Asia Pacific Journal of Advanced Business and Social Studies
ISBN (eBook): 978 0 9943656 7 5
Year: 2015 , Volume: 1, Issue: 1

THE CONTRIBUTIONS OF FISHER'S KNOWLEDGE TO MARINE FISHERIES MANAGEMENT A CASE STUDY OF A COASTAL COMMUNE IN VIETNAM

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Abstract

This paper examines the contributions of fisher's knowledge to marine fisheries management for sustainable development. This study argues that fisher's knowledge has significant contributions to sustainable management of marine fisheries. We investigate fisher's knowledge by using techniques of participant observation, interviews, and group discussions. The study finds that the local fishers have technological and ecological knowledge of fishing seasons and weather conditions, stars, seawater colour, current strength and direction, fish movement, seabed and fish habits. This knowledge is used to decide when, where, and how to fish. The study finds that this knowledge is significant in marine fisheries management since it can supplement scientific knowledge. Moreover, this knowledge can be used to build a knowledge base that can help the fisher's to fish effectively and avoid hazards at sea and the officials to manage the fisheries sector efficiently. Especially, this knowledge also gives valuable information for fish stock assessment and fisheries planning such as designing appropriate closed fishing seasons and marine protected areas suggested by the ecosystem approach.

Keywords: Fisher's knowledge, contributions, marine fisheries management, sustainable development, Vietnam.

1. Introduction

Vietnam fisheries sector plays an important role in the economy and livelihoods of coastal people (Danida, 2010; Lai *et al.*, 2009), constituting about 3.2% of the Vietnam's GDP (Danida, 2010). The fisheries sector provides millions of employment opportunities in coastal areas with 700,000 direct and 1.5 million indirect jobs (Lai *et al.*, 2009). The resource is being depleted due to increase in population and development of effective and destructive fishing gears (Danida, 2010; Lai *et al.*, 2009). In this situation, improved marine fisheries management is urgently required to protect marine fisheries for sustainable development. Evidently, the Vietnamese government failed to provide the required management due to lack of human and financial resources (Dang, 2008; Stream, 2004). Moreover, Centralized government-based management systems don't pay any attention to fisher's local knowledge. Instead, they are heavily reliant on research based on biological and ecological knowledge developed in research institutes and universities (Nielsen *et al.*, 2004). Such knowledge is normally unintelligible for local fishers and other stakeholders (Degnbol and Jarre, 2004; Viswanathan, 2011). Consequently, people do not comply with the rules when they are

complicated and difficult to understand (Pomeroy *et al.*, 2001). Noncompliance with the rules is one of the main reasons leading to the failure of top-down management (Dang, 2008; Kuperan and Sutinen, 1998). An *et al.* (2008) believes that the use of both local knowledge and scientific expertise can offer a better resolution to the existing fisheries management issues in Vietnam. Moreover, the integration of fishers' knowledge and practices into contemporary management systems has the potential to diminish adverse social and environmental impacts of management leading to socially and environmentally sustainable systems (Nielsen *et al.*, 2004). In Vietnam, no research has been conducted to understand how fishers' knowledge works and its application to fisheries management. As Wilson *et al.* (2006, p.530) states that most research of fisher's knowledge has focused on cataloguing content rather than investigating its nature and how it is able to be used in fisheries management. Therefore, it is important to understand fisher's knowledge in order to find better solutions for marine fisheries management. This paper is conducted to investigate the contributions of fisher's knowledge to marine fisheries management. This paper argues that fisher's knowledge has significant contributions to marine fisheries management for sustainable development.

2. Conceptual framework

There has not been any universally accepted definition of fisher knowledge in the literature. Fisher knowledge was referred to as local or traditional knowledge. According to Berkes (1993, p.3), traditional knowledge is defined as "a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment". This kind of knowledge is an attribute of societies with historical continuity in resource use practices. Traditional knowledge is identified by Drew (2005, p.1287) as a useful construct that represents knowledge gathered from undertaking several different pursuits, such as hunting, medicinal collection, preparation for spiritual ceremonies, or maintenance of a household economy. He explains that these pursuits are common activities in the society and typical ways that people interact with the nature. These interactions over generations create traditional knowledge. Traditional knowledge is accumulated through trial and error. Utomo (2010, p.24) narrows down traditional knowledge in fisheries field "knowledge that has existed to arrange fishing activities from gears management, fishing seasons, target catch, and specified areas". This knowledge has existed to meet human demands and to conserve the nature for future. Moreover, according to Grant (2006), fishers have technological and ecological knowledge of fishing that evolved over time. They use this knowledge to make daily decisions related to when, how, and where to fish. Grant and Berkes (2007) assert that fisher knowledge is based on observation, experience, and trial-and-error.

Based on the description above, the term fisher's knowledge used in this research specifically refers to technological and ecological knowledge held by local fishers, which was generated through observation, experience, and trial and error. The knowledge has existed in the fishing community to help fishers to organize and arrange their fishing activities consisting of operation of their fishing gears, boats, and other equipment; fishing seasons; fishing methods; target fish species; and fishing ground.

The research will clarify that fisher's knowledge has significant contributions to marine fisheries management for sustainable fisheries development as suggested by Charles (1994).

3. Descriptions of study area

The criteria applied in the selection of study site include: the dependence on marine fisheries, the diversity of fishing activities, and the ease of obtaining information. Phuoc Hai commune was chosen utilizing these criteria, following the review of related documents and utilizing the researchers' expertise.

Phuoc Hai is one of the communes within Dat Do district, Ba Ria - Vung Tau province, Vietnam (Figure 1). Fishing is the main livelihood activity of the local people, which contributes a remarkable 70% of the total household income (Household survey, 2013).

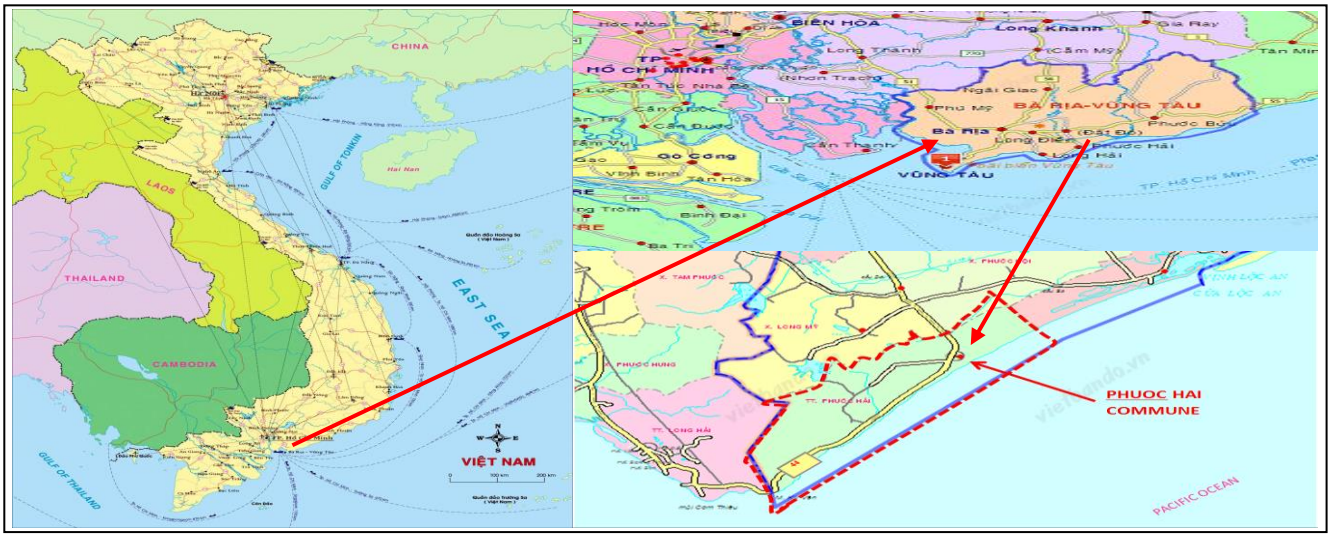


Figure 1: Geographical position of Phuoc Hai commune (Source: Vietnam Government Portal, 2014)

In relation to fishing style, fishers in Phuoc Hai are categorized into coastal and offshore fishing groups. The offshore fishers use cabin boats, which are between 16 - 25 m long, and have 90 - 550 horse-power (hp) engines (Figure 2). Single trawl nets and pair trawl nets are mainly used by the offshore fishers. The coastal fishers use jolly boats (13 - 18 m long and 20 - 89 hp engines), basket boats (5 - 9 m in length and 1 - 89 hp engines), and bamboo baskets (2.8 - 3.5 m diameter and 1 - 19 hp engines) (Figure 2). A larger variety of fishing gear is employed by the coastal fishers and includes three layer nets, layer nets, scad nets, drag nets and herring nets.

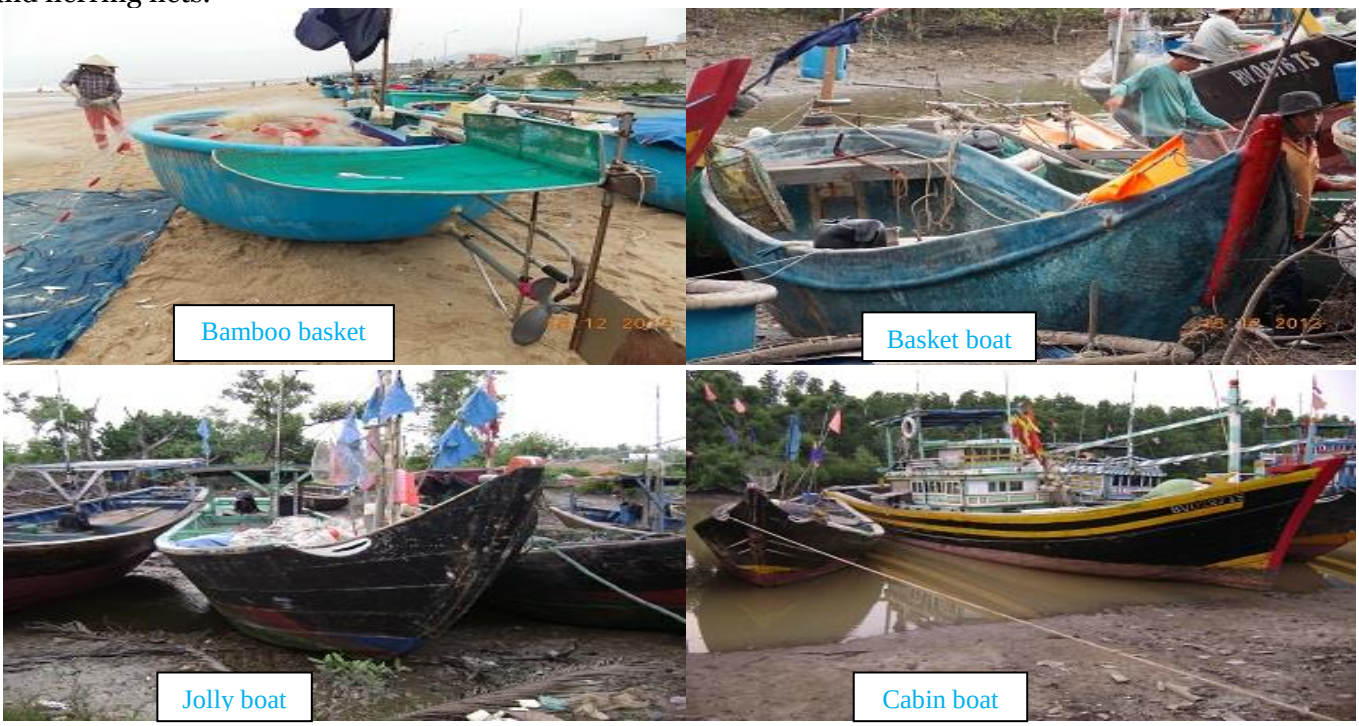


Figure 2: Cabin boat, jolly boat, basket boat, and bamboo basket (Photos: Nguyen Bach Dang, 2013).

4. Methodology

4.1. Data collection methods:

Data and information collection was conducted between May and December 2013.

Participant observation: This method was used at the first time to visit the study site. To observe and understand fishing activities, the researchers also stayed on boats and participated in fishing activities such as collecting fish, washing gears, and preparing gear.

Information used for this chapter consists of secondary and primary data. Secondary information includes materials related to fishing gear operation to have initial understanding of the ways fishers operate their fishing gear to catch fish. In terms of primary information, this paper mainly uses the qualitative data collected from group discussions and interviews, which used separate checklists consisting of opened and closed questions. The researchers interviewed eight experienced fishers from different fisher's groups who have deep knowledge of different types of fishing gear. These interviews enable us to get information on fisher's technological and ecological knowledge. Group discussions were conducted with the participation of three experienced fishers, the communal fisheries official, and the vice head of the commune to understand the significance of fisher's knowledge to marine fisheries management.

4.2. Data analysis:

Qualitative information and data collected from the group discussions and interviews were synthesized and reviewed continuously form the start to the end of the fieldwork to ensure collecting data sufficiently. The researchers organized and classified the information and data based on the themes assigned in the checklists, which include the knowledge used to decide when, where, and how to fish and its significance to marine fisheries management. Subsequently, the researchers combine and compare the information and data across these themes to find common patterns, similarities, and differences to elaborate the issues, to establish evidence for the research findings, and to support the argument.

5. Results and discussions

5.1. Knowledge used to decide when to fish:

There are two main fishing seasons including the southern and northern season in the study site. The northern season corresponds with the dry season from November to April of the lunar year. This season is called "Vụ Bắc" in Vietnamese by the locals as this season is affected by the northern – northeast wind from the Pacific Ocean. There is almost no rain and cloud; however, the wind is very strong and intensive in this period. The sea is rough and the condition is not good for fishers to go fishing. The local fishers stay ashore in most of the time in this season. Therefore, the local fishers consider this as lean season of the year. On the contrary, the southern season called "Vụ Nam" in Vietnamese by the locals lasts from May to October of lunar year. This season is rainy season and is affected by the southern – southwest wind from the Indian Ocean. The wind is calm, so the sea is smooth for fishing. By understanding fishing seasons and weather condition, the local fishers put their efforts into fishing in the southern season so that they can compensate for their loss in the northern season.

5.2. Knowledge used to decide where to fish:

The local fishers have ecological knowledge of waves, stars, seawater colour, current strength and direction, fish movement, and seabed that help them to decide where they should go fishing.

Waves: The local fishers state that understanding waves is crucial to overcome obstacle on sea caused by big waves. Normally, there are two waves moving together: the bigger one moving first called “mother wave” and smaller one moving right after called “kid wave”. The local boats are mostly sunk by the small wave since the local fishers just pay their attention to escape the big wave. The way to deal with such kinds of waves is to modify the bow of a boat to move straight on both the big and small waves. The local fishers are also able to assess if there are big waves that is based on the wind force. The local fishers comment that there will be no wave if the wind force is under four (Beaufort number), having small waves if the wind force is over four to six, and having big waves if the wind force is over six. Moreover, big waves are also present in sand dune in low tide regime.

Stars: The local fishers use stars to define the direction on the sea. The great bear is used as an indicator to define the direction. If they want to go straight from the coast to the open sea, the great bear locates right on the back. Similarly, if they go to the right or the left, the great bear is on the back of the right or the left shoulder, respectively. Conversely, if they go from the open sea to the coast, the great bear is in front. In addition to the great bear, the local fishers also use the morning and evening stars to find the direction on sea but these stars are not as popular as the great bear since they just arise in a very short period in the day.

Seawater colour: The seawater mainly has three colours: deep blue, pale, and muddy. Firstly, the deep blue coloured seawater mostly arises in the southern season when the sea is calm. When the seawater colour is in deep blue, fish species are mainly the ones living near the surface of seawater such as herring, sardine, scad, and anchovy, etc. The fishing gear suitable for operating in the deep blue coloured seawater is floating nets such as drag net, herring net, three layer net. This is mainly because these nets are made of transparent catguts, so the fish are not able to recognize the presence of these nets. In addition, fish hooking by using bait is also favoured by the local fishers as the fish can see clearly the bait in deep blue coloured seawater. On the contrary, the pale coloured seawater principally occurs in the northern season when the sea becomes rough. The pale coloured seawater is a good condition for fishing gears operating at the bottom of the sea including diving net, bottom trawl net, and crab net. These fishing nets catch demersal fish such as crab, squid, prawn, and croceine croaker, etc. The local fishers prefer the pale coloured seawater since it is suitable for both floating nets and nets operating at the bottom of the sea. Finally, the seawater changes to muddy colour when the sea becomes extremely rough due to storms. Moreover, the muddy colour of the seawater is derived from the marine algae. There is almost no fish in muddy coloured seawater.

Current strength and direction: The current strength and direction are dependent on the tide regime. The tide regime is identified based on both knowledge of the moon and the time following the fishing seasons. According to the respondents, the moon rising in the east means that the tide is high and the moon setting in the east means that the tide is on the ebb. On the contrary, the moon rising in the west means that the tide is on the ebb and vice versa. In the southern season, the tide is on the ebb in the late afternoon from 4 pm to midnight. In the northern season, the tide is also on the ebb from the early morning of 3 am to the midday. It means that in this period of the southern and northern seasons, the current is strong and the current direction is from the coast to the sea. Conversely, in the remaining time of the southern and northern seasons, the tide is high or stable, which means that the current moves softly and the current direction is from the sea to the coast. The strong current makes fish drift away and their fishing gear tangled. Therefore, they prefer fishing in the time of high or stable tide when they can catch more fish and operate their fishing gear easily. Particularly, understanding the current strength and direction is meaningful in deciding where they should place their nets and avoiding loss of their fishing gear. For instance, to catch more fish, the local fishers who use floating nets such as herring net and drag net place their nets above coral reefs. If the current direction is from the sea to the coast, the fishers must place their nets in the distance

far enough from the coral reef to the sea. The estimation of distance is basd on the strength of the current so that when their nets are above the coral reef, they would be drifted slowly to catch fish and avoid being caught in the reef.

Fish movement: Fish movement is quite different between the southern and northern seasons. The southern season is affected by the southern – southwest wind, so fish migrates from the open sea to the coastal areas. It is the reason why the southern season is the peak one of the year as all kinds of fishing gear can be deployed in the coastal areas to catch fish. Moreover, since the local fishers do not go far away to catch fish, they can save their fishing costs. On the contrary, the northern season is impacted by the strong wind from the northern – northeast and cold weather, the fish therefore move from the coastal areas to the open sea. The local fishers must go further to catch fish, leading to increase in fishing cost.

The local fishers have their own ways to identify the movement of fish. The local fishers confirm that the pelagic fish normally migrate following the shoal with the area from 50 m^2 to 100 m^2. The indicator that signifies the existence of the fish shoal is the presence of a flock of seabirds flying near the surface of seawater. Besides, the local fishers have a particular way to detect the presence of fish shoal. One fisher dives from 0.5 – 0.7 m under the surface of seawater to listen to the sound of the fish. The accuracy of listening to the sound of the fish is determined by the skills and experience of the diver who is able to distinguish the sound of fish from other sounds such as the sounds of boat engines, seawater current, etc. Additionally, the local fishers make the shelter from bamboo and coconut leaves to attract fish to move to live under.

Seabed: The local fishers have knowledge of seabed structure that helps them to define where they should drop their nets to catch more fish. According to the respondents, the seabed of fishing ground is divided into three main areas, including northern bay, the fishing ground from Thanh Hóa to Khánh Hòa province, and the fishing ground from Ninh Thuận to Cà Mau province. In which the seabed of northern bay and Thanh Hóa to Khánh Hòa province has high water depth, many reefs, which is very rough, and not a good condition for fishing. Meanwhile, the seabed of the fishing ground from Ninh Thuận to Cà Mau province is smooth and has many coral reefs, which are favourable conditions for fishing. The respondents take the view that the seabed with 30- 50 m water depth has more fish, while the seabed with under 10 m water depth only has pelagic fish suitable for coastal fishers who use basket boats and bamboo baskets. The seabed where there are many corals has more fish than the one where there are many reefs. Moreover, the respondents also state that the fishing grounds in the southern provinces from Tiền Giang to Cà Mau have many kinds of fish. It is because there are a large number of estuaries that are in good conditions for fish spawning and good habitats for fish.

5.3. Knowledge used to decide how to fish:

The knowledge of fish habit accompanied with technological knowledge helps the local fishers decide how to fish. According to the respondents, every fish species has its distinct habit. Understanding their habits is important in identifying the exact and appropriate methods to catch them. There are plenty of fishing methods used by the local fishers; however, this section will describe some special fishing methods used based on their particular knowledge of fish habit.

Squid: the local fishers know that squid's skin is too slippery to be caught by nets. The local fishers have special way to catch squid by combining fly-fishing, scoop nets, and incandescent lamps. The fly-fishing is the fishing method made of reel and line of 20 – 30 m length. The line is cast with light baits in the forms of artificial flies. The artificial flies made of golden lamé and lamé hairs or of plastic in forms of artificial shrimps or fish (Figure 3). The distance between the artificial flies is about 1 m. Being attracted by both the artificial flies and the incandescent lamp, squid come up the surface of seawater from the seabed. The fishers use

the scoop net to catch squid right after squid is coming up because squid can move backward very quickly.

Figure 3: Fly-fishing and scoop nets

Photo: Nguyen Bach Dang, 2013

Crab: Crabs are attracted by rotten and tough bait with strong smell. The popular diets of crab are blowfish and marine eel since the meat of these kinds of fish is tough and is able to be kept for some days to be rotten. The local fishers use two types of fishing methods to catch crab, consisting of crab net and crab trap. A crab net includes from 50 to 100 net units connected together. One unit of crab net is made of catgut and has about 3 m height, 50 m length, and mesh size of 4-5 cm. A crab net consists of a string of gillnets kept more or less vertical by floats on the upper line and weights on the lower line or fixing net. The net on the upper line drifts with the current, near the surface or mid-water. A crab net is set up following the spiral to avoid being tangled with other fishing gear. The bait is tied to the floats to draw crab. A crab trap consists of from 1200 to 1500 traps connected by the line. The gap between two of these traps is about 3 m. One trap is in cylinder formed by two iron circles of 50 cm diameter and iron bars of 60 cm height (Figure 4). The bait is kept in the centre of the cylinder by a string. Crab traps are placed at the seabed following the spiral with 1 km circumference to avoid being tangled with other fishing gear, especially the bottom trawl nets.

Figure 4: Crab trap

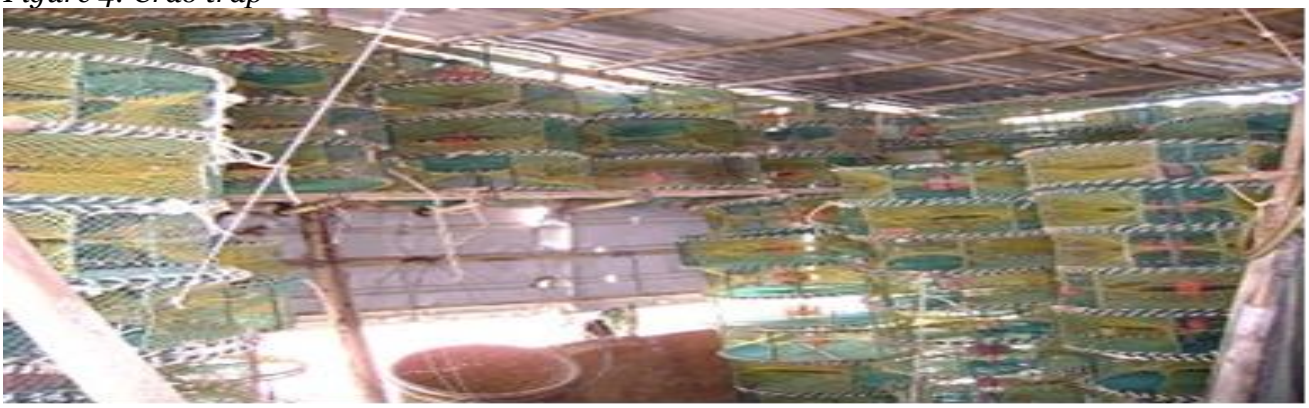
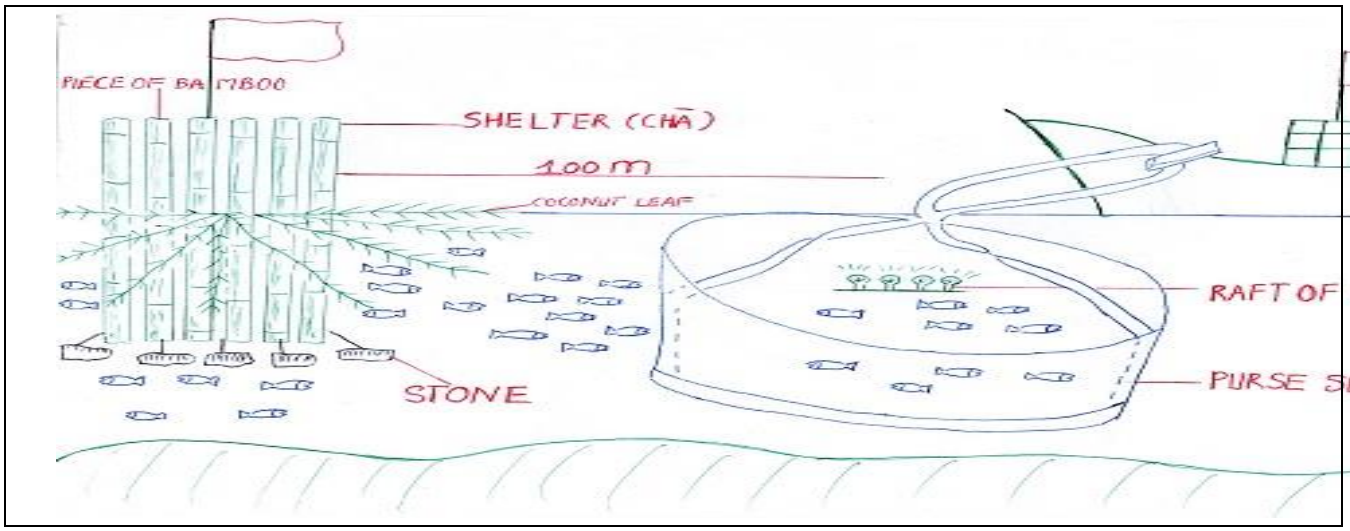


Photo: Nguyen Bach Dang, 2013

The local fishers state that every fish species has its own favourite diet. Knowing the diet of fish species is important to determine the type of bait to use to hook particular fish species. For example, the diets of both tuna and mackerel are small fresh fish, which include scad, yellow-stripe scad, herring, and sardine. Sharks favour bigger fresh fish such as mackerel and threadfin.

The local fishers know that some pelagic fish species, which include scad, anchovy, blue fish, mackerel, tuna, and yellow-stripe scad, need a shelter to avoid the sunshine. The local fishers make the shelter from stone, bamboos, strings, and coconut leaves to attract fish to gather under the shelter. The shelter, called “chà” by the locals, is a cluster of from 15 to 20 pieces of bamboos fixed by heavy stones. The stones are tied to the bamboos by strings. The coconut leaves are attached to the bamboos to make shade for fish and to keep the cluster float on the surface of seawater (Figure 5). To catch the fish gathering in the shelter, the local fishers use purse seines with about 500 m length deployed in dark nights in combination with strong surface lamps kept on a raft to attract the fish from the shelter. The raft with strong lamps is placed about 100 m far from the shelter so that the purse seines are able to be operated easily and to avoid being caught to the shelter. Purse seines are set around the raft where having the located fish shoal by the boat. The setting of purse seine is conducted as quickly as possible to prevent trapped fish from escaping. After the setting, purse seine is closed by pulling the purse line through the rings. Then, the fishers use scoop nets or trawl nets to catch the fish trapped in purse seine (Figure 5).

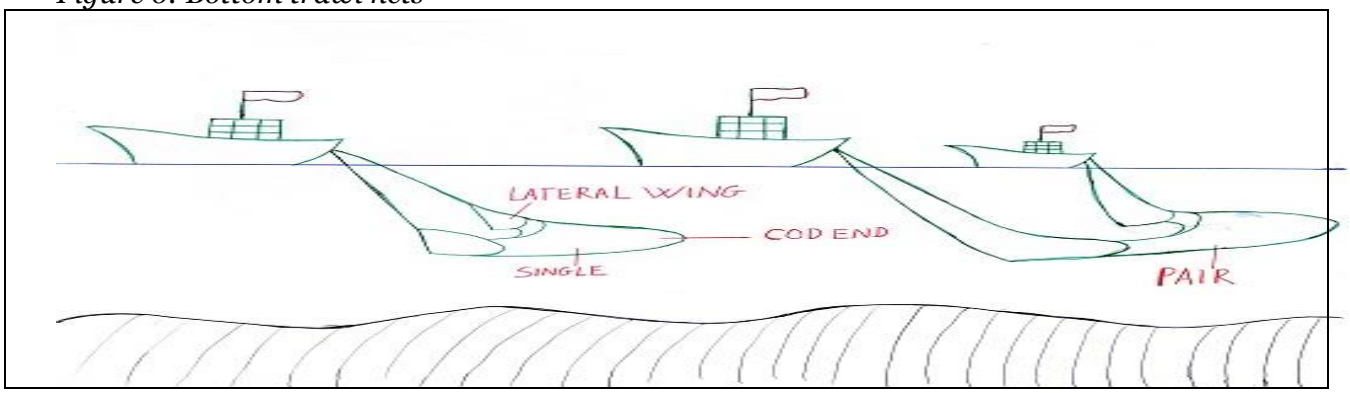
Figure 5: Shelter (Chà) and Purse seine



Source: Drawn by the first author based on interviews, 2013

The local fishers mostly use the bottom trawl nets to catch demersal fish species. A bottom trawl is a cone-shaped net with a body ending in a cod end. The net has two lateral wings extending forward from the opening. The mouth of the trawl is framed by headline and ground rope. The smallest size of mesh is about 20 mm. This net is to catch species living on or near the bottom. There are two kinds of bottom trawl nets used by the local fishers, which include single and pair trawl nets (Figure 6). The deeper is the fishing ground where the bottom trawl nets operate is, the higher is the horsepower of the boat engines to tow these nets.

Figure 6: Bottom trawl nets



Source: Drawn by the first author based on Interviews, 2013

The local fishers also have knowledge of fish sounds to identify where the fish shoal will be located. The local fishers have traditional skill of underwater listening to distinguish the fish sounds from other sounds such as wave, boat engine. Although fish searching machines are used widely, the local fishers confirm that they still need the skill to assess if there is enough fish gathering in the required place to drop their nets. The underwater listening is performed by a fisher who dives from 0.5 – 0.7 m under the surface of seawater. The fisher, based on his own experience, is able to identify whether there are many fish or not, whether they are demersal or pelagic fish, and in what direction they are moving within from 3 to 5 km radius. The net is used to catch fish in this case is diving net, called "Lưới Lặn" in Vietnamese by the locals. A diving net consists of from 100 to 150 units of nets made of catgut connected together. Each unit of diving net has 4 m height, and 50 m length, and mesh size of from 6.8 to 7 cm. The diving net is set surrounding the diver following the spiral from the outside to the centre at the bottom of the sea to impede fish escaping from the net.

5.4. Discussions

It is commonly accepted that fisher's knowledge can bring many benefits for marine fisheries management. Scholars state that fisher knowledge can complement scientific knowledge to ensure scientific validity and subsequently make the scientific knowledge become more acceptable to fishers and other stakeholders (Johannes *et al.*, 2000; Mackinson, 2001). Therefore, according to these scholars, fisheries policies and regulations should be set up based on both scientific and practical knowledge to ensure high compliance of fishers. For example, the research finds that understanding how fishers operate their bottom trawl nets is important in improving the compatibility of the fisheries regulations of horse power of boat, fishing gear and fishing distance. As mentioned, the deeper the fishing ground where the bottom trawl nets are operated is, the higher the horse power of the boat engine needed to be.

The fisher's knowledge is able to offer real information that can be used to manage the fisheries sector (Bergmann *et al.*, 2004; Silvano and Begossi, 2005). The process of finding and catching fish of the local fishers starts with understanding the fishing seasons and weather

conditions to decide when they should go fishing. Subsequently, based on their ecological knowledge of fish habit and technological knowledge of fishing gear, the local fishers choose the most appropriate fishing methods to catch specific fish. At sea, the local fishers define where to fish and how to fish based on their ecological knowledge of waves, stars, seawater colour, current strength and direction, fish movement, seabed, and fish habit. The result of the group discussion state that this knowledge can be used by the fisheries manager to build the knowledge base that helps them understand fishing career. Moreover, this knowledge base is useful for the local fishers to fish sustainably as well as to avoid loss due to natural hazards at sea.

Fishers have broad ecological and technological knowledge of fishery that can deliver useful qualitative data for fisheries planning and assessment (Grant, 2006; Grant and Berkes, 2007). This knowledge can be used in planning closed seasons rationally to both protect spawning of fish and ensure the livelihoods of fishers (Silvano and Begossi, 2012). For instance, in the study site, closed seasons, besides being constructed on the basis of the biological spawning characteristics of fish species, should mostly be planned in the northern season since it is not a favourable time for going fishing due to strong wind and rough sea. The closed seasons mostly set up in this season are quite appropriate for the local fishers because it is not the main fishing season.

Fisher's knowledge can be used to plan and design marine protected areas suggested by the ecosystem approach to fisheries management since spawning aggregations are able to be identified through fisher's knowledge (Johannes and Neis, 2007; Mathew, 2011). According to Chapman and Kramer (2000), the migration of most of fish species are not recognized. The fisher's knowledge of fish movement could fill the existing gap in biological knowledge and it is also useful to support conservation measures such as defining the shape and size of marine protected area. In the study site, the local fishers understand exactly where fish gathers and how fish moves thanks to their ecological knowledge of fish movement and seabed. According to Bunce *et al.* (2008), these management measures are accepted by the local fishers since they are based on their knowledge.

Fisher's knowledge is useful in recognizing fish stock (Johannes and Neis, 2007; Silvano and Begossi, 2012). In fact, the knowledge of fishing season, fish movement, seabed, and seawater colour may indicate the status of fish stock in the study site. For instance, fishers have knowledge of fish sounds and they can identify if there is a lot of fish by using their diving and listening skills. Fishers know that fish moves from the open sea to the coast in the southern season, which means that there is more fish in the coastal area in the southern season or fish normally gathers near the estuaries that are good habitats for many kinds of fish.

6. Conclusions:

Based on the above findings of fisher's knowledge and the concept of sustainable fisheries development, this research finds that fisher's knowledge have meaningful contributions to marine fisheries management for sustainable fisheries development. Through fisher's knowledge, the fisheries managers are able to get valuable information on the fisher's real demand and practical fishing knowledge that helps them manage the fisheries sector effectively. This information is helpful in building fisheries policies and regulations appropriated with the real situation of the fishing community. Fisher's knowledge can supplement scientific knowledge to make fishers and other stakeholders accept the scientific knowledge and follow the rules based on that knowledge. Fisher's knowledge also delivers valuable information for fish stock assessment and fisheries planning, which is very necessary and important for designing appropriate closed fishing seasons and marine protected areas suggested by the ecosystem approach.

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