RESEARCH ARTICLE

Assessment of the Acetes Beach Seine Fishery in Miagao, Iloilo, Philippines

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ABSTRACT

Gear type and characteristics, catch rates and landings, and the status of the Acetes beach seine fishery in Miagao, Iloilo were investigated based on the fishery-dependent data and formal interviews on all the coastal barangays. Specimen collection for morphological identification of species and determining the catch per unit effort (CPUE) were conducted at Brgy. Damilisan, Miagao, Iloilo from November 2021 to April 2022. The genus *Acetes* is known to aggregate in the coastal waters during nighttime and are captured using beach seines. The results of the morphological analysis revealed that the specimens collected were *Acetes intermedius*. In Miagao, there were 28 licensed beach seine operators. The total line length of a beach seine towing line ranged from 130 to 280 m and was deployed at depths of 5 – 60 m. The operators were all males, and most of them worked under an owner having an income of PHP 516.67 – PHP 2,673.33 per week. The crew comprises 4 to 5 persons, including the operator, 2–3 boat rowers, and 1 in charge of deploying the net; the rest are rope haulers. The operations were affected by environmental factors such as monsoons, tides, open and closed seasons, and hauling time. In Brgy. Damilisan, the highest monthly mean catch rate was 90.33 kg/haul, and the highest monthly estimated total landings was 2341.44 kg, which was recorded in January 2022. The information collected defined the seasonality of *Acetes* and the fishery practices that will help in the management of the beach seine fishery.

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1. INTRODUCTION

The genus *Acetes* are planktonic shrimps (Omori 1976), and they usually thrive in tropical and subtropical waters, specifically in estuarine and coastal areas (Omori 1977). These minute-size sergestid shrimps are caught in depths of <1–150 m. The capture of *Acetes* is an important industry and a crucial commodity worldwide. From 1979 to 1989, an average annual catch of 228,850 tons was reported, primarily from the Indo-Asia. *Acetes* spp. are used as bait, shrimp paste, and feed meal (Xiao and Greenwood 1993) and are part of the diet of fishes, large shrimps, and birds living near the coast (Omori 1974; Xiao & Greenwood 1993). Furthermore, *Acetes* spp. contribute to the production of neritic waters, mangroves, and seagrasses ecosystem. They are often compared to the Antarctic krill in their respective environmental habitats because of their significance to predators such as some species of squids, finfish species (e.g., whales, sharks, and some commercially critical pelagic fishes), prawns, young crocodiles, baleen whales, and people harvesting them, specifically in Asia (Omori 1974; Omori 1975; Omori1977; Xiao and Greenwood 1993). Similar to the marine zooplankton (e.g., krill and mysids), swarming or schooling and strong sociality are also demonstrated by *Acetes* within different spatiotemporal scales (Henry 1977; Nair 1977; Ikeda and Skjodal 1980).

Acetes spp. is a sergestid decapod and its local name varies depending on the local dialect of a given place in the Philippines; generally, it is locally known as "alamang." There are three species of *Acetes* identified in the Philippines, and these are *A. erythraeus* (Manila Bay, Paracle Bay, and Iligan Bay), *A. intermedius* (Iloilo, Panay, and Panguil Bay), and *A. sibogae* (Manila Bay

and Iloilo) (Omori 1974; Metillo 2011; Metillo et al. 2015). In Iligan Bay, Philippines, a study on the diet composition of *A. intermedius* explained the species being an omnivorous tropical niche in which the adults are zooplanktivores, which vary in abundance of prey. It also emphasized the importance of *A. intermedius* in linking fish predators and zooplankton, and it competes with other micronekton like fish larvae and post-larval penaeid shrimps that rely on plankton as a source of food (Metillo2011). While various observations have been reported on the swarming behavior of *Acetes*, the reason behind this behavior still needs to be investigated.

In the Philippines, the recently recorded landings of marine and municipal fisheries for Acetes were 8,965.51 MT, 8,067.96 MT, and 7,223.86 MT in 2018, 2019, and 2020, respectively (PSA 2020). The earliest data of *Acetes* spp. landings in the country were in the years 1997-2021, wherein 7,329 MT, 8,242 MT, 8,901 MT, 8,488 MT, and 8,896 MT were recorded, respectively (PSA 1997). In Southern Iloilo, Philippines, particularly in coastal municipalities, the capturing of these small sergestid shrimps is a traditional local industry. It is locally called as "hipon," and they aggregate in coastal areas of these municipalities from December to May (Iguban et al. 2017). The catches are mainly processed into sun-dried shrimps (locally known as "kalkag"), shrimp paste (locally known as "ginamos"), or fermented and salted together with juvenile fishes (locally known as "tinabal") (Bagarinao 2008).

In Oton and Tigbauan, Iloilo, the *Acetes* industry started in the 1950s, wherein commercial exploitation increased as the years passed (Iguban et al. 2017). In the coastal areas of the mentioned municipalities, catching *Acetes* is a tradition and a source of livelihood amongst operators and the crew, the processors, and the traders. However, not much is known about the status of the stocks and how exploitation and even climate change impact these resources. Such impacts, if present, could affect households dependent on the industry.

The beach seine is one popular gear to catch these sergestid shrimps in the Philippine coastal waters. A beach seine comprises netting and a pair of wings set to the surface and down to the bottom, which acts as a barrier that encloses fish and prevents escape (Monteclaro and Abunal 2013). In the Panay Island, beach seining along the coast is a traditional and essential industry. Some coastal barangays of Miagao, Iloilo, have been using beach seines for several decades, with some households depending on this for food and income. The target species are small sergestid shrimps Acetes, juvenile, larval, and post-larval clupeids (Monteclaro and Abunal 2013). A local ordinance exists in the municipality wherein open and closed season is implemented (November–April is the open season and May–October is the closed season), prohibiting year-round beach seine operations. This study was conducted to define the Acetes spp. beach seine fishery in Miagao, Iloilo, Philippines, through formal interviews and to assess the catch rates and landings in Brgy. Damilisan in order to determine the seasonality of Acetes spp. and the by-catch of the fishery during the open season.

2. MATERIALS AND METHODS

2.1 Study site

This study was conducted in Miagao, Iloilo, Philippines, which has a total of 119 barangays and 22 of these are coastal barangays namely: Baybay Sur, Baybay Norte, Sapa, Guibongan, Kirayan Sur, Kirayan Norte, Banuyao, Naulid, Maninila, Gines, Dingle, Calampitao, Mambatad, Bacauan, Palaca, Tabunacan, Damilisan, Oyungan, Lanutan, Maringyan, San Rafael, and Narat-an (Figure 1). The 22 coastal barangays cover a 16-km coastline and 24 hectares of municipal water (Añasco et al. 2016). Twelve coastal barangays were chosen for the interview, and Barangay Damilisan was chosen as the sampling site for CPUE, and total landings of *Acetes* spp.

2.2 Sample collection and identification of Acetes spp. specimens

Samples of *Acetes* came from beach seine operators in Brgy. Damilisan who operated nearshore from November 1, 2021, to April 30, 2022. Specimens of *Acetes* were collected using 100 mL sampling bottles. These bottles were filled with specimens of about 50–150 g, ensuring a 2-in headspace between the cover. Sampling was done during nighttime. Samples were collected, placed in a small sampling vial/bottle, and submerged using 10% formalin to guarantee preservation. Collected samples were labeled with the date of sampling. These were transported to the University of the Philippines Visayas-Institute of Marine Fisheries and Oceanology microtechnique laboratory for analysis. A total of 1800 specimens were analyzed throughout the study period using the morphological identification keys developed by Omori (1975) for species identification.

2.3 Assessment of the fishing effort

Three beach seine operators in Brgy. Damilisan, Miagao, Iloilo that target *Acetes* spp. were asked to record their beach seine operations. A logbook was provided for them to list the date of operation, the time in which each haul started and finished, total catch per haul quantified in local terms such as per "caltex" (~1kg) or per "banyera" (~40–45 kgs). Landings with *Acetes* spp. present plus bycatch were recorded as Total Catch (TC). *Acetes* catch (AC) was quantified in the total catch since the operators tended to separate their fish catch from the *Acetes* catch. However, if their bycatch was less than 1 kg, it was assumed that TC was equal to AC. This was done three times a week each month for six months.

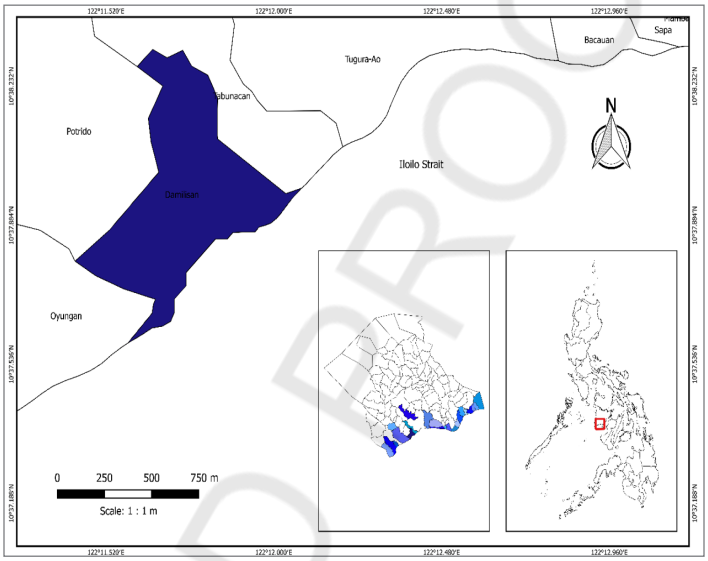

Figure 1. Location of the sampling areas in Miagao, Iloilo. Station 1: Barangay Damlilisan Miagao, Iloilo, for fishing effort. Inset maps include the map of the Philippines, wherein the Municipality of Miagao is marked in a square (lower right), and the coastal barangays in Miagao visited for the formal interviews are highlighted (lower left). Base maps were obtained from PhilGIS and projected to WGS 84 using QGIS 2.18.23.

2.4 Interview surveys

A formal interview was conducted with beach seine operators in Miagao, Iloilo from March 24, 2022, until April 10, 2022. The Municipal Agriculturist Office of Miagao (2022) recorded 28 licensed beach seine operators in 2022, and this was the basis for obtaining respondents. The number of beach seine operators per barangay was described through a heat-map distribution using QGIS 2.18.23. Fifteen respondents were chosen for the Key Informant Interview (KII). The questionnaires that were used to interview the operators were based on the criteria that were provided by the Food and Agriculture Organization (FAO) (1998) in identifying catch and discards (Table 1), and the gear types and characteristics (Table 2). Socio-economic profiling was based on the KII guide questions for the evaluation of socioeconomics and marine resource utilization in selected coastal communities (FAO 2014). The respondents estimated all their measurements in fathoms ("dupa"), which were later converted into meters. The conversion factor of fathoms was used in which 1 fathom is equal to 1.828804 meters (Butcher et al. 2006). A voice recorder was used to record all the answers of the key informants. The participation of the interviewees in the KII was voluntary and an informed consent form was provided (Appendix A). An ethical clearance from the University of the Philippines Visayas – Research Ethics Board was secured for this study (Appendix B & C). The guide questions used in the interview are in Appendix D.

2.5 Data processing of catch rates and landings

All data processing and analyses were performed using Microsoft Excel 2013. Bar graphs were used to describe the dataset for Catch rates and landings.

The mean monthly catch rates, mean bycatch, total estimated landings, bycatches, and mean number of operations each night in a month were graphed in Microsoft Excel (2013) using a bar graph.

$$\text{Mean monthly catch rates for Acetes} = \frac{\textit{Acetes}\text{ catch in a month (kg)}}{\text{Effort (number of days)}}$$

For the mean monthly catch rates of *Acetes*, the AC was used and computed using the formula:

$$\text{Mean monthly bycatch rates} = \frac{(\text{Total catch} - \textit{Acetes}\text{ catch})}{\text{Effort (number of days)}}$$

For the mean number of operations in a month, the number of operations each night was recorded. It was computed using the formula:

$$\text{Mean number of operations in a month} = \frac{\text{Total number of operations in a month}}{\text{number of days sampled in a month}}$$

Using the obtained mean monthly catch rates for *Acetes* and bycatches, the total estimated landings for *Acetes* and bycatches was computed using the formula:

Total estimated landings for *Acetes* (kg)=
(Mean monthly catch rates for *Acetes*) x (number of days operating in a month) x (mean number of operations in a month)

Total estimated landings for bycatch (kg)=
(Mean monthly bycatch rates) x (number of days operating in a month) x (mean number of operations in a month)

Table 1. Catch and discards variables collected during the interviews (FAO 1998).

DATA TYPE	VARIABLES
Target species/ species group	Species (species group)
Total catch	Weight; number; number of baskets/bins/ boxes; holds (volume)
Species composition	Sampled fish species, number of baskets/ bins/boxes/holds by species
Average size and weight of the organism	Sampled fish species, length, weight; catch weight by size gradings
Discards	Species; weight, number of baskets/bins/ boxes; whole/macerated

Table 2. Gear description and characteristics collected during interviews (FAO 1998).

DATA TYPE	VARIABLES
Gear	Gear type
Construction	Mesh, material, hook size, doors, TED grids
Size	Length, depth, headline, foot rope, hook spacing, total line length
Deployment	Bottom, midwater, surface, fixed, anchored, free floating, association
Subsidiary vessels	Dinghies, scout, net boat
Electronics	Beacons, net sonde, mass sensors
Markings	Gear number, vessel identification
Bait	Type of bait used in association with the gear

3. RESULTS

3.1 The beach seine fishery in Miagao

The boat used in the beach seine fishery in Miagao, Iloilo, had a general dimension of 7.62 m x 0.71 m x 0.87 m (LxWxH) which can carry a 130–280 m long beach seine net, accessories, and 4–5 crew members. Attached to the boat were outriggers on each side for stability. A boat paddle is used for maneuvering (Figure 2A). The main operator, or "Mayor/Maestro", controls the boat rudder and is responsible for the deployment of the net. The beach seine net was described as a net with two wings ("puna") (Figure 2D), a body, and a bunt/cod-end ("puyohan") (Figure 2F). The mesh size of each part of the gear was 2.5 cm for the wings, 0.35 cm for its body, and 0.125 cm for the bunt. It was observed that the

Figure 2A. A typical beach seine in Brgy. Damilisan, Miagao, Iloilo with labeled parts.

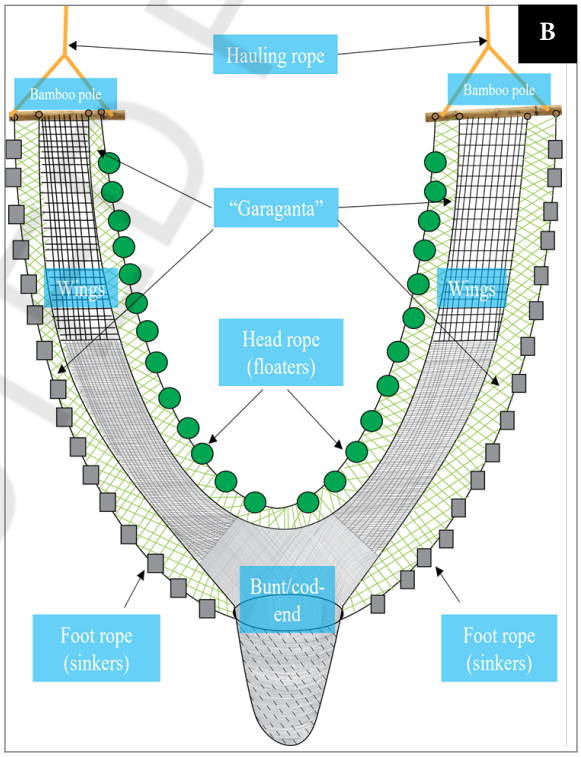

Figure 2B. Illustrated structure and design of a beach seine in Brgy. Damilisan Miagao, Iloilo.

Figure 2C. (C) A beach seine in Brgy. Damilisan Miagao, Iloilo.

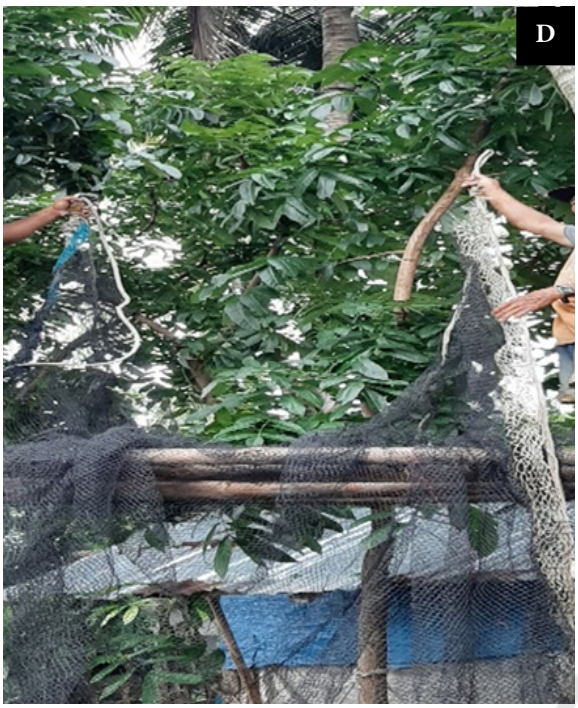

Figure 2C. (D) Wings with hauling rope.

Figure 2C. (E) Mouth of the cod-end.

Figure 2C. (F) Cod-end.

bunt/cod-end has multiple layers of fine mesh net and strong stitching to ensure that the weight of captured organisms will not destroy the net bag. Floaters and sinkers (Figure 2H-I) ensured that the net would be deployed accordingly in the water. A bamboo pole ("bada-bada") (Figure 2G) was present on each end of the wing to guarantee that the net would assume a correct form. A green twine was stitched to the net, the floaters and sinkers, locally called "garaganta." Just

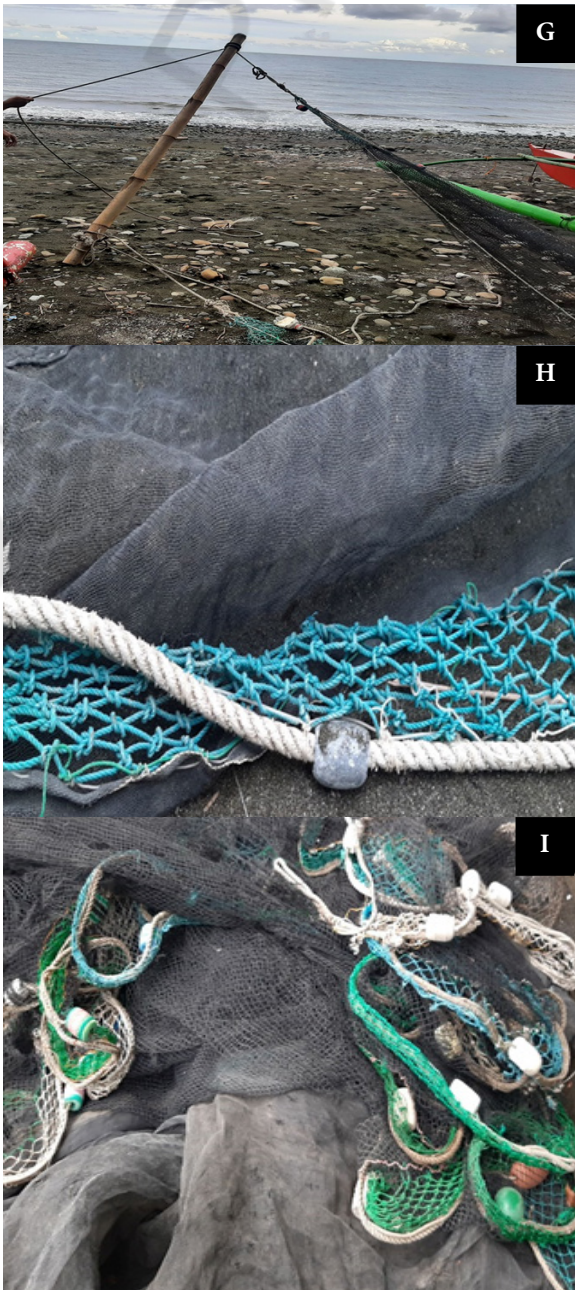

Figure 2D. (G) Beach seine attached to the bamboo pole using the hauling rope; (H) sinkers; and (I) floaters. The green netting present on the floaters and sinkers is the "garaganta."

like the bamboo pole, the "garaganta" also guaranteed the correct form of the beach seine. A long towing line made of rope was attached to the beach seine. People use the towing line to pull the net towards the shore. Before the crew sails to the sea, the first set of ropes is set, followed by the net, and then a second rope to encircle the organisms present. After the net had been cast, the people rowed the boat docks ashore to assist other people in pulling the rope on both wings. Usually, only the main operator remains aboard the boat to check if the net is being pulled simultaneously by giving commands to both ends. When the bamboo pole ("bada-bada") comes near the coast, the haulers will flip the bamboo pole to pull the sinker line, thereby ensuring that the fish cannot escape the enclosure. Based on the interviews, a minimum of 11 people are required to start the operations, wherein 4 to 5 people would serve as the crew ("mayor" and boat rowers). The rope haulers are commonly called "boso," wherein they participate in the fishery for a share of the catch. However, the respondents classified "boso" as someone regular during the operations, and "bolero" is a term that refers to people whose participation in the beach seining process is temporary. The "boso" and "boleros" usually supply the operation with a workforce specifically for pulling the rope, arranging the net to the boat, and towing the boat to the coast after operations have ended. The operation usually starts at around 5:00 PM onwards (as mandated by the LGU as the allowable time to deploy their beach seines). A single operation takes about 30–60 minutes to complete, depending on the number of rope pullers and the wind and water current present.

After hauling the net, the fish catch is usually separated from the *Acetes* spp. catch. The fish catch is placed in a bamboo-stitched container called "bakuwa" (Figure 3A). If the fish catch is abundant, they usually give some to the people and their share of *Acetes*. However, if the fish catch is few, it usually goes directly to the owner and operator, and only the *Acetes* catch is distributed to the rope haulers. There were some days that there were no *Acetes* caught, and the catch consisted of post-larval and larval clupeids commonly known as "marugbas," which have a higher economic value than *Acetes spp*. The owner, operator, and crew members usually sold their share of *Acetes spp.* per "banyera" (Figure 3B) or per "caltex" (Figure 3C), which were priced at around PHP 1,500.00 and PHP 50.00, respectively. The owners and operators usually have a contact person to whom they will sell their *Acetes spp*. Then, these contact persons would sell these *Acetes spp.* in mountainous barangays. As for

Figure 3. Post-harvest activities of the beach seine fishery in Brgy. Damilisan Miagao, Iloilo. (A) fish catch placed in a container locally called "bakuwa" separated from the Acetes catch; (B) Acetes catch placed in a tub called "banyera;" (C) Acetes placed in a container locally called "caltex;" and (D) sorting of catch for distribution amongst owner, main operator ("maestro"), crew members, and rope-pullers ("boso" and "bolero").

the rope-pullers' share of *Acetes spp.* catch, they tend to process it into a fish paste and then trade it to people living in mountainous areas for fruits, vegetables, or money.

Beach seine operators use a system to quantify their *Acetes spp.* catch so that it is distributed equally amongst the owner, main operator (Mayor), and crew members. The catch is transferred to containers called "banyeras" (Figure 3B) (~35–40 kg) and then equally distributed using another container called "caltex" (Figure 3C) (~1 kg). The *Acetes* spp. catch is placed on a table to facilitate equal distribution (Figure 3D).

3.2 Gear type and characteristics

In the past, beach seine net or "sahid" was made of heavy plant fibers which were heavy when submerged in water. The gear design and mesh size in the past did not differ much in the current beach seine since beach seiners were already capturing *Acetes* spp. before. Abaca plant fibers were used in the rope and net construction of the previous beach seine. Through time, plant fibers were replaced by synthetic nets. The materials used and structure of the gear had a pair of wings ("puna"), body, bunt ("puyo"), floaters and sinkers, bamboo pole ("bada-bada") which is attached

to each end of the wings, and fine mesh net that gets smaller in size starting from the wings and ending from the bag. The average total line length ranged from 130–280 m. The average depth in which they deploy the gear ranged from 5 m to 60 m because there are coastal barangays in Miagao wherein their coastal fishing ground is shallow ("lantad"), while others had deeper coastal fishing grounds ("kantilado"). Some also utilize a secondary fishing vessel because it helps in looking for clumps of *Acetes* at night (13.33%), assisting in the deployment and adjustment of the net (6.67%), a light boat ("lilang boat,"), which was used to lure pelagic fishes towards the coast (26.67%). All the respondents used a flashlight as an accessory since they were operating at night. One respondent said that they were using both a flashlight and a walkie-talkie. They were not using any baits; however, they used a flashlight to scout clumps of *Acetes* spp. in the water ("palanaw/paninggad"). If they could not find any, their catch would be based on luck, wherein they deploy the net randomly ("paswerte-swerte/patapang") (Table 3).

3.3 Catch rates and landings of Acetes intermedius in Brgy. Damilisan, Miagao

In Barangay Damilisan, beach seining typically ranged from 1 to 4 operations each night. From November 2021 to February 2022, there was an average of two operations per night. After February 2022, the daily operations declined (March and April). The number of operations for a month ranged from 13 to 28 operations. The species were identified to be *Acetes intermedius* based on morphological identification keys.

The highest monthly mean catch rate was 90.33 kg/haul, recorded in January 2022. The highest monthly mean bycatch was 1.92 kg/haul observed in November 2021 (Figure 4). The highest estimated landing of *Acetes* (2341.44 kg) was recorded in January 2022. The highest estimated landing of bycatch (47.84 kg) was recorded in November 2021 (Figure 5). Examples of these bycatch recorded were clupeids, slipmouths, goatfishes, mackerels, halfbeaks, scads, mullets, bigeyes, snappers, and rays. Some bycatch that was harmful and could not be consumed, such as pufferfish and jellyfish, were discarded.

3.3 Key informant interviews

3.3.1 The status of the fishery

The use of fine-mesh nets, such as beach seines, "lilang" and lift nets (locally called "bentahan") in Miagao, Iloilo, was being regulated by the Local Government Unit (LGU) of Miagao through its implementing agency, the Municipal Agriculturist's Office (MAO) through licensing and implementation of an open and closed season. Under Municipal Ordinance No. 2019-17, the closed season for fine-mesh nets was being enforced from May to October each year. Based on Miagao LGU-MAO records, there were 28 licensed beach seine operators in 2022 (Figure 6).

Table 3. Gear type and characteristics of beach seine fishery from interviews of operators in Miagao, Iloilo.

	Profile	Frequency	Percentage
Materials used	Fine mesh nets, multifilament nylon, Polyethylene rope, floaters and sinkers, and a bamboo pole		
Estimated total line length	130-280 m		
Estimated depth in which the gear was deployed	5-60 m		
Secondary fishing vessels in the fishing operation	None	8	53.33
	Used to search for clumps of Acetes	2	13.33
	Used to assist in adjusting the net in the water	1	6.67
	Used as a light boat ("lilang") to lure fishes toward the coast	4	26.67
Accessories used in fishing operations	Flashlight and (one respondent) walkie-talkie		
Baits or techniques used to ensure that target species will be caught	No baits. The operator will use a flashlight to check for swarm of Acetes in the water ("Palanaw/Paninggad"). If no Acetes will be found by the operator, they will just deploy the net in the water and will hope for a good catch based on luck ("Paswerte-swerte/Patapang").		

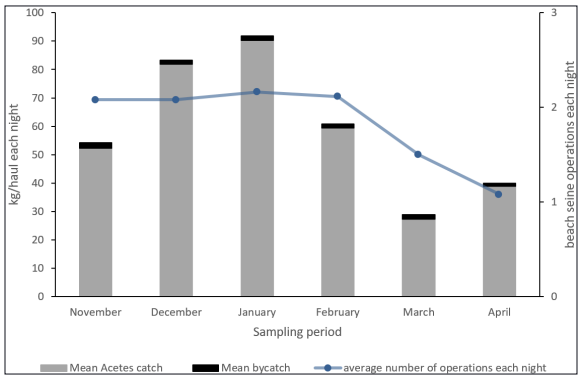

Figure 4. Monthly mean catch rates of *Acetes* and bycatch of beach seine operations in Damilisan, Miagao, Iloilo. The line graph shows the mean monthly number of operations each night.

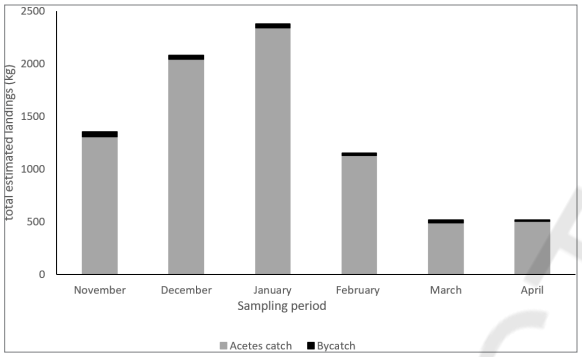

Figure 5. Total estimated landings of *Acetes* and bycatch of beach seine operations every month in Damilisan, Miagao, Iloilo.

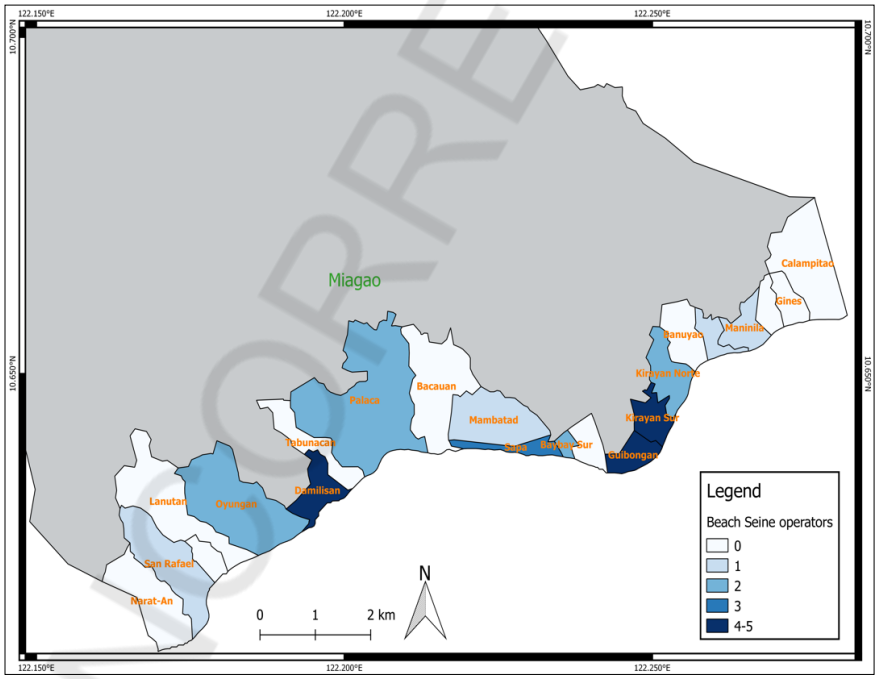

Figure 6. Heat-map distribution of beach seine operators in the coastal barangays of Miagao, Iloilo, based on the data of Miagao LGU-MAO. Base maps were obtained from PhilGIS and projected to WGS 84 using QGIS 2.18.23.

3.3.2 Socio-demographic profile

Table 4 shows the socio-demographic profile of interview respondents. All operators were male, with ages ranging from 20 to 70 years old. Most of the operators belonged to the age group of 51–60 (33.33%) and 61–70 years old (26.67%); two of the operators belonged to the age group of 20–30 years old (13.33%), followed by 31–40 years old (20%), and one in the 41–50 years old (6.67%). Based on their educational background, most of them were elementary graduates (26.67%) and high school undergraduates (26.67); two of them finished high school (13.33%), one was a senior high school graduate (6.67%), followed by two college undergraduates (13.33%) and college graduates (13.33%). Ten were married (66.67%), two were single (13.33%) and widowed (13.33%), and one operator was separated from his spouse (6.67%). Nine respondents had a household size of 1–5 (60%), and six had 6–10 (40%). All operators were Roman Catholic. The number of years in the community ranged from 5–61 years. Finally, all operators were members of a fisherfolk organization at their respective barangays.

3.3.3 Income and economic status

The estimated average daily income ranged from PHP 516.67 to PHP 2,673.33. Pricing for *Acetes* was usually based on per "banyera" (PHP 800 – PHP 1,500) or per "caltex" (PHP 50.00). Aside from beach seining, all relied on non-fishing activities like construction or carpentry (73.33%), livestock farming (pigs and chickens) (6.67%), farming (26.67%), or other employment such as security guard (6.67%) or working as LGU employee (6.67%). Meanwhile, some beach seine operators had multiple jobs. As for the ownership of the fishing boat, most of them were operating for the owner (60%), while others owned (20%) or co-owned with their relatives (ancestral property) (20%) (Table 5).

Table 4. Socio-demographic profile of beach seine operators in Miagao, Iloilo.

	Profile	Frequency	Percentage
Sex	Male	15	100
	Female	0	0
Age	20-30 years old	2	13.33
	31-40 years old	3	20.00
	41-50 years old	1	6.67
	51-60 years old	5	33.33
	61-70 years old	4	26.67
Educational Background	Elementary graduate	4	26.67
	High School undergraduate	4	26.67
	High School graduate	2	13.33
	Senior High School	1	6.67
	College undergraduate	2	13.33
	College graduate	2	13.33
Civil Status	Single	2	13.33
	Married	10	66.67
	Widowed	2	13.33
	Separated	1	6.67
Household size	1-5 household size	9	60.00
	6-10 household size	6	40.00
Religion	All are Roman Catholic	15	100
Number of years in the community	5 to 61 years		
Membership in any fisherfolk organization	Yes. All of them are members of their barangay's fisherfolk organization.		

Table 5. Income and economic status of operators based on interviews in Miagao, Iloilo.

	Profile	Frequency	Percentage
Estimated average daily income	Php 516.67 - Php 2,673.33		
Income from non-fishing activities	Construction worker/ Carpentry	11	73.33
	Livestock (pigs, chickens etc.)	1	6.67
	Security guard	1	6.67
	Farmer	4	26.67
	LGU personnel (job hire)	1	6.67
Ownership of the fishing boat	Owned by someone else	9	60.00
	Owned by him	3	20.00
	Co-owners (ancestral property)	3	20.00

3.3.4 Catch and discards variables

The catch per operation of *Acetes* beach seining was estimated to be 12.18–170.78 kg. There were times when there was little or no catch at all and times when the catch was abundant. Aside from *Acetes*, there were bycatches included in the net (considering this was a fine mesh net), such as those belonging to clupeids, slipmouths, lanternfishes, goatfishes, mackerels, tunas, halfbeaks, jacks, scads, mullets, bigeyes, sillaginids, snappers, pufferfishes, and rays. The average daily catch of captured organisms aside from *Acetes* ranged from 2.03 kg to 8.67 kg. Discarded catchwere usually fish species that were not consumable or poisonous

such as pufferfishes, jellyfishes, some wrasses, and sea turtles (Table 6).

3.3.5 Crew composition

The crew for beach seining was composed of the main operator ("mayor/ maestro"), who was responsible for commanding the crew, setting the net, and controlling the rudder of the boat. In contrast, the boat rowers were responsible for rowing the big boat. Sometimes, another person oversaw deploying the net; thus, the average crew members was 4 to 5 persons (i.e., one main operator, boat rowers, and one deploying the net). The estimated number of people needed to complete the fishing operation was 9–15 persons, of which 4–5 were onboard the boat. After the main operator deployed the net, the boat rowers and the one deploying the net would also help pull the rope. The crew members were usually locals of the barangay, and the permanent ones were called "boso." The temporary ones were mainly assigned to the rope pulling and were called "boleros." They only come to help for a share of the catch during their free time. The "boleros" were mostly persons from adjacent barangays, while others came from the mountain barangays. The crew members mainly consisted of adult males (73.33%), while others had a combination of adult males and male children (20%), and there was one that employed female children (6.67%). The main operator designated the females for rope hauling. The children among the crew were primarily responsible for boat rowing. Before they became main operators, they shared that they started as boat rowers and learned the trade by observing how the main operator functioned and deployed the boat. The number of people needed to pull the rope ranged from 10 to 35 persons (if ten persons, then five on each side, if 35, then 17 on one side and 18 on one side). In splitting the catch, the usual mode was a 50-50 split wherein 50% went to the boat's owner, and the other half went to the main operator and the rest of the crew. However, some modifications, like 40%, went to the owner, 10% to the main operator, and 50% to the rest of the crew. It all depended on how generous the owner and the main operator were. The 50% share of the crew was split using a "caltex" container, and then a 2:1 handful ratio will be used to split the catch evenly among the crew members. This 2:1 ratio means that two handfuls of *Acetes* will be given to the crew that rowed the boat and deployed the net, whereas one handful will be given to rope pullers. The splitting of the catch could also vary depending on the catch since there were times when the catch was high and when the catch was low, but most of the time, they tend to split their share equally amongst themselves (Table 7).

3.3.6 Beach seine operators perception to the fishery

Environmental factors that affected *Acetes* catch were strong winds (“pugada”) and water currents (“baskog sulog”). These often resulted in a decrease in the catch. Also, extra effort was needed by the rope pullers as this could quickly exhaust them, thus decreasing the number of operations. Wind direction was also a determinant for a good *Acetes* catch because, based on the respondents, they preferred the northeast monsoon (“Amihan”) as compared to its counterpart, the southwest monsoon (“Habagat”); hence the timing of the open season was favorable to them. The tides were also a factor that affected the fishing grounds with a shallow coastal area (“lantad”) but did not affect areas with a deeper coastal area (“kantilado”). In shallow coastal areas, a high tide is translated to a good catch since they perceived that both *Acetes* and fishes were present, but if it was a low tide, then fishes tend to be in deeper areas of the sea (Table 8).

Table 6. Catch and discards of beach seines based on interviews of beach seine operators in Miagao, Iloilo.

Profile	Response
Estimated catch of Acetes per operation	12.18-170.78 kg
Other species/organisms present during Acetes fishing operations	Clupeidae, Leiognathidae, Myctophidae, Mullidae, Scombridae, Hemiraphidae, Carangidae, Mugilidae, Priacanthidae, Sillaginidae, Lutjanidae, Diodontidae, Batoidea, Ulmaridae, Labridae, Cheloniidae
Average weight of species/organisms present during Acetes fishing operations	2.03-8.67 kg
Species/organisms discarded and why?	Diodontidae, Ulmaridae, Labridae, and Cheloniidae. These organisms are discarded because they are not suitable to be eaten or caught. Some have poisonous toxins.

Table 7. Crew composition of beach seining based on interviews in Miagao, Iloilo.

Profile		Response	
How many crew members are needed to start the operations?		4-5 persons in total (1 "mayor"/main operator, 2-3 boat rowers, and 1 deploying the net).	
Are the crew members locals of the barangay?		All crew members are locals of the Barangay.	
		Frequency	**Percentage**
How many crew members are male/female/children?	No children. All are adult males.	11	73.33
	No female, some male children, and some adult males.	3	20.00
	One female and male child, and adult males.	1	6.67
How many people are usually present in pulling the rope?		10 – 35 persons (If ten persons, then five on each side. If thirty-five persons, then seventeen on one side and eighteen on the other side etc.).	
Are the rope pullers locals of the barangay?		The boat rowers and the one deploying the net are also rope pullers however they are a permanent part of the crew and are called "boso". Most of the rope pullers are temporary and come only in their free time for the share of the catch and they are called "boleros".	
How do you split the catch amongst the crew and rope pullers?		The most common type is 50-50 wherein 50% goes to the owner and 50% goes to the crew. A modification to this is that 40% goes to the owner and 10% goes to the main operator and 50% goes to the crew, "boso" and "boleros".	

Table 8. Perception of operators to the beach seine fishery based on interviews in Miagao, Iloilo.

Profile	Perception	
Environmental factors affecting Acetes catch.	Intense winds and currents.	Decrease in catch.
	Northeast monsoon ("Amihan")	Increase in catch.
	Southwest monsoon ("Habagat")	Decrease in catch.
	Hight tide	Increase in catch (in shallow coastal areas).
	Low tide	Decrease in catch (in shallow coastal areas).
Issues and concerns in the fishery.	Open and Closed season	Limited to six months of operation.
	Time	During the open season, they can deploy only at nighttime and not in the daytime.
	Entangling of the net on the rocks.	Broken nets result in maintenance which leads to costs.
	Competition with another fishery (e.g., "lilang" or "bentahan").	Competition affected catch.
How many beach seine units in the past?	Sixty-five beach seine units in the past. Thirty-five beach seine units as of the present time (including unlicensed non-operating units).	
What are the reasons for the increase/decrease of beach seine units in the area?	Maintenance problems.	
	Conflict with another fishery.	
	Owners sold their units, and others died.	
	Did not continue operating because of declining catch.	
	The open and closed seasons discouraged operators and owners.	

The issues and concerns about the fishery raised by the respondents were the implementation of the open and closed seasons. They perceived the open season as a privilege to fish any time of the day they wanted even though the Municipal Ordinance of the LGU stated that they were only permitted to operate at night to catch *Acetes* and not the school of fish that were present during the day. The entangling of the net to the stones at the bottom of the sea resulted in maintenance problems and poor catch, and other fisheries like "lilang" and "bentahan" could compete with them since this fishery also operated in the coastal areas (Table 8).

When asked how many beach seine units were present in the past, they estimated that there used to be 65 beach seine units in Miagao. At the time of the study, only 35 units remained (including unlicensed ones that were non-operational). The reasons behind the decrease in units were the problem in maintaining the gear and the fishing boat, which is costly, having conflicts with other fishery, owners selling their units, death of operators, and halting of operation due to poor catch. Others were discouraged from continuing due to the implementation of the open and closed seasons since they were experiencing declining catches. They observed that the prohibition contributed to this decline because it limited their operations (Table 8).

4. DISCUSSION

In the Philippines, beach seines are among the standard fishing gear used in coastal areas. In the Southern Iloilo coastal municipalities, it was considered a traditional type of fishing gear wherein the locals of a particular area and those in adjacent areas congregate to perform beach seining. It has been regarded as an essential source of food and income for many households. The fishery targets small sergestid shrimp, *Acetes spp.*, juvenile clupeids, and larval and post-larval clupeids (Monteclaro and Abunal 2013). While the beach seine industry in Miagao, Iloilo continued, the local government interventions instituted measures to ensure the industry remained sustainable. Open and closed seasons were implemented in the municipality, which aimed to regulate the beach seine, "lilang," and "bentahan" fishery. As stated in Republic Act 10654 Section 93, fine mesh nets are not allowed except for some target species like fry, glass eels, elvers, tabios, and *Acetes* ("alamang") since these organisms are considered small yet mature. The use of small-scale fishing gears like skimming push nets ("sud sud"), practiced in Tigbauan and Oton, Iloilo, in targeting *Acetes* spp. (Ferrer et al. 2003, could minimize fish bycatch. The open season in the municipality lasts for six months, coinciding with the northeast monsoon ("Amihan") and dry season from November to April. The issue with using a beach seine is that it is non-selective, which could capture species other than *Acetes* and disturb the sediment. Because of this, the beach seine fishery may be detrimental to marine ecology and biodiversity.

Based on the mean monthly catch rates for *Acetes*, it can be observed that they increased until they reached their peak in January, and they declined in February. The mean monthly catch rates started to decline in February even though the average number of operations was maintained (~2 operations). From March onwards, there were only 1-1.5 operations, which resulted in a drastic decline in catch rates. According to the operators in Damilisan, *Acetes* catch was declining as the months approached the season of the southwest monsoon since, for them, the monsoon influences *Acetes* abundance. This could be the reason why operations were declining from March onwards since the operators believed that *Acetes* spp. catch will be few. When conducting operations during nighttime, only a small portion of bycatch was recorded in mean monthly bycatch rates and estimated total landings (Figures 3 and 4). The majority of the beach seine operations at night guaranteed *Acetes* spp. with minimal bycatch. However, the bycatch also consisted of post-larval and juvenile fishes of fishes mentioned previously in the catch and discards (Table 6). Monteclaro and Abunal (2013) reported that aside from the clupeid larvae, larvae of other families, such as terapon grunt, anchovies, slipmouths, gobies, and mojarras, are caught by beach seining. The highest estimated total landings for *Acetes* were recorded in January and declined after that month. The trend of the estimated landings was similar to the data obtained by Monteclaro and Abunal (2013) in Baybay Norte, Miagao, Iloilo. However, their data recorded February as the highest landings of *Acetes*, which contrasted with the results of this study since a decline was observed in the same month. Starting from February and the following months, it was observed that operators in Damilisan tend to target pelagic fishes like pacific redtail scad (*Decapterus kurroides*) and the Philippine snubhose halfbeak (*Meladepalion breve*) using the lightboats of the "lilang" fishery. These pelagic fishes' targeting continued until the end of the open season. The frequency of the operators

targeting *Acetes* from February onwards tends to drop, which could explain the lower catch rates in these months. Based on an informal interview, the operators said *Acetes* was declining in February, which is why they target these pelagic fishes. It was observed that many municipal fishers also position themselves in the pelagic zone targeting these species during nighttime. The month of February could be the peak recruitment of pelagic fishes and *Acetes*. The LGU had defined the limits of the beach seine fishery to *Acetes* only, and this targeting of pelagic fishes is a strict violation of RA 10654. The beach seine fishery should be strictly limited to *Acetes* so that operations will be considered legal and sustainable to the ecosystem of the fishing grounds. The trend of the monthly CPUE and total landings for *Acetes* in most months were similar to the recorded data of Monteclaro and Abunal (2013) when they assessed the catch rates and composition of the beach seine fishery in Northern Panay Gulf during the northeast monsoon. However, their study recorded high landings in January and February, whereas in this study, landings in February were lower.

Most owners hired an experienced operator for a share of the catch, while some served as the operators themselves. These operators that work under an owner cannot finance the construction and maintenance of a beach seine. The owners informally hire an operator, and they agree on terms and conditions, specifically on the share of the catch. The catch would be split between the owner, operator, crew members, and rope haulers which affects income if the catch is poor. Male operators dominated beach seining because females were limited to rope hauling. Because of this, females cannot gain the experience male boat rowers have in observing the operator on how to maneuver the beach seine. Beach seine operators live most of their lives in their respective hometowns and have been familiar with beach seining for a long time. They had been full-time operators in their early years, which was a compromise to their education. A year-round operation before encouraged a lot of them to focus on beach seining. The operators could not depend on the fishery alone to sustain themselves and their families due to government restrictions and declining catch leading to fluctuating income. The LGU will not have a hard time assessing and monitoring beach seines because all of them are compliant with the existing policies.

Their gears have yet to be modified. They still use the same materials as fine mesh nets, multifilament nylon, polyethylene rope, floaters and sinkers, and a bamboo pole, which is similar to the study of Monteclaro and Abunal (2013). The nets used in the beach seine were sectioned into three parts and had the same mesh sizes, similar to the study of Monteclaro and Abunal (2013). However, they did not mention the stitched green twine (~3 cm mesh size) across the wings and bunt, locally called the "garaganta." Based on the operators, the "garaganta" provided stability on the sinkers and floaters attached to the body and bunt. The total line lengths are also different, ranging from 130 to 280 meters. This was based on the fishing ground they were deploying; for instance, shallow fishing grounds have shorter total line lengths than deeper fishing grounds. The average depth in which they deployed their gear ranged from 5 to 60 meters. It is an appropriate depth for *Acetes* since they are found at depths less than 50 meters and are aggregated at the surface at a depth of 20 meters (Omori 1975) at night since they vertically migrate during the day (Diel Vertical Migration). A secondary fishing boat that assisted in the operations was common in the fishery since the crew members could practically handle the net. Some use secondary fishing boats if the net is entangled in the rocks or to adjust the net in the water. The only problem with using a secondary fishing boat is using light boats to lure pelagic fishes toward the coast, which changes their target species. This gives the impression that the beach seine fishery targeted pelagic fish, which the law strictly does not allow. All interviewed participants used a flashlight as their accessory since operations were conducted at night to scout for clumps of *Acetes*. Omori (1975) observed that *Acetes* are active during the nighttime and described the species as dot-like organisms producing blue-green light. They also use a flashlight to signal the rope pullers to close the net. However, technological interventions could be implemented to make the operation more efficient, like using a walkie-talkie to signal the rope pullers ashore.

According to the respondents, their estimated *Acetes* catch ranged from 12.18 to 170.78 kgs per operation, making their catch per operation vary per day. Environmental factors such as rain, strong winds and currents, low tides, and high tides affect their operations and catch. Their catch of other organisms when targeting *Acetes* ranged from 2.03 to 8.67 kgs, which is a small percentage of the catch. As Monteclaro and Abunal (2013) suggested, the beach seine fishery should define how many percent of the total catch should be comprised of allowable species to ensure sustainability. The respondents' perception of the total catch and *Acetes* catch was similar to the study's results for total landings (Figure 4). To ensure

that the target species of the beach seine most of the time is *Acetes*, they should conduct their operations only at nighttime to reduce bycatch. This is why the LGU still regulated them even though it was open season. The start of the operations during nighttime is a problem with the open season because of the summer solstice, which means longer days and shorter nights. The diel vertical migration of *Acetes* is affected (Chiou et al. 2003), which is why a fixed schedule of 5 PM by the LGU should be adjusted if longer days will be experienced during the open season. Catch rates and composition were similar to the results of Monteclaro and Abunal (2013), and the reason why some organisms were discarded was that they were not appropriate to be consumed (e.g., turtles, jellyfish) and toxins (e.g., pufferfishes). The exception to this was rays, which people consumed because of their favorable taste.

The beach seine fishery was composed of permanent ("boso") and temporary ("bolero") crew members. Permanent crew members consisted of 1 main operator who commanded the crew and was responsible for deploying the net, 2 to 3 boat rowers, and the rest were rope pullers. There should be at least ten persons who were permanent members of the operation so it could commence. The temporary members were usually assigned to the rope pulling. According to Monteclaro and Abunal (2013), "boso" were the rope-pullers since they were defined as someone that is not part of the crew and were only present for a share of the catch for their food supply. However, the respondents said they had people always present for the rope-pulling, so they would not depend on the "boleros." These people were usually locals of the barangay. An average of 10–35 persons were present during the fishing operations, which could exceed depending on the availability of the people. Usually, the temporary members come from the local barangay, adjacent barangays, and barangays from mountainous areas who want a share of the fish catch. If many rope pullers were present, the fishing operation would be efficient because this would shorten the time needed to finish one operation, thus, more operations for that day. The problem with many people in the operations was that if there were a poor catch, splitting would be difficult, leaving the temporary members empty-handed. The good thing about beach seine was its openness to society since it did not discriminate against who would join the operations and did not require a broad set of skills that motivated the temporary members. The main operator even favored the crew members and rope-pullers because he knew most of the effort came from them, which encouraged them to continue this fishery.

According to the respondents, the northeast monsoon is the most favorable since it means higher *Acetes* catch, while the southwest monsoon provided decreased catch. According to Chiou et al. (2000) and Jiang and Guo (1983), wind direction and intensity affect the habitat dispersal of *Acetes*, bringing them to the coastal areas.

The open and closed seasons are necessary to control fine-mesh net users' fishing efforts. The closed season was placed during the rainy season when operations were inefficient. The time was also a conflict for them because they thought that they could deploy during the daytime during the open season when they saw a school of fish jumping in the water ("pamunong"). The entangling of the nets meant maintenance costs, and the competition with the other fishery was a problem that the LGU should manage so that no conflict would arise between them. Based on the respondents, there was a decline in beach seine operators over time. During the time that there were no regulations, there were about 65 operators, and when regulations were applied, it slowly declined to 35 as the years passed. The reasons for this decline were the maintenance costs, owners not continuing because of the death of crew members, selling their units (financial needs), and being discouraged by the restrictions.

5. CONCLUSION

The *Acetes* beach seine is a traditional fishery in Miagao, Iloilo, with several enhanced techniques introduced to it, such as the use of light boats to lure pelagic fishes and walkie-talkies to command the rope haulers synchronously. The beach seine structure, operations, and distribution of catch are maintained traditionally. The number of beach seine operators declined in half when the local ordinance for fine-mesh nets was implemented. However, the *Acetes* beach seine fishery experiences fluctuating catch, and many coastal communities, primarily those belonging to low-income households, were dependent on it. The problem of the fishery is the actual time when nighttime starts (due to summer solstice), competition with other fine mesh net fisheries, and bycatch of other fish species. To solve these problems, a controlled and flexible fishing time should be implemented to ensure that the high percent of the catch of the beach seine fishery is Acetes , and the LGU should set specific guidelines for fine-mesh net users to minimize conflict.

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AUTHOR CONTRIBUTIONS

Gaudiel RM: Concept framework, Assessment, Methodology, Data collection and analysis, preparation of draft, editing of manuscript. **Monteclaro HM**: Conceptualization, Supervision, Validation, Writing, Review, Editing of manuscript. **Leonida JIL**: Validation, Review, Editing of manuscript. **Mediodia, DP:** Validation, Review, Editing of manuscript. **Wilfredo L. Campos**: Validation, Review, Editing of manuscript.

CONFLICT OF INTEREST

To the best of our knowledge, there is no existing conflict of interest.

ETHICS STATEMENT

The study required human respondents, and a research ethics board conducted an expedite review prior to conducting the study and gave a research ethics clearance.

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