1,500 m, consisting of 3–5 sets of net at 300 m per set, as shown in Figure 2b. The net was made from blue nylon monofilament, with a mesh size of 115 mm; the depth of the net was 120 cm (Figure 2c). The float line consisted of two polyethene ropes (3 mm diameter) attached with buoy (3.80 cm diameter and 2.20 cm thickness) to support the net and tied with a rope on the top (Figure 2d). The distance between each buoy was about 3 m, with 100 buoy per set. The lead sinkers (each about 12.5 g in weight) were attached to the bottom rope at an interval of 50 cm (600 lead weights per set) (Figure 2e). Both ends of the net were fixed with 5–7 kg of anchors on each side (Figure 2f), which were attached to flag buoys to indicate the position of the net underwater (Figure 2g). Typically, bottom gillnet fishing was conducted in the early morning, with a soaking time of 1–3 days and operations occurring 10–15 times per month. The nets were anchored to the sea floor, targeting spiny lobsters.

Data collection

The study was conducted using both participant and non-participant observation methods by researchers. Fishers in the study area who primarily engage in lobster fishing were selected as case studies. The impact of lobster fishing using bottom gillnet from two fishing grounds was examined (one fishing boat from each fishing ground was selected). Each boat was required to go fishing at least once a week, depending on environmental factors in the fishing area such as water currents, tide variations, and monsoons. Each study boat used four gillnet panels (each net 1,200 m in length)

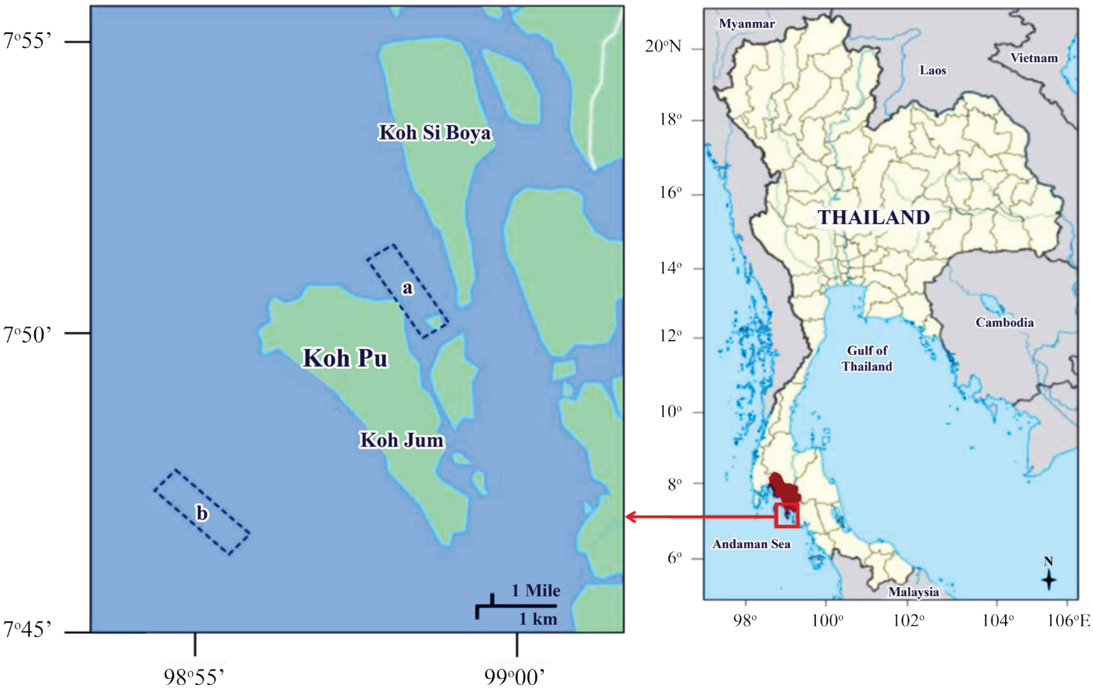

Figure 1. Locations of spiny lobster bottom gillnet fishing in small-scale fisheries in Koh Pu, Krabi province, Southern Thailand: (a) seagrass ecosystem (7º50´–7º52´N, 98º56´–98º59´E) in the front area of Koh Pu; FG1, and (b) artificial reef ecosystem (7º46´–7º48´N, 98º49´–98º58´E) in the back area of Koh Pu; FG2.

for fishing. Each fishing operation time (soaking time of the net) lasted approximately 24 h, starting around 6:00–8:00 a.m., and the nets were retrieved at the same time the next day. The boats then returned to shore to collect data and record the results of each fishing operation at the boat landing point on the Koh Pu. The process began with recording thetotal amount of caught (in grams), followed by separating and identifying the groups and species of the caught to count and measure the quantity of each species. The catch was divided into target species of spiny lobster (*Panulirus* spp.), and some bycatch of aquatic animals in terms of marketable value and discard species, including recorded grouping by type from the bycatch (Portunidae crabs, fish, and others).

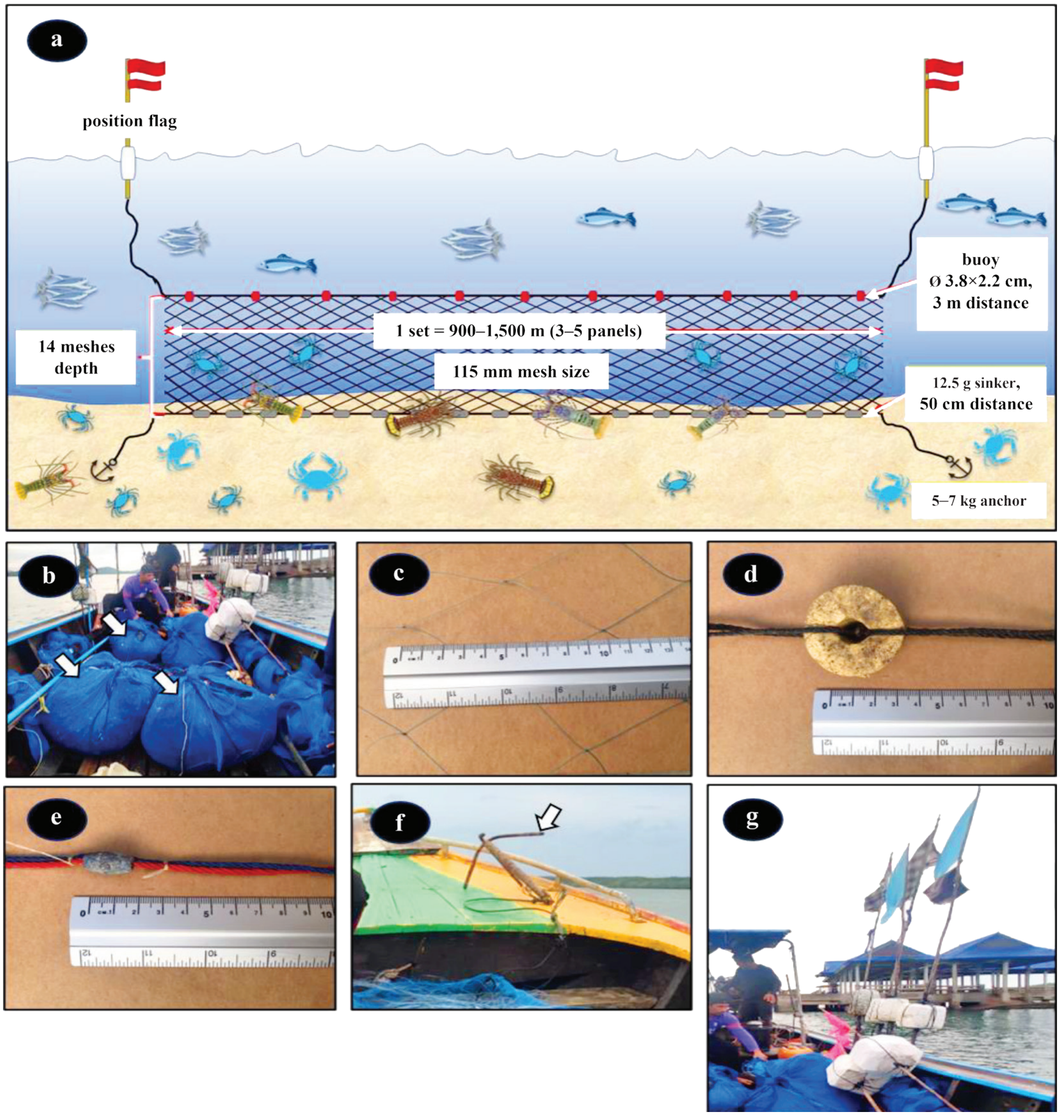

Figure 2. Bottom gillnet used by small-scale fishers in Koh Pu, Krabi province, Southern Thailand, targeting spiny lobster: (a) basic net structure; (b) one gillnet panel with 3–5 sets per panel (white arrows); (c) net mesh size; (d) buoy for top support of net; (e) lead sinker on net bottom rope; (f) anchors at ends of net set (white arrow); (g) flag buoys for marking net location.

The data was recorded from September 2022 to February 2023. The main catch and bycatch from the bottom gillnets of the study boats were segregated and identified to the species level using the FAO species identification field guide sheets (Carpenter and Niem, 1998) and reviews from the Andaman Sea coast of Thailand for crabs (Davie *et al*., 2002), fish (Satapoomin, 2011), and others (Panjarat, 2008). The data recorded for catch analysis consisted of species, body weight, quantity, monthly catch, and catch per unit effort (CPUE) in each fishing ground.

In addition, the water quality parameters such as salinity, pH, dissolved oxygen concentration (DO), and temperature were monitored once a month as a part of the onboard surveys using a refractometer (Master-S10 alpha), portable pH meter (pHTestr30), and oxygen probe (Pro20i), respectively. Water samples were collected at a depth of about 1 m below the water surface using a vertical-type water sampler (GEM 420-SS).

Data analysis

The catch data were expressed in the mean± standard deviation (SD). Monthly catch was total catch from beginning to the end of each month. CPUE estimation was based on the catch from the net of 1,200 m long with an operation time of about 24 h. The CPUE was calculated using the following Equation (Banerji, 1980):

$$\text{CPUE (g}\cdot\text{h}^{-1}) = \frac{\text{weight of total catch (g)}}{\text{operating time (h)}}$$

We evaluated the variance of the data before conducting the t-test to ensure the assumptions were satisfied. Levene's test was performed to assess the homogeneity of variance. Then, the differences in means for catches, CPUE of bottom gillnet fishing, and water conditions across two fishing grounds were analyzed using independent-sample t-tests at the 95% level of confidence interval. Data were analyzed using the IBM SPSS Statistics for Windows software (version 21.0; IBM Corp.; Armonk, NY, USA).

RESULTS

Over the course of the six-month study, bottom gillnet fishing was operated 12.2±4.8 and 13.0±2.6 time·month^{-1} ($p>0.05$) in the fishing grounds of FG1 and FG2 of Koh Pu, respectively. Physical investigation indicated that water parameters ($n = 6$), including salinity, pH, DO, and water temperature, were not significantly different among two fishing grounds. For the fishing grounds in the FG1 and FG2, the mean salinity were 29.66±2.51 and 31.33±2.08 psu ($p>0.05$), the mean pH were 7.72±0.25 and 7.70±0.25 ($p>0.05$), the mean DO were 6.48±0.27 and 6.07±0.06 mg·L^{-1} ($p>0.05$), and the mean water temperature were 28.73±1.28 and 29.50±0.86 °C ($p>0.05$), respectively.

Catches and catch composition

The catch results showed that bottom gillnet fishing in FG1 yielded 22 species, including two lobsters (one individual per species), 11 economic species, and nine discard species. In FG2, 23 species were caught, consisting of three lobsters (one individual per species), 13 economic species, and seven discarded species, as shown in Table 1.

The total catch by weight from FG1 and FG2 was 71,720.0±38,016.9 g·month^{-1} and 78,700.0± 17,702.8 g·month^{-1}, respectively, with no significant difference between the two fishing grounds. Similarly, the catch rate of spiny lobsters showed no significant difference. Bycatch composition, including Portunidae crab (swimming crabs), fish, and other groups, also did not differ significantly between the fishing grounds (t-test; $p = 0.223$, 0.179, and 0.166, respectively), as shown in Table 2.

The mud spiny lobster (*P. polyphagus*) was caught using bottom gillnet in both fishing grounds and was present every month. In contrast, the ornate spiny lobster (*P. ornatus*) was caught in some months from both fishing grounds, while the painted spiny lobster (*P. versicolor*) was found only in the FG2 (Figure 3a). In FG1, 91.7% of the spiny lobster consisted of mud spiny lobster, with 8.3% ornate spiny lobster. In FG2, the composition was 64.3% mud spiny lobster, 21.4% ornate spiny lobster, and 14.3% painted spiny lobster (Figure 3b).

Table 1. Total catches of bottom gillnet fishing in seagrass ecosystem (FG1) and artificial reef ecosystem (FG2) in Koh Pu, Krabi province, Southern Thailand from September 2022 to February 2023.

Common name	Scientific name	Fishing ground	
		FG1	FG2
Target species			
Mud spiny lobster	*Panulirus polyphagus*	*	*
Ornate spiny lobster	*Panulirus ornatus*	*	*
Painted spiny lobster	*Panulirus versicolor*		*
Bycatch			
Economic species			
Blue swimming crab	*Portunus pelagicus*	*	*
Commerson’s sole	*Synaptura commersonnii*		*
Crucifix crab	*Charybdis feriata*	*	*
Fourfinger threadfin	*Eleutheronema tebradactylum*	*	
Groupers	*Epinephelus* spp.		*
Harry hotlips	*Plectorhinchus gibbosus*		*
Horse-eye jack	*Caranx latus*	*	*
Indian threadfish	*Alectis indica*		*
Mangrove red snapper	*Lutjanus argentimaculatus*	*	
Mantis shrimp	*Miyakella nepa*	*	
Queenfishes	*Scomberoides commersonianus*		*
Pink ear emperor	*Lethrinus lentjan*		*
Rock crab	*Charybdis natator*	*	
Sandfish	*Holothuria scabra*	*	
Sand lobster	*Thenus orientalis*		*
Scaly whipray	*Brevitrygon imbricata*	*	*
Snappers	*Lutjanus* spp.		*
Three-spot swimming crab	*Portunus sanguinolentus*	*	*
Triangle-tailed horseshoe crab	*Tachypleus gigas*	*	
Discarded species			
Bartail flathead	*Platycephalus indicus*		*
Bigeyes	*Priacanthus* spp.		*
Black long-armed crab	*Rhinolambrus longispinis*	*	
Box crab	*Calappa bilineata*	*	
Flower moon crab	*Matuta planipes*		*
Largetooth flounder	*Pseudorhombus arsius*		*
Long-armed crab	*Parthenope longimanus*	*	*
Long-eyed swimming crab	*Podophthalmus vigil*		*
Longhorn cowfish	*Lactoria cornuta*	*	*
Porter crab	*Dorippe quadridens*	*	
Red-knobbed starfish	*Protoreaster lincki*	*	
Spider decorator crab	*Camposcia retusa*	*	
Trapezium horse conch	*Pleuroploca trapezium*	*	
Venus comb	*Murex djarianensis poppei*	*	

The mean body weight of spiny lobsters caught with bottom gillnet at both fishing grounds is shown in Figure 4. No significant difference was found in the mean body weight between FG1 (538.5±150.2 g, n = 13) and FG2 (650.0±165.3 g, n = 14).

Table 2. Monthly catch (mean±SD) of spiny lobsters and bycatch by aquatic animal groups from bottom gillnet fishing in the seagrass ecosystem (FG1) and artificial reef ecosystem (FG2) of Koh Pu, from September 2022 to February 2023.

Item	Monthly catch (g·month^{-1})	
	FG1	FG2
Spiny lobsters (*Panulirus* spp.)	1,400.0±1,106.8	3,033.3±665.8
Portunidae crabs (swimming crabs)	38,840.0±22,747.0	60,233.3±19,108.2
Fishes	23,860.0±13,521.2	11,166.7±5,278.6
Others	7,620.0±3,071.2	4,266.7±2,579.4
Total catch	71,720.0±38,016.9	78,700.0±17,702.8

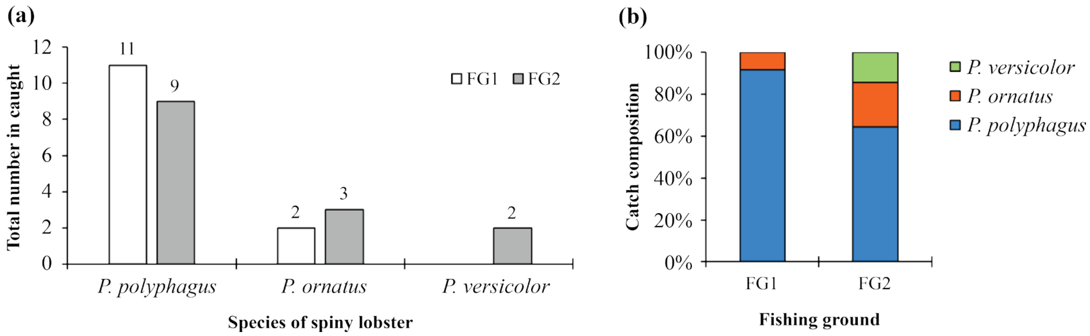

Figure 3. Total number (a) and catch composition (b) of spiny lobsters (*Panulirus* spp.) caught using bottom gillnets in the seagrass ecosystem (FG1) and artificial reef ecosystem (FG2) at Koh Pu from September 2022 to February 2023.

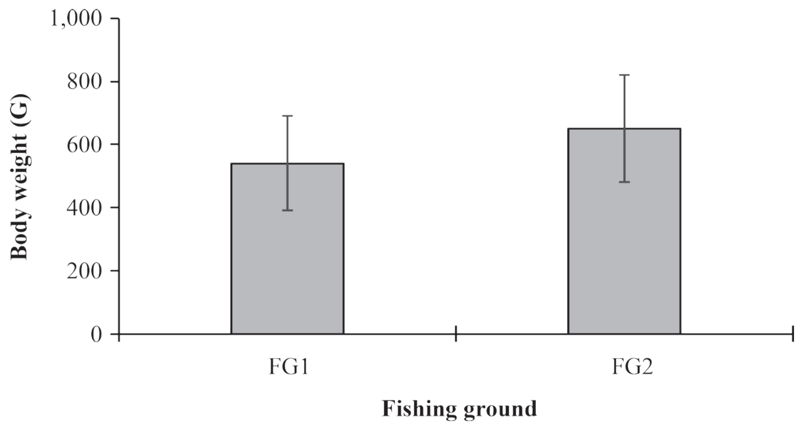

Figure 4. Body weight (mean±SD) of spiny lobsters (*Panulirus* spp.) caught using bottom gillnets in the seagrass ecosystem (FG1) and artificial reef ecosystem (FG2) at Koh Pu from September 2022 to February 2023.

Catch per unit of effort

Table 3 shows the CPUE comparison for spiny lobsters caught using bottom gillnets in the two fishing grounds. No significant differences were found between FG1 and FG2 in the mean CPUE of the target species, each bycatch group, or the total catch (p>0.05).

Table 3. Comparison of CPUE (mean±SD) from bottom gillnet fishing in the seagrass ecosystem (FG1) and artificial reef ecosystem (FG2) at Koh Pu from September 2022 to February 2023.

Item	CPUE ($g \cdot h^{-1}$)	
	FG1	FG2
Spiny lobsters (*Panulirus* spp.)	58.3±46.1	126.4±27.7
Portunidae crabs (swimming crabs)	1,618.3±947.8	2,509.7±796.2
Fishes	994.2±563.4	465.3±219.9
Others	317.5±128.0	177.8±107.5
Total catch	2,988.3±1,584.0	3,279.2±737.6

DISCUSSION

In the Koh Pu area, fishing primarily relies on bottom gillnets, similar to other Thai fishing grounds (Fazrul *et al*., 2015; Derrick *et al*., 2017; Jutagate and Sawusdee, 2022). Local spiny lobster fisheries target adult lobsters using these nets, particularly in Trang, Phuket, and Phang Nga provinces (Nitiratsuwan *et al*., 2017; Chamnina *et al*., 2022). The fishing grounds for spiny lobster in Koh Pu are characterized by different depth ranges: 4–12 m in the seagrass ecosystem (FG1) and 15–20 m in the artificial reef ecosystem (FG2). The measured seawater parameters in FG1 and FG2 were within optimal ranges for spiny lobsters (Carpenter and Niem, 1998; Phillips and Smith, 2006; Radhakrishnan *et al*., 2019; FAO, 2022), with salinity ranged 29.6–31.3 psu, pH ranged 7.7–7.2, DO ranged 6.0–6.4 $mg \cdot L^{-1}$, and temperature ranged 28.7–29.5°C.

During the study, only three spiny lobster species were caught using bottom gillnets: mud spiny lobster (*P. polyphagus*), ornate spiny lobster (*P. ornatus*), and painted spiny lobster (*P. versicolor*). The mud spiny lobster was the most frequently caught species in both fishing grounds, a pattern consistent with reports from other coastal areas of Thailand. For instance, in Phuket Province, trawl net catches were predominantly mud spiny lobsters, with ornate spiny lobsters comprising only 3.3% of the total caught (Bhatiyasevi and Kittiwattanawong, 1994). Similarly, in Trang Province, over 90% of lobsters caught using crab gill nets were mud spiny lobsters, with ornate spiny lobsters being the next most common (Nitiratsuwan *et al*., 2017). A similar trend was reported in Ban Chong Lad (Phang Nga Province), Ban Khao Thong and Ao Nao (Krabi Province), where crab gillnets and fish traps predominantly yields mud spiny lobster, followed by ornate and painted spiny lobsters (Oniam *et al*., 2024). This suggests that mud spiny lobsters are more widely distributed and abundant than other species.

Regarding bycatch, the dominant species were swimming crabs (*Portunidae*), including the blue swimming crab (*Portunus pelagicus*), the crucifix crab (*Charybdis feriata*), and the three-spot swimming crab (*P. sanguinolentus*). These species are economically valuable, generating income comparable to some fish species in this area, such as Commerson's sole (*Synaptura commersonnii*), groupers (*Epinephelus* spp.), snappers (*Lutjanus* spp.), and the horse-eye jack (*Caranx* spp.).

The CPUE for both total catch and bycatch showed no significant differences between the two fishing grounds. This indicates that bycatch species, particularly economic species, provide a consistent income for fishers in the Koh Pu when spiny lobsters are not available. This multi-species catch composition is typical of small-scale coastal fisheries in tropical areas, where set gillnets capture a variety of species due to the high productivity of the fishing grounds (Kumar *et al.*, 2013; Fazrul *et al*., 2015; Kim *et al*., 2021; Jutagate and Sawusdee, 2022; Wang *et al*., 2022).

Catch data from this study suggest that spiny lobster stocks in Koh Pu are lower than those crabs, fish, and other aquatic species due to their limited distribution along the coast of Thailand (Nitiratsuwan *et al*., 2017; Oniam *et al*., 2024). Additionally, spiny lobster CPUE is lower than that of other fisheries, such as those targeting crabs, squid, and other marine species (Arkronrat *et al*., 2017; Jutagate and Sawusdee, 2022). However, this low CPUE is typical for spiny lobster fisheries, especially when using traditional fishing gear, as lobsters are found only in specific habitats crucial for their survival (Bhatiyasevi and Kittiwattanawong, 1994; Davie *et al*., 2002; Satapoomin, 2011; Higgs, 2016; Nitiratsuwan *et al*., 2017; Radhakrishnan *et al*., 2019; Chamnina *et al*., 2022; Oniam *et al*., 2024).

Given this, the studied fishing grounds are vital for spiny lobster fisheries and resource conservation. Sustainable spiny lobster management in Thailand requires habitat protection and conservation strategies. Artificial habitats, lobster sanctuaries, and reserves have been effective in restoring lobster populations in India (Radhakrishnan and Thangaraja, 2008). Similarly, non-destructive fishing methods have supported lobster conservation in various locations, such as free diving and hand collection in Aneityum Island, Vanuatu (Pakoa *et al*., 2012), lobster traps and artificial shelters in the Bahamas (Higgs, 2016), and traps along the Western Australian coastline (Tuffley *et al*., 2021).

Variations in fishing time, geography, and environmental conditions (e.g., monsoon season) can affect gillnet catch rates (Pradhan *et al*., 2019; Jutagate and Sawusdee, 2022). Therefore, further studies should focus on small-scale spiny lobster fisheries using bottom gillnets in Koh Pu under normal weather conditions (outside the monsoon season) to monitor monthly catch trends and CPUE. This would provide empirical data for improving the management of the Koh Pu fishery.

CONCLUSIONS

Catch data from bottom gillnets provide valuable insights for fishers and local communities to better understand their resources and implement effective management strategies. The monthly catch and CPUE of spiny lobsters from small-scale bottom gillnet fisheries in the seagrass (FG1) and artificial reef (FG2) ecosystems of Koh Pu showed no significant differences. A total of two spiny lobster species were caught in FG1, while three species were found in FG2. This information is essential for enhancing conservation efforts and improving the management of spiny lobster fishing grounds, contributing to biodiversity preservation.

By integrating catch and CPUE data with habitat-specific information, we gain a comprehensive understanding of spiny lobster populations and their ecosystems. This insight is crucial for developing effective conservation strategies that ensure the long-term sustainability of lobster resources while supporting the livelihoods of small-scale fishers.

To advance spiny lobster conservation and management, it is essential to protect targeted habitats and implementing sustainable fishing practices, More importantly, local community involvement in conservation efforts needs to be expanded and strengthened.

Future research should explore the relationship between fishing grounds and environmental factors, such as seasons, currents, and lunar cycles, to better understand their influence on bottom gillnet fishing. This would provide critical data for enhancing the sustainable management of spiny lobster fisheries in Koh Pu.

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