FISH for the PEOPLE

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Fisheries Governance and Institutional Transformation for Effective Regional Economic Integration

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Editorial

The world is in an environmental crisis, and most of the blame is placed on the fast growing population and irresponsible exploitation of natural resources by man. Consequently, forecasts indicate that food supply can no longer serve the population's food demand, while dismal graphs continue to portray dwindling production from agriculture including fisheries. Specifically for the fisheries sector, figures continue to decrease and seem to reach a plateau, but it is also a general knowledge that the world's natural fisheries resources still have the potentials to produce more fish for the fast growing population, if only exploitation of the remaining resources is carried out in a more sustainable way while the degraded resources are left untouched and allowed to recover. Therefore, tapping such potentials should be done in a responsible manner with a moral sense of conserving the natural reserves. This could be attained if countries will make sure that good governance in fisheries coupled with institutional transformation is enforced although such effort usually comes with a price tag.

The Southeast Asian region can still afford to boast of its steadily increasing production from fisheries of about 7% per year, annually contributing not less than 19% to world's total fisheries production, but to perpetuate such status is a major concern. With such foresight, governments of the ASEAN-SEAFDEC Member Countries through their Ministers and Senior Officials responsible for fisheries, adopted in June 2011 the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020, demonstrating the countries' concerted recognition of the need to sustain the region's supply of fish and fishery products to improve food security, and of the crucial role that sustainable fisheries could play in the development and realization of the ASEAN Community by 2015. The Resolution and Plan of Action spells out the requirements for sustainable fisheries development which dovetail the promotion of good governance in fisheries and institutional transformation with effective regional economic integration. This implies the need to attain an almost unified and uniform development in fisheries in the region to be consistent with the goals of the economic integration.

The World Bank and UNDP considered governance as *the way power is exercised by economic, political, social, and administrative authority in managing the affairs of a country*. Meanwhile, UNDP specified that *good governance should be among other things participatory, transparent, accountable, and is also effective and equitable, and promote the rule of law*, and the World Bank added that *good governance is epitomized by predictable, open and enlightened policy making; a bureaucracy imbued with a professional ethos; an executive arm of government accountable for its actions; and a strong civil society participating in public affairs; and all behaving under the rule of law*. Therefore, good governance *ensures that political, social and economic priorities are based on broad consensus in society and that the voices of the* *poorest and the most vulnerable are heard in decision-making over the allocation of development resources*. In fisheries, good governance involves a multi-disciplinary effort where participative mechanism and co-management systems are embedded in such a way that the responsibility to manage the fisheries resources is shared between the government and users especially at the local level. Such effort should however, be reinforced with capacity building to ensure efficient stakeholders' participation in governance, especially the small-scale fishing communities.

SEAFDEC as the technical arm of the ASEAN on fisheries development has been exerting efforts to promote good governance in fisheries in the Southeast Asian region, by calling upon the countries to make institutional reforms based on the Resolution and Plan of Action in order to improve the way their fisheries are managed, monitored and controlled. Through its projects implemented at its Training Department and Marine Fishery Resources Development and Management Department, and with funding from the Japanese Trust Fund as well as from Sweden and other sources, SEAFDEC has been developing measures to eliminate illegal and destructive fishing practices as well as improve the management of fishing capacity to ensure that the fisheries resources remain healthy for the present and future generations. Traceability of fisheries has been championed through the implementation of catch certification and other control measures. In aquaculture, SEAFDEC through its Aquaculture Department, advances the project on Meeting Social and Economic Challenges in Aquaculture with multi-pronged objectives of developing aquaculture technology pathways as means of alleviating poverty in rural areas, addressing inadequacies of human resource to transfer knowledge and practices of sustainable aquaculture technologies from researchers to fish farmers in remote rural communities, and enhancing stakeholders cooperation in promoting aquaculture technologies. SEAFDEC through its newly established Inland Fishery Resources Development and Management Department in Indonesia would also continue to promote the sustainable development of inland capture fisheries focusing on co-management, as a way of alleviating poverty in rural areas.

These efforts are meant to attain sustainable development of fisheries in the region for effective regional economic integration, and at the same time enable the ASEAN to play the active role of strengthening the ASEAN-Japan Friendship and Cooperation as it soars high into its next 40 years and beyond. Nonetheless, the successful promotion of sustainable fisheries would require effective collaborative efforts among stakeholders including research institutions, government agencies, research institutions, funding agencies and collaborating partners, and the resource users, especially the small-scale fishers and fish farmers. On the occasion of the 40th Anniversary of the ASEAN-Japan Friendship and Cooperation in December 2013, SEAFDEC expresses the well wishes to the ASEAN and Japan, and calls on all concerned to adhere to an age-old Chinese proverb *"give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime"*, which in this case could also mean that cooperation among all concerned to attain good governance in fisheries with institutional transformation should be strengthened all the way out and not half-heartedly promoted, in order that lifetime achievement in sustainable fisheries for the benefit of future generations could be attained.

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CONTENTS

FISH for the PEOPLE is a special publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC) to promote sustainable fisheries for food security in the ASEAN region.

Adaptive Strategies in Coping with Climate Variability: Experience of Philippine Traditional Indigenous Fishers

Al Jayson Songcuan and *Mudjekeewis Santos*

Variation in climate is a natural phenomenon extending over almost all time scales, from seasonal to yearly changes and spatial ranging from regional to global. Climate variability is not often observed as compared to weather that varies on a daily basis. Common drivers of climate variability include *El Niño* and *La Niña* events, volcanic eruptions and sunspots. However, this year-to-year variation known as climate variability can escalate into long-term continuous transformation commonly referred to as climate change. In many literatures, climate change is, in many ways from a simple *"any change in the long-term climatology, regardless of its cause"*, to a more specific *"rapid change in climate that can be linked directly or indirectly to anthropogenic activities"*. Climate change is a natural phenomenon, most often extending decades or geological timescales (Roessig *et al.*, 2004, Baede *et al.*, 2001). However, anthropogenic activities that led to increased greenhouse gas concentration in the atmosphere (IPCC, 1996; Gribbin, 1998 in Roessig *et al.*, 2004; Sarmiento and Gruber, 2002; Baede *et al.*, 2001) drive the change in climate to occur more rapidly. Compared to year-to-year climate variability, climate change is slow and gradual, and therefore is difficult to remark on without scientific evidence.

Impacts of Climate Variability and Climate Change on Philippine Fisheries

Efforts to study the impacts of climate variability are emerging fast not only in the Philippines but in other countries as well, and in different fields of sciences including fisheries, specifically the direct and indirect impacts to fisheries. On one hand, biological and ecological impacts could be direct such as alteration of growth, physiology, behavior development, reproductive capacity, mortality, and distribution of aquatic species that further lead to changes in productivity, community structure, and ecosystem composition. On the other hand, socio-economic impacts could be the indirect effects of climate variability on fisheries. One of the natural resources leaned on by Filipinos for livelihood and source of their dietary protein is the fisheries resources, and fisheries play a vital role to Philippine economy by providing employment and income to rural areas and coastal communities. With many coastal communities that abound the country, mainly dependent on fisheries for livelihood and sustenance, any changes that negatively affect fisheries would be detrimental to the socio-economic conditions of the communities.

Philippine Fisheries

Many Southeast Asian countries including the Philippines are dependent on fisheries resources to improve their socio-economic conditions. The Philippines is rich in aquatic resources ranging from commercially-important to threatened and endangered species (Barut, 2003), and the scientific reports of Carpenter and Springer (2005) indicated that the country is the center of marine biodiversity in the world. The people of the Philippines, known as Filipinos, are dependent on marine fisheries resources for their livelihoods and source of dietary protein. The Philippines, as the 6th top fish producing country in the world, 9th in aquaculture, and 3rd in marine plants (BFAR, 2010), embraces rich fishing grounds teeming with fisheries resources that supply food to the whole country. Fish and fishery products provide about 70% of the protein requirements of about 1.6 million Filipinos. Being an archipelagic country with over 2.2 million km^2 of highly productive seas, fishing has been a major source of livelihood for almost 70% of communities located in coastal areas. The fisheries sector is therefore vital to the Philippine economy providing employment and income especially to rural areas and coastal communities. It was known in 2009, that the country's fisheries sector employed a total of 1,614,368 fishing operators nationwide of which the municipal fisheries sector accounted for the majority (85.0%) while the commercial and aquaculture sectors only accounted for 1.0% and 14.0% of the operators, respectively. The fisheries sector also contributed to approximately 2.2% (170.3 billion USD) to the country's GDP and export earnings of about 452 million USD (BFAR, 2009).

Climate Variability and Traditional Knowledge

Traditional knowledge, also referred to as indigenous or traditional ecological knowledge, local knowledge, farmers' knowledge, folk knowledge, and indigenous science (Nakashima *et al.*, 2012; Berkes *et al.*, 1995), is the accumulated knowledge retained by indigenous people throughout generations that is passed to each generation thereafter. Traditional ecological knowledge actually guides the current generation in countless ways, on how to interact with the environment and pass on the practices that affect their daily lives.

Indigenous knowledge covers a wide range of ideas including livelihood, community structure, rituals and traditions, and most importantly, survival strategies. The use of traditional knowledge in science has been recognized as significant (Trosper and Parrotta, 2012) although study on traditional knowledge is considerably new to climate science. However, it has already proven its significance to other fields of sciences such as in social sciences, traditional medicine, agriculture and forestry, and resource management as well as studies in impact assessment and biodiversity conservation (Gadgil *et al*., 1993, Alexander *et al*., 2011).

Recent studies on the impacts of climate variability seem to indicate that indigenous people are among the most vulnerable, in view of their community structure, education, population size, lack of recognized and social rights, and lack of access on information that contribute to their sensitivity. Their high dependence on natural resources for livelihood and sustenance added to their high sensitivity to any changes that affect the natural resources. Being highly vulnerable, indigenous people are therefore not mere victims to the impacts of climate variability since their high sensitivity to climate vulnerability makes them persist in the same environment amidst increasing climate variability due to the skills and adaptive strategies that they have developed. Traditional ecological knowledge has been proven to be essential to the economic and cultural survival of indigenous people. In climate science, traditional ecological knowledge has also been shown to be potentially useful in understanding the impacts of climate variability on the environment across spatial and temporal scales for organisms, habitat, and ecosystem (Nabhan, 2010) and can also provide significant short- and medium-term climate and weather patterns forecasting (Parrotta and Agnoletti, 2012). Nevertheless, the skills and adaptive strategies developed by indigenous people could be of importance to climate science, especially in developing adaptation strategies to climate change. This suggests the potential of traditional ecological knowledge in climate change assessment and adaptation (Salick and Ross, 2009).

Climate Variability and Traditional Fishing Practices: Case Study

In order to assess local awareness, cultural belief and community support system that could lead to indigenous climate risk adaptation measures for long-term effect of climate change based on historical events, cultural beliefs, and traditional adaptation measures, a case study

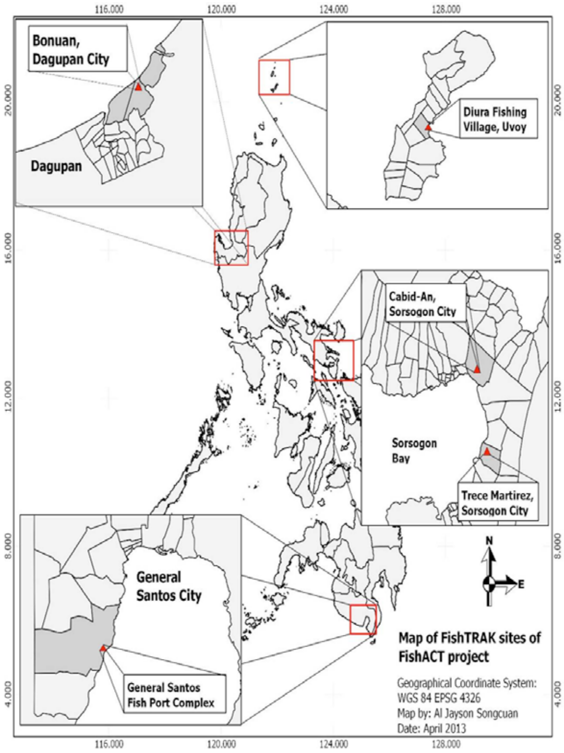

Fig. 1. Map of the Philippines showing the study sites for the case study on the Relevance of Fisheries Traditional Knowledge (FishTRAK) and Indigenous Fisheries Practices in Developing Climate Change Adaptation Strategies

was conducted in major fisheries areas of the Philippines, namely: General Santos, Sorsogon, Dagupan, and Batanes (**Fig. 1**) to assess the effect of climate change on priority fisheries commodities as well as to document traditional knowledge on fisheries practices and climate change adaptation strategies. The four study sites were selected based on different criteria, such as degree of exposure to climate change impacts (General Santos, Batanes and Sorsogon), primary commodity (all four sites), type of fisheries (General Santos, Dagupan, and Sorsogon), and cultural background (Batanes). Data were collected through on-site and house-to-house interviews using prepared questionnaires, so-designed to promote a free flowing and story-telling-like conversation. Respondents were fishers preferably older than 50 years old, with sufficient experience in fisheries and are able to provide historical accounts and traditional knowledge. However, due to some constraints such as time and day of the interview, and unavailability of some respondents, fishers with at least 20 years of experience in fishing and those who are knowledgeable of traditional fisheries practices and adaptation practices were also considered for the interview.

General Santos: Tuna Fisheries in the Heat

Located in southern Mindanao, General Santos City was chosen as one of the study sites due to its low exposure to tropical storms. Based on the 50-year storm trajectory

Fig. 2. Philippines and the 50-year storm trajectory record of National Oceanic and Atmospheric Administration (NOAA)

record of NOAA (**Fig. 2**), General Santos or Mindanao in general, has not experienced any tropical storm for more than five (5) decades. In 2012, however, Mindanao was hit by two (2) strong typhoons (Pablo and Sendong, international code-names Bopha and Washi, respectively). Additionally, General Santos City is considered as the Tuna Capital of the Philippines. Comprising about 30.0% of the country's total annual catch from commercial fisheries, tuna is one of the primary and high-valued commodities in the Philippines (BFAR, 2010). In fact, tuna fishing has evolved and changed totally in time. During early times, about five (5) decades ago, Philippine fishers used to catch tuna using a stone fixed with hook and bait attached to a nylon string.

Fishers of yesteryears were able to catch big and small tunas only a few kilometers away from shore, using traditional practices. However, in the past two (2) decades or so, fishers have to go to farther distances for a good catch of tuna. The emergence of modern fishing methods and gears coupled with the equivalent increase in their fishing pressure resulted in major decline in catch, starting in 1990 according to anecdotal information.

Although not being aware of the issues on climate change or the effects of global warming, local fishers have been experiencing the impacts of climate change. Many fishers have felt the progressing increases in temperature during the past decades, while a keen observation by most of the interviewed fishers correlates high temperature to difficulty in catching tuna. According to long line fishers, warm days are the most difficult times to catch tuna in depths where before they usually got good tuna catch. Nowadays, they needed to use lines which are several meters longer than before. Tuna seem to go deeper to feed during warm days compared with the cooler days. Increase in temperature brought about by climate change causes more frequent stratification between warmer surface water and cooler deeper water which in turn causes a decline in primary productivity (World Bank, 2000). Consequently, increase in the surface water temperature coupled with decrease in primary productivity in the equatorial or tropical region results in migration of tuna population towards higher latitude. This behavior can cause a special distribution shift of tuna population towards higher latitudes slowly depleting the stocks in the tropics.

In view of the pressure on tuna fishing brought about by fishing activity and the impacts of climate change, majority of the fishers relying solely in tuna fisheries slowly began diversifying their livelihoods. Since depending mainly in the slowly declining tuna industry seems unsustainable, some tuna fishers are now engaged in the culture of grouper and milkfish in marine cages, and seaweeds (**Fig. 3**). However, majority of the local fishers, especially those who are not aware of the climate change phenomenon and its impacts on the decreasing fisheries catch, still rely on the country's tuna industry, not only by engaging in fishing but also by working in canning factories and ice plants.

Fig. 3. Seaweeds culture and processing as alternative livelihoods for some fishers in General Santos City

Sorsogon: Growing Seaweed Industry amidst Storm Entry Point

Facing the Pacific Ocean, Bicol is one of the regions of the Philippines most frequented by storms (**Fig. 2**). In fact, the Bicol Region is often the entry point of majority of the tropical storms passing the country. Sorsogon, one of the provinces in the Bicol Region, is in the southeastern part of Luzon. It is bounded by the Pacific Ocean on the east and San Bernardino Strait on the south. The province was selected as one of the study sites due to its high exposure to harsh climatic events being located in storms' entry point.

In addition, Sorsogon is one of the important producers of seaweeds in the country, especially from 13 of its 14 municipalities located in coastal areas including Sorsogon City. The seaweeds industry in Sorsogon started in the late 70s to early 80s when fisherfolks collected wild seaweeds from near reef areas - mostly for commercial purposes. The seaweeds collected belong to genus *Galidiela*, *Eucheuma*, *Gracilaria*, *Sargassum*, and *Kappaphycus*. Traditional harvest methods include uprooting and scraping off seaweeds from their substrates. After collection, instead of immediately selling the harvests, these are sun-dried for 2-3 days depending on the weather condition for better market value. However, such practice of collecting seaweeds was considered destructive especially to adjacent habitats and very unsustainable in the context of conservation. Nonetheless, in order to support the growing seaweed industry in Bicol Region, the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) started its Seaweed Production and Development Project in Sorsogon in 1992 with funding support from the United Nations Development Program (UNDP) of the Food and Agriculture Organization of the United Nations (FAO). The project resulted in the establishment of the Philippine National Seaweed Research and Development Center (NSRDC) in 1998 which was subsequently renamed the National Seaweeds Technology and Development Center (NSTDC) after the Philippine Fisheries Code of 1998 was enacted into RA 8550. Through the NSTDC, research studies and training courses that focus on the improvement of seaweed farming were conducted, resulting in the promotion of highly sustainable seaweed culture methods in the Philippines. Nowadays, majority of former seaweed gatherers adopt such culture methods as the long-line floating system, mono-lines and bamboo stakes methods, and other environmentally-safe culture methods. Henceforth, local seaweed farmers reported that their seaweeds production has significantly increased with the improvement of culture methods and local government support.

Although improvements in seaweed farming continue to advance in Sorsogon, productivity of its seaweed industry did not increase much. Seaweed growers through supporting literatures observed that seaweeds are very sensitive to different variables such as water quality, rainfall, temperature, salinity, and weather events. Slight changes in any of these conditions greatly affect the growth and productivity of seaweeds. One of the major problems they experienced is the occurrence of "ice-ice" episodes. As described by seaweed growers, "ice-ice" is a disease condition caused by the occurrence of white "substances" that attach to the seaweeds, which if not immediately removed, could infect nearby seaweed stocks. This disease, in particular, causes whitening as well as fragmentation of seaweed branches which could result in highly decreasing annual production. When asked about what causes the "ice-ice" outbreak, 90% of the respondents remarkably observed that disease episodes most commonly occur after excessive rainfall or during hot weather. Excess rainfall leads to decreased salinity as well as drop in temperature, whereas hot weather increases both salinity and temperature. Both conditions are considered unfavorable for seaweeds to grow and observed to promote the outbreak of "ice-ice" disease.

In addition to seaweeds disease, another major factor that affects the seaweed industry in Sorsogon is linked to its geographical location which is inevitable. This is the occurrence of extreme weather events due to extended and frequent rainfall. In such situation, drying which increases the market value of the harvest by three-folds, takes longer and worse, seaweed growers are sometimes forced to sell their harvests without drying. Complete loss of harvests and materials for culture due to extreme weather events were also recounted by seaweed growers. In an effort to address the concern and in order to minimize losses due to extreme weather events, seaweed growers have properly timed the planting of seaweeds in such as a way that rainy season or months with usual extreme weather events are avoided. In addition, growers have built drying huts in case unexpected rains occur while drying their harvests. Recently however, they have observed that the patterns of extreme weather events are changing and becoming more frequent and more intense. In fact, about 3-4 years ago, majority of them completely lost their harvests due

Actual collection of indigenous knowledge from local people on climate change adaptation and traditional fisheries practices to an unexpectedly strong typhoon that hit the Province. With years of experience and high exposure to extreme weather events, many seaweed growers have diversified their livelihood as well as made adjustments to adapt to the current and worsening climatic condition. Most of them are now going into aquasilviculture in mangrove areas while some are engaged in service jobs such as carpentry.

Although Sorsogon is highly exposed to the impacts of climate change, the adaptive capacity of the inhabitants is relatively higher than in other areas of the country. This is attributed to the strong community support and awareness program on the impacts of climate change. Educating the people of the Province on the current issue of climate change, its nature, causes, and potential impacts is carried out through radio plugs and television programs. In addition, seminars, workshops, and trainings on how to deal with the impacts of climate change through adaptation and risk reduction, and diversification of livelihoods are arranged by local government and non-government groups.

Dagupan: Bangus Capital under Climate Change Crisis

Located at the southern border of Lingayen Gulf, Dagupan in Pangasinan Province is provided with a unique and favorable site for aquaculture. Regarded as the center of *bangus* (milkfish) production, and known to produce the tastiest milkfish in the Philippines, Dagupan became one of the priority sites for the study. Second to seaweeds as the top aquaculture commodity of the Philippines, *bangus* has been cultured by the people in Dagupan for a very long time. Its *bangus* has been labeled as the tastiest milkfish in the country. However, the trademark slowly diminished alongside with the shift in aquaculture practices. The traditional *bangus* aquaculture method had changed completely since the day that the people of Dagupan first put it to practice.

Traditional *bangus* aquaculture practice includes the use of fertilizer and guano as well as the utilization of natural food source known as *lablab* or the greenish black moss (**Fig. 4**) found in pond soil. In the past, aquafarmers from Dagupan followed a *lablab* growth cycle, so that after one harvest, the pond is not immediately restocked. Instead, the pond water is reduced to a minimum, then, the water and soil is treated with the chemical *Bristan* to kill oysters, snails and other pests that primarily competes with *lablab* as food source (**Fig. 5**). After applying *Bristan*, the pond is dried to avoid contamination of the drainage and irrigation systems. Afterwards, new pond water is let in, fertilizer is then added and *bangus* fry is stocked.

Fig. 4. Growth of *lablab* (greenish black moss) in pond soil provides natural food for milkfish

Fig. 5. Oysters, snails, barnacles are pests and major competitors to natural *lablab* as source of food for milkfish

The use of guano as fertilizer promotes the growth of *lablab*, which, according to milkfish growers, enhances the growth and quality of *bangus* being cultured. Such practice was however last used in 1990s, after most *bangus* farmers shifted to using artificial feeds, a more expensive practice. Such shift in aquaculture practice was due to the ban of *Bristan* by the government when cases of harmful effects of *Bristan* on the skin of farmers exposed to contaminated water from irrigation canals were reported.

The use of artificial feeds resulted in lower income of *bangus* farmers due to high cost of production. Although the use of artificial feeds has been reported to enhance the growth of *bangus* cultured, it poses a threat when coupled with the impacts of climate change. A common concern of milkfish growers using artificial feeds is the high probability of fish kill occurrence due to several factors. Fish kills occur more frequently when artificial feeds are used because of deoxygenation brought about by decomposing feeds from excessive feeding which is worsened by environmental factors such as high temperature and increased precipitation. Excess feeds settle at the bottom of the ponds and when it accumulates, high temperature hastens its decomposition that takes up the dissolved oxygen in the pond water. Also, sudden precipitation especially after feeding causes the deposited feeds to be re-suspended potentially causing gill clogging on the cultured fish. In addition, heavy precipitation causes overflowing of culture ponds leading to loss of fish stocks.

In order to keep up with the changing climate, *bangus* farmers time their restocking to cool and dry months, which are considered the most optimum condition for culturing milkfish according to local *bangus* growers. Increasing the stocking size also allows them to cope up with the high cost of feeds and also lessens the probability of overfeeding although it could increase the risk of overstocking. Some ponds are also designed with high walls, netted walls or surrounded by *nipa* plants to serve as screens to avoid the escape of stocks during flooding. Some *bangus* growers also allow algae or *lumot* to grow in their ponds to consume any excess organic materials from feeds and eventually to serve as food for the fish stocked.

Batanes: Home to Indigenous Dorado Fishing Practice

Situated on the northernmost part of the Philippines, Batanes has a rich culture and unique traditional fisheries practices. It is home to *Ivatan* tribe and is known for its dried dorado fish, a main source of livelihood for most fishers in the Province. Being located along the typhoon belt, Batanes is very highly exposed to extreme weather events. However, despite being isolated and highly exposed, the *Ivatan*s are known to be adaptive to such changes which made them interesting subjects for the study in view of their traditional adaptation strategies.

Known to be farmers, fishers, and boat makers, *Ivatan*s practice traditional fisheries which are very unique and diverse. Even though some practices or traditional fishing gears are generally no longer used in any other parts of the country at present because of modernization, most of these gears are still utilized by local fishers of Batanes. One of the major fisheries commodities of Batanes is the dorado fish (*Coryphaena hippurus*), commonly known as dolphin fish and locally called *muhi-muhi* (*mahi-mahi* in Hawaii). The fishing season for dorado is from March to May, and fishing for this fish is not simple. The local practice strictly follows a series of preparations and rituals. Annually around February, the *Ivatan*s perform the *vanuvanua* ritual where a pig, cow or carabao is slaughtered and the blood is collected for offering to their gods and praying for good harvests. If slaughtering any of the three animals would not give them good harvest, chicken or other animal blood may be used as offering. Since other parts of the *vanuvanua* ritual are said to be sacred, this is strictly performed by *Ivatan* tribes only. The *Ivatans* believed and experienced that not performing the ritual prior to *dorado* fishing would bring bad harvest.

Since dorado fish does not eat dead bait, fishers have to catch flying fish prior to *dorado* fishing season with the use of *yuyos*, a small piece of wood with hooks attached by nylons to floaters (**Fig. 6a** and **Fig. 6b**) and *tuyungan* (a traditional hook and line (**Fig. 6c**)), with the flying fish kept alive to be used as bait.

Fig. 6. Traditional fishing gears used by *Ivatans* of Diura fishing village: (a) *yuyos*; (b) *yuyos* with floaters; (c) *tuyungan*; and (d) the traditional fishing boat *mataw*

Other beliefs include careful handling of fish harvest as dropping the fish is considered a bad omen which could bring them poor catch and harvest. Another belief is avoiding the use of carts, cars, bikes or carabaos while transporting the fish, so that the fish is usually carried manually to local drying areas. Storage bins for the dorado fish should be left open during the day for the rest of the season to ensure a good catch. Dorado fishing makes use of a traditional fishing boat locally called *mataw* (**Fig. 6d**), where *mataw* fishing has been derived.

After fishing for dorado, the catch is brought to *patarukon*, a local dryer where the catch will be dried for days (**Fig. 7a**). This is meant to increase its market value as well as to

Fig. 7. Traditional drying area for dorado catch known as *patarukon* (a) and (b) cogon house where dried dorado is stored

prolong its shelf life. After drying, the dried fish is brought to cogon houses for storage (**Fig. 7b**).

When there is enough stock of dried fish in the cogon houses, the fishing leader of a village, such as in Diura Village of Mahatao District, convenes local meetings among representatives of each family. During the meeting, the dried stocks are divided and distributed equally to each family in the village (**Fig. 8**). Any excess stock is sold to interested families or traded for other goods such as rice and fruits. The price of dried dorado (regular size) could be as high as Philippine Pesos 1,000.00 each (Philippine Pesos 500 for each half), where Philippine Pesos 40 = USD1.00), thus, providing good income for each family. During off fishing season, local fishers catch groupers or *lapu-lapu*, and rabbit fish or *samaral* using *nanawuy* (**Fig. 9**), a unique traditional fishing gear where gillnet is attached to two long bamboo poles and usually flung in shallow waters or in waters where schools of fishes are espied. Sometimes, fishers also use *hasu*, a traditional hook and line where a hook is attached to a local plant *hasu* using a nylon twine.

Fig.8. Local residents of a village in Batanes dividing and distributing dried dorado fish to every family in the village

Fig. 9. *Nanawuy*, a unique traditional fishing gear used in shallow-near shore waters to catch *samaral*

Being located along the typhoon belt, Batanes Province is prone to experience extreme weather and severe storms. As an adaptation, in-land houses and those located in coastal areas are designed and made of stones (known as *bahay na bato* or stone houses) while houses near coastal areas are elevated two feet above the ground. The unique design of the stone houses protects the inhabitants from extreme storm events.

During prolonged storms, which usually happen in this Province and scarcity of resources (food), local inhabitants utilize the whole banana plant which are relatively abundant to the area and can tolerate heavy precipitation, for food. The whole banana plant from its fruit, stem as well as roots, is eaten.

Acknowledging the fact that the local people cannot rely solely on fishing due to frequent rains and severe storms, most of them are also engaged in agriculture-related alternative livelihoods. So that even though Batanes is highly exposed to the impacts of climate change, the inhabitants are relatively less vulnerable due to their high adaptive capacity.

Summary and Way Forward

Climate variability is a natural phenomenon. However, increase in variability both in intensity and frequency, driven by different factors put coastal and indigenous communities to a wide range of risks. Indigenous communities are among the most sensitive groups to the impacts of climate variability. Nevertheless, their high adaptive capacity and indigenous knowledge in adapting to climate variability have led to their survival, offering great potential for developing climate change adaptation strategies. Being highly exposed to climate variability despite their sensitivity, affected people on the one hand are offered opportunities to develop more diverse and efficient adaptation strategies. On the other hand, low adaptive capacity due to low exposure to climate variability can also lead to further risks brought about by changing climatic patterns. The study therefore deduces that the effects of climate variability vary in different areas depending on the nature and level of resource dependence of the communities. The results of the study further imply the promotion of varying and more localized management or adaptive strategy that would enable affected communities to cope with climate variability.

Bahay na bato - a traditional stone house of local residents of Batanes Province

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Improving Data Collection on Sharks in Southeast Asia: Regional Approach to Address CITES-related Concerns

Sawitree Chamsai, Somboon Siriraksophon, Worawit Wanchana, Hotmaida Purba, Imelda Riti Anak Rantty, Neil Kenneth P. Catibog, and *Tran Van Hao*

The possible inclusion of economically-important shark and ray species in the CITES Appendices proposed during the CITES-CoP16 in March 2013, is bound to happen after September 2014. It is therefore urgent to review the literature and other relevant data and information on these species to be able to synthesize the implementation of CITES-related matters, improve data collection on sharks and rays in Southeast Asia, and develop a regional approach for addressing such concern. It has been recognized that in the Southeast Asian region, sharks and rays are incidental catch and for such reason, recording of data on sharks and rays is generally made by group and not by species. Through a series of regional technical meetings including the recent Regional Workshop on Data Collection Methodology for the Assessment of Shark Stock Status in October 2013, it was recommended that data collection on shark and ray species should be initiated by SEAFDEC starting with some major species, such as the CITES-listed species, *e.g.* hammerhead and oceanic whitetip sharks, and manta rays. The same concern was also raised during the Sixteenth Meeting of the Fisheries Consultative Group (FCG) of the ASEAN-SEAFDEC Strategic Partnership (ASSP) in November 2013 in Penang, Malaysia. In this regard, SEAFDEC would initiate the development of a standardized data collection sheet for the countries in the Southeast Asian region to record the Sharks CPUE data specific to the types of fishing gears and logbooks focusing on sharks and rays. SEAFDEC in close collaboration with the Member Countries would also developed the plan of activities in pilot areas in the Andaman Sea (Myanmar, Thailand, and Indonesia); Gulf of Thailand and South China Sea (Thailand, Malaysia, and Vietnam); and Sulu-Sulawesi Seas (Indonesia, Malaysia and Philippines).

During the Sixteenth Meeting of the Conference of the Parties (CoP16) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on 3-14 March 2013 in Bangkok, Thailand, five out of seven proposals to list commercially-exploited aquatic species in the CITES Appendices had been accepted. This means that the inclusion of shark and ray species in the CITES Appendices proposed during the CoP16 will put in place the measures in 18 months from the CoP16, *i.e.* in September 2014. Thus, the Parties must now be preparing for the implementation of the upcoming listings of several shark and ray species, including the oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead shark (*Sphyrna lewini*), great hammerhead shark (*Sphyrna mokarran*), smooth hammerhead shark (*Sphyrna zigaena*), porbeagle shark (*Lamna nasus*), and manta rays (*Manta* spp.) (**Fig. 1**).

Concerned by such predicament, the SEAFDEC Council during its 45th Meeting in April 2013 recommended that SEAFDEC should review the region's information on shark and ray resources as well as the conservation measures in order to obtain scientific evidence on the status of the stocks of sharks and rays. In this connection, SEAFDEC was encouraged to cooperate closely with FAO and relevant organizations in jointly addressing such CITES issues, while FAO was asked to also consider not only the development of scientific advice but also raising practical and general problems associated with CITES listings of aquatic species such as the non-detriment findings (NDF), and the inertial nature of CITES decisions, *i.e.* once a species is listed this will not be easily delisted. In addition, SEAFDEC was also requested to seize the opportunity of utilizing the commitment made by the European Union (EU) to provide funds for capacity building in activities related to the listing of marine species in the CITES Appendices for the benefit of the countries of Southeast Asia. Such activities could focus on shark-related aspects particularly on taxonomy, NDF and in updating the information on marketing of shark products in the region.

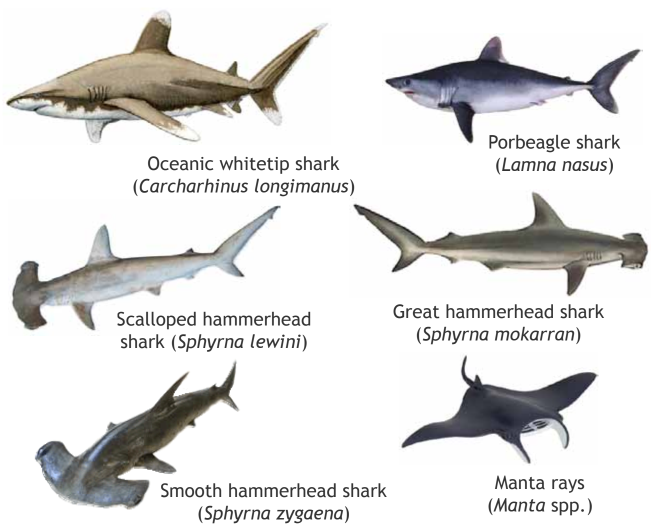

Fig. 1. Shark and ray species to be included in the CITES Appendices in September 2014

In this regard, the ASEAN Member States were encouraged to convey to the CITES Secretariat responsible for capacity building, their requests for funding support from the EU funds for sharks, and were assured that the SEAFDEC Secretariat would follow-up such requests with the CITES Secretariat. Meanwhile, the SEAFDEC Training Department (TD) organized the Regional Workshop on Data Collection Methodology for the Assessment of Shark Stock Status on 23-25 October 2013 in Bangkok, Thailand under the FCG/ASSP Framework funded by the Japanese Trust Fund (JTF). During the Workshop, the actions of the Parties by 14 September 2014 were discussed and clarified

Box 1. Shark Data Collection Systems of SEAFDEC Member Countries

Brunei Darussalam

Sharks landed in Brunei Darussalam are not target species but are incidental catch from fisheries targeting other commercial value species. Four shark species listed under CITES are found in the country's waters, namely: *Carcharodon carcharias*, *Cetorhinus maximus*, *Rhincodon typus*, and *Pristis microdon*. In the country's Fisheries Order 2009 on issuance of fishing license, a condition prohibiting the catching of any species of sharks is included and that sharks caught as incidental catch must be released back to the sea in good condition. As for the conservation and management of shark resources, the country's effort is challenged by insufficient data on the status of stocks of sharks as well as on spatial and temporal distribution of sharks, inadequate number of trained personnel to focus on shark identification and biology, and lack of specific research solely focused on sharks as current researches are mostly undertaken as part of other research studies such as stock assessment surveys using trawl (Matzaimi Haji Juna and Azri Waliyuddin Haji Nasir, 2013).

Cambodia

Studies on marine living resources including sharks and rays have not been undertaken in detail in Cambodia, but Tana (1996 and 1999) and Jensen and Try (2002) reported that 20 species of sharks are found in the country's waters, including the whale shark which is a rare species. The country has not developed any collaborative mechanism with commercial or large-scale industries to collect data and information on sharks, and as a result, data on sharks are reported in the official statistics of the Fisheries Administration as part of the country's total marine fish production. Reports also indicate that shark products (meat and fins) are consumed locally in the coastal areas of Cambodia and nearby cities. The domestic market price of shark's meat is about 7,000-8,000 riels/kg (around US$2.00 /kg) in the coastal areas, while the country does not export processed sharks (Suy Serywath, 2013).

Indonesia

Shark fishery in Indonesia has been going on for a long time, but data collection on sharks started only in the 70s. Based on the country's available statistics, eleven species groups are reported with five groups of sharks recorded separately, namely: thresher sharks, hammerhead sharks, dogfish sharks, mackerel sharks/makos, and requiem sharks. Meanwhile, rays are classified into six groups, namely: stingrays, manta rays, eagle rays, shovelnose rays, white-spotted wedge-fishes, and sawfishes. The country's NPOA-Sharks developed in 2010 still awaits the approval of the Minister. The NPOA-Sharks identifies key issues for the management of the country's sharks and rays, and the key actions to be undertaken such as review of the status of shark and ray fisheries, data compilation and collection methods and processes, among others. Nevertheless, some elements of the NPOA-Sharks have been carried out such as identification of sharks landed by species, training of enumerators, and conduct of annual review of relevant documents on sharks and rays. Data collection on sharks is still difficult to undertake considering that artisanal fishing boats unload the sharks caught in remote small landing sites, while species identification remains a major issue because only part of shark's body is landed (*e.g.* fins) at ports. Research, publication and information of shark fisheries are also limited, while there is little information on biological data of sharks species landed. Therefore, stock assessment of sharks in Indonesia has not yet been conducted (Diding Sudira Efendi and Dian Novianto, 2013). However, an Indonesian local government in Raja Ampat District took a major leap by issuing Local Government Regulation No. 9 in 2012 prohibiting the fishing of sharks, manta rays and certain types of fish in the marine waters of Raja Ampat. The said regulation stipulates that anybody caught hunting any species of sharks or manta rays will be jailed for at least six months and pay a fine of Rupiah 50.0 million (US$ 5148.00). Such important initiative taken by this local government contributes and supports the achievement targeted in the national conservation program on sharks and rays (Anonymous, 2013).

Malaysia

As a signatory to CITES, Malaysia has an obligation to implement measures to ensure the international trade of products of shark species is protected under the convention and is both legal and sustainable, as per the CITES Section, Fisheries Biosecurity Division, Department of Fisheries Malaysia. The country is also committed to enhance its efforts in the management and conservation of sharks and rays, and to report the results of such initiatives at regional and international fora. In this regard, the country has been undertaken measures to continuously improve its relevant policies and regulations under the current legal frameworks (Ahmad Ali, 2013). After the CITES-CoP16, Malaysia planned to amend its International Trade in Endangered Species Act 2008 (Act 686) to ensure that trading of hundreds of species including their parts and derivatives is controlled by various national authorities, and to control import and export, re-export and introduction from the sea, possession, transit, breeding or propagation of species listed under this Act. In addition, NPOA-Sharks with the main objective of ensuring the conservation and management of sharks and their long-term sustainable utilization was developed by the Department of Fisheries Malaysia to initially cover the period 2006-2010 but extended to 2013-2017 under NPOA-Sharks (Plan 2). Several issues on catch data collection on sharks had been reported, such as inadequate knowledge on taxonomy of elasmobranches (high diversity of sharks (63 species) and rays (83 species)) and staff involved in data collection considering the number of private jetties, *e.g.* in Perak State alone there are more than 500 (>2000 fishing vessels), manpower to sample more vessels at district level is insufficient. Meanwhile, some staff with experiences in taxonomy are usually transferred to other divisions, and funding support from the government is limited to conduct extensive research for the whole country (Abd. Haris Hilmi bin Ahmad Arshad and Ahmad bin Ali, 2013).

Box 1. Shark Data Collection Systems of SEAFDEC Member Countries (Cont'd)
Myanmar Shark fisheries in Myanmar are small-scale utilizing wooden boats with engine of not more than 25 hp. Most of the country's shark landings are incidental catch as there are only very few dedicated elasmobranches fishers. Elasmobranches are caught as by-catch in bottom trawl and gillnet fisheries. However, there is still no specific data on shark fisheries compiled by the Department of Fisheries notwithstanding the Department of Fisheries regulation prohibiting the use of specifically designed fishing that targets on sharks. However, based on the Department of Fisheries Order No. 2/2004 dated 5 May 2004 on shark resources conservation, shark fishing operation in the protected areas starting from Ross Island (12° 13´ N, 98° 05.2´ E) to Lampi Island (10° 48´ N, 98° 16.1´ E) is prohibited, although sharks and rays are used sustainably by the country's tourism activities, especially in shark-watching dive tours (Nilar Htwe, 2013).
Philippines According to the Checklist of Philippine Chondrichthyes (Compagno *et al.*, 2005), there are at least 163 species (3 chimaeras, 94 sharks and 66 batoids) found in Philippine waters, but the Philippine Bureau of Agricultural Statistics (BAS) lists the production of sharks in a single category, the same for rays. However, there are also other sources of data on sharks in the country such as National Statistics Office (trade data on by-products), Fisheries Regulatory and Quarantine Division (export-import data) of the Philippine Bureau of Fisheries and Aquatic Resources (BFAR), BFAR National Stock Assessment Program (specific landed catch data), BFAR Fisheries Observer's Program (on-board fishing vessels data), among others. The Philippines is also a signatory to CITES and based on its own Republic Act 8550 signed in 1998, which provides for "the development, management and conservation of the fisheries and aquatic resources", all species listed in CITES are automatically protected in the Philippines. Since the whale shark is listed as vulnerable in the IUCN Red List Criteria and Appendix II of the CITES, a Fisheries Administrative Order was enacted by the Department of Agriculture-BFAR (DA-BFAR FAO No. 143 series of 1998) to protect the whale sharks and manta rays, and ban the "taking or catching, selling, purchasing and possessing, transporting and exporting of whale sharks and manta rays". In 2009, NPOA-Sharks was adopted to ensure the conservation and management of sharks and their long-term sustainable use, and to provide as national guideline for managers and interested stakeholders to incorporate the issues concerning sharks and rays into the overall management of fisheries resources in the country. The country's overall efforts are still confronted with concerns on the need to improve scientific data collection platforms, conduct socio-economic studies, and address shark finning issues (Torres, 2013).
Thailand As non-target species in Thai fisheries, sharks and rays comprise only a small proportion in the country's total catch of demersal fishes (less than 2% for sharks and 3-4% for rays), thus, the national fishery statistics lists all catch of shark and ray species only in one group. Based on the study of the Department of Fisheries (DOF) of Thailand in 2013, there are 63 species each of sharks and rays. The major challenge in the data collection on sharks and rays is the insufficient number of shark and ray specialists, while guidebooks and database system for shark resource management remains inadequate (Tassapon Krajangdara, 2013). Although the development of its NPOA-Sharks had been initiated in 2005, it is not yet completed. However, some elements of the said draft NPOA-Sharks had been implemented by the DOF, mainly on data collection on sharks and rays but the involvement of stakeholders remains inadequate. The DOF plans to conduct several activities in order to obtain endorsement of the NPOA-Sharks, such as data collection on rays in 2013-2014, capacity building of officials and other relevant officers, development of shark and ray identification sheets, publication of field guides for identification of sharks and rays, and information dissemination on sharks conservation that includes releasing of the bamboo sharks (*Chiloscyllium* spp.) and blacktip reef sharks (*Carcharhinus melanopterus*).
Vietnam Shark fisheries in Vietnam are small-scale, while catch rate and catch composition of sharks are relatively low. There are no dedicated elasmobranches fishers, and almost elasmobranches are caught as by-catch. The high value of sharks leads to their high exploitation rate. Although shark fins are not much used for domestic consumption, these are exported to China. The constraints in data collection and assessment of stocks of sharks include inadequate research on shark biology, lack of standard format for data collection and analysis, lack of taxonomists in elasmobranches, and insufficient species information and catch composition. Studies on shark resources have not yet been comprehensively conducted in Vietnam. However, some information about the country's shark fisheries were sourced from results of some projects conducted in 2000-2005, *e.g.* Assessment of Living Marine Resources in Vietnam, Research of Stock Biomass and the Ability to Exploit Large Pelagic Fish in the Offshore Waters of Central and Southeast Vietnam. Results from such studies suggested that in the study areas, there are 38 species of sharks belonging to 23 genus. In 2005-2010, the data on sharks had not been regularly updated but the country is conducting a study on the Changes of Fisheries Resources in South Vietnam (2011-2015), which includes a compilation of additional information on species composition and distribution of shark species in Vietnam waters. In addition, the country's project on Building Database Systems to Investigate Biodiversity, Resources, Oceanography and Marine Fisheries (2011-2015) would also serve as basis for collecting national data on fisheries including information on sharks (Le Huu Tuan Anh, 2013).

to prepare the Southeast Asian countries of any eventuality. The Workshop also discussed the issues that should be considered by the countries, namely: (1) legality of the issues including relevant national laws, legal acquisitions, RFMOs, enforcements; (2) sustainability including NDFs, development of scientific evidence, introduction from the sea; and (3) traceability including permits, identification, reporting, and database development. In order to compile the initial information, the countries reported on the status of their respective efforts in sharks data collection (**Box 1**), offered their foresights on how to improve sharks data collection in order to carry out stocks assessment on sharks and rays, and identified the regional support needed from SEAFDEC and other organizations by the Member Countries once the listing shark species in the CITES Appendices should take place.

Recommendations and Way Forward to Improve Assessment of the Status of Stocks of Sharks/Rays

Based on the status reports provided by the countries on the utilization of sharks in their respective countries, it can be noted that sharks and rays are considered as incidental catch. In many cases, the available national statistics recorded sharks and rays by groups but not up to the species level except for Malaysia and Thailand, where pilot projects are being carried out to record data landings of sharks and rays at species level. The most common issues that confront the region include the inadequacy of experts and competent officers in elasmobranches taxonomy, insufficiency of knowledge and expertise to identify shark's parts and derivatives, and biological data, stock structure, and spatial and temporal distribution of sharks and rays which still remain lacking and inadequate. In order to improve the assessment of status of shark/ray stocks in the region, data collection on these species should be initiated as soon as possible. Since species identification may be difficult to undertake as part of routine data collection, the use of illustrations, group of species, should be promoted. Moreover, catch-and-release data should also be collected in the countries where sharks/rays fisheries are totally banned. A step-by-step approach is necessary starting with stakeholders' consultations to explain what to do and what to achieve in sharks data collection, and in estimating the abundance and biomass of sharks/rays using catch and effort data (CPUE).

As recommended during the October 2013 Regional Workshop, a standardized CPUE for specific type of fishing gears (trawl, gillnet, purse seine, longline, handline) would be developed, and sharks' landing data to be recorded using logbooks. The current data sheet used by enumerators in Malaysia could be used as guide for other countries. Furthermore, SEAFDEC/TD and the Marine Fishery Resources Development and Management Department (MFRDMD) have been encouraged to work closely with the Member Countries in order to come up with sets of pilot activities in sampling sites which could include areas in the Andaman Sea (Myanmar, Thailand, and Indonesia); Gulf of Thailand and South China Sea (Thailand, Malaysia, and Vietnam); and Sulu-Sulawesi Seas (Malaysia and Philippines).

The proposed pilot sites in the region are shown in **Fig. 2**, and as planned, data collection on three (3) species of hammerhead sharks (CITES Appendix II), thresher sharks (IOTC), and manta ray (CITES Appendix II) (**Fig. 3**) will be focused at these selected pilot sites. From the CITES Secretariat point of view, there are issues that should be addressed in conducting regional and national capacity building, the detailed information of which could be gleaned from the country reports in **Box 2**. The issues include: (1) the need to enhance close cooperation between CITES-authorities and fisheries-related agencies in the countries; (2) development of work plans to focus on existing legal aspects (legal acquisition, national laws), sustainability (stock assessments, NDFs), and traceability (identification, reporting, database development); and (3) consideration of the national/regional needs.

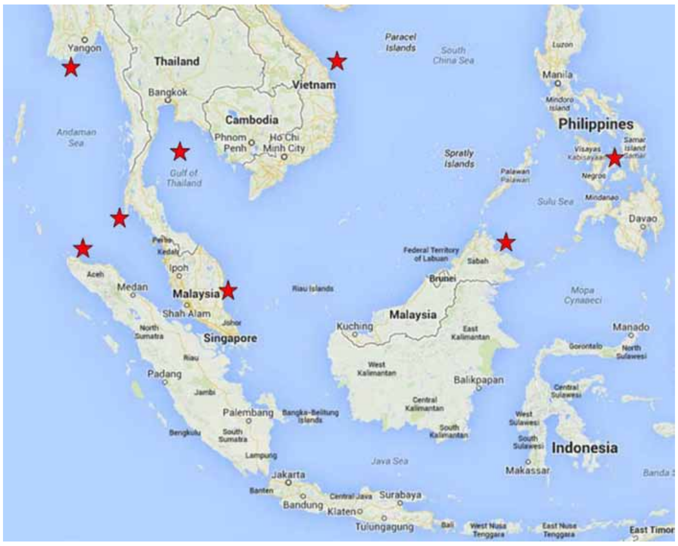

Fig. 2. Proposed project sites for the pilot activities on recording of CPUE on sharks and rays in Southeast Asia

Fig. 3. Selected species to be studied in the pilot activities

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Box 2. Information on Several Countries' Responses to the Regulation Adopted during CoP16

European Union

After the CoP16, the European Union (EU) has committed to make available Euros 1.2 million to the CITES Secretariat to support the developing countries in the sustainable management and enhanced implementation of CITES regulations for commercially-exploited aquatic species. This financial assistance will be used to strengthen scientific, institutional and enforcement capacity. In this connection, the EU asked the wildlife trade monitoring network TRAFFIC to carry out a rapid assessment of the capacity building priorities and needs in developing countries. In June 2013, the EU Council of Ministers formally adopted a strengthened ban on shark finning and entirely banned the finning of sharks caught by EU vessels, and that sharks must be landed with their fins naturally attached. During discussions held in Bonn in July 2013, Germany announced that a study had been launched to develop guidelines and recommendations for CITES Parties on the conduct of non-detriment findings (NDFs) for porbeagle sharks and other shark species, and that an international workshop on NDFs for sharks is planned to be conducted in 2014 (Juan Carlos Vasquez, 2013).

India

According to the TRAFFIC report (Mundy-Taylor and Crook, 2013), India has the world's second-largest shark fisheries next to Indonesia. In August 2013, the Ministry of Environment and Forests issued a policy on 'fins naturally attached' which implies that sharks can be finned only at ports or harbors and not onboard fishing boats in the high seas. Violators of such law could face up to seven years in prison under the assumption that any detached fins brought onshore come from species protected under Schedule I of the Indian Wildlife (Protection) Act. This policy is considered the best and most cost-effective way of enforcing the finning ban while providing avenue for species identification and data collection, considering that identification of shark species solely from its fins has been very difficult (Graef, 2013).

Japan

In a press release by CITES on 14 September 2013, it was reported that Japan has entered reservations (Any Party/Member State of CITES may make a unilateral statement) that it will not be bound by the provisions of the Convention relating to trade of particular species listed in the Appendices (or in parts or derivatives of species listed in Appendix III) on all five shark species. This means that they will not be bound by CITES regulations when trading these species. However, Japan expressed its willingness to comply voluntarily with the Convention requirements for export permits and to provide technical support to prepare for the entry into effect of the sharks listing including of shark fin identification.

China

While opposing the inclusion of these shark species in the CITES Appendices at CoP16, China continues to have concerns regarding the implementation of measure in the spirit of international cooperation under CITES, but is with full respect for the decisions adopted at CoP16. As such, China will apply the CITES rules to the concerned shark species, and hence did not enter any reservations.

Malaysia

A review of the country's NPOA-Sharks (2006) is in the final stages through stakeholders' consultation to be completed in September 2013. The revised NPOA-Sharks would to be published before the end of 2013 (IOTC Secretariat, 2013). The amendment of the International Trade in Endangered Species Act 2008 (Act 686) included the five species of sharks and manta rays listed in Appendix II CITES to be listed in the Third Schedule of the Act. Amendment by the Ministry of Natural Resources and Environment (NRE) was completed in November 2013 and finalized by the Scientific Authority (SA) of the Department of Fisheries (DOF) Malaysia on Fish and Marine Life, and sent to NRE for final action. There are several other measures that DOF Malaysia is currently implementing and will continue to carry out in the future. These include: (1) conduct of non-detrimental findings (NDFs) study for sharks and rays listed in Appendix II of CITES; (2) preventing the international trade of saw fish (*Pristis microdon*); (3) listing of all products from the sharks and manta rays that are listed in Appendix I and Appendix II of CITES; (4) enhancing the catch records on sharks and stingrays listed in Appendix II of CITES; (5) enforcing the use of trader's records of stocks of sharks and rays listed in Appendix II of CITES; (6) maintaining and updating the records from processors of products of sharks and rays listed in Appendix II of CITES; (7) enforcing the regulation that all import and export of any specimen of sharks and rays listed under Appendix II of CITES must be with CITES permits; (8) implementing the procedures of the Introduction From the Sea (IFS) in the event of landing of specimens of sharks and rays listed under Appendix II of CITES, which have been caught in waters not under the sovereignty of any country (specimens caught in waters not under the jurisdiction of any state).

Thailand

Thailand with its Notification of the Ministry of Natural Resources and Environment issued on 27 June 2013 already included sharks and rays species adopted during the CITES-CoP16 into its regulations (Ministry of Natural Resources and Environment, 2013).

Vietnam

Circular No. 40/2013/TT-BNNPTNT issued on 5 September 2013 by the Ministry of Agriculture and Rural Development (MARD) listed shark and ray species in the CITES Appendix as protected species. Currently, there are no regulations banning the exploitation and trading of shark species in Vietnam due to lack of database on species composition and distribution. Research activities on marine resources are being conducted in Vietnam waters (2012-2015), the results of which could provide information for the development of database on shark and ray species. Based on such information, Vietnam will develop its NPOA-Sharks. Meanwhile, dissemination of the CITES regulations on the exploitation and trade of sharks and rays as well as capacity building for fisheries managers and researchers also will be the top priority in the near future (Le Huu Tuan Anh, 2013).

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Regional Cooperation for Sustainable Utilization of Neritic Tunas in Southeast Asia

Somboon Siriraksophon, Achmad Poernomo and *Alma C. Dickson*

The oceans and seas of the Southeast Asian region abound with several species of oceanic and neritic tunas that are of high economic importance. Such resources not only generate export revenues for the countries of the region but also provide important protein sources for local populace. While oceanic tunas migrate over large sea areas and oceans, neritic tunas inhabit the economic zones and in the sub-regional seas of Southeast Asia. Statistical reports have indicated that oceanic tuna resources have been declining, this situation makes neritic tuna resources becoming more economically-important to the extent that the resources have increasingly become the target for commercial and local fisheries, especially that attractive prices are offered for such tunas by the fish processing industry. The distribution and migration of neritic tuna stocks in the waters and sub-regions of Southeast Asia however, as well as their utilization remain uncertain making it difficult to develop appropriate tuna management plans at national and sub-regional levels. Therefore, it has become necessary to establish a regional cooperation for the utilization of neritic tunas for the Southeast Asian region to address critical issues and concerns on their sustainability.

Recommendations provided by the Tuna Regional Fisheries Management Organizations (TRFMOs), such as the Indian Ocean Tuna Commission (IOTC) and the West Central Pacific Fisheries Commission (WCPFC), have been used as basis for the development of management plans and conduct of activities for the sustainable exploitation of oceanic tunas but not for neritic tunas. It is therefore crucial for the Southeast Asian region to develop common approaches for the management and utilization of neritic tunas, to ensure the sustainable use of available regional neritic tuna resources and to maximize the economic benefits that could be gained by the countries in the region. Such approaches call for the development of collaborative management plans for neritic tuna fisheries in the region and sub-regions, in order that the sustainability of these rich and important trans-boundary resources is assured.

The need to develop a plan of action for regional cooperation on neritic tunas in the Southeast Asian region was recognized and expressed by the SEAFDEC Member Countries during the 45th Meeting of the SEAFDEC Council in April 2013. It was also during such Meeting that the SEAFDEC Council of Directors supported the proposal of the SEAFDEC Secretariat to strengthen regional and sub-regional cooperation for the conservation and sustainable management of neritic tuna fisheries in the Southeast Asian waters. Through such collaborative cooperation, countries and producers should be able to show and verify the sustainability of neritic tuna fisheries. In order to support the need to develop collaborative management approaches, a case study was conducted by SEAFDEC Secretariat with support from Government of Japan and Sweden, and with technical support from concerned SEAFDEC Member Countries to review the information on tuna catch from the Southeast Asian region and to come up with the status and trends of neritic tuna fisheries in the region. Meanwhile, consultations with Member Countries have been carried out to determine the ways and means of promoting regional and sub-regional cooperation on the sustainable utilization of neritic tuna resources in the Southeast Asian region.

The Case Study

The case study conducted by the SEAFDEC Secretariat was aimed at determining the status and trends of neritic tuna exploitation from the EEZ of Southeast Asian countries focusing on the four most economically-important neritic tunas in the region (**Fig. 1**), namely: longtail tuna (*Thunnus tonggol*), kawakawa or eastern little tuna (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), and bullet tuna (*Auxis rochei*). The study was conducted in collaboration with national focal points from five major tuna producing countries of Southeast Asia, namely: Indonesia, Philippines, Thailand, Vietnam, and Malaysia. Analysis of the tuna production centered on the exploitations within the EEZ of the Southeast Asian countries, where the data and information used for the analysis were sourced from national fisheries statistics,

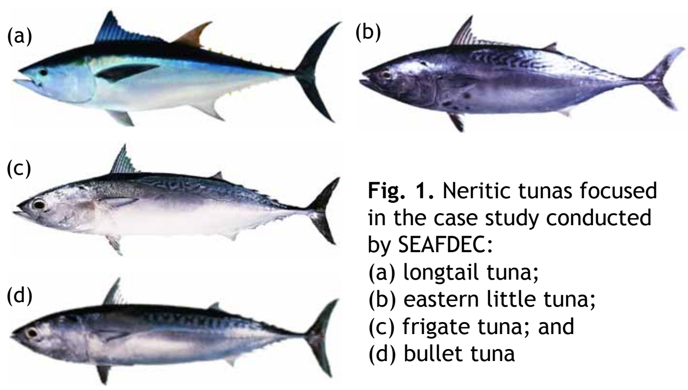

Fig. 1. Neritic tunas focused in the case study conducted by SEAFDEC:
(a) longtail tuna;
(b) eastern little tuna;
(c) frigate tuna; and
(d) bullet tuna

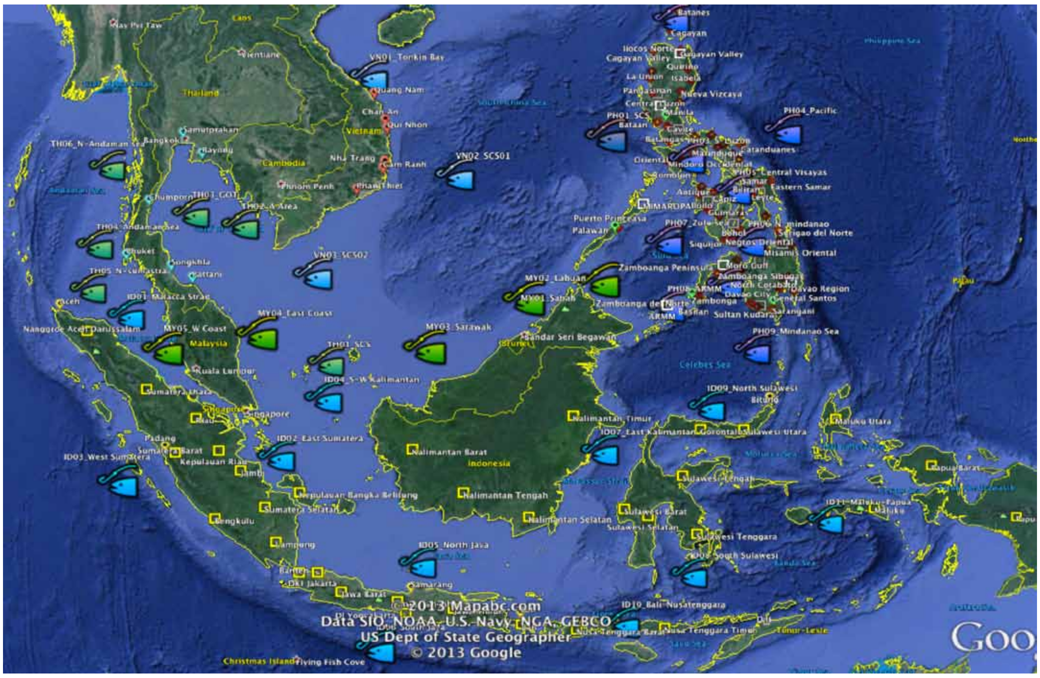

Fig. 2. Locations of fisheries administrative offices, selected landing sites and identified fishing areas by country

data samplings at selected landing sites and results of consultations with national focal points. **Fig. 2** shows the fisheries administrative offices responsible for tuna data collection in the Philippines and Indonesia, the selected landing sites for data collection in Thailand and Vietnam, and the fishing areas within the EEZ of Southeast Asian countries.

The origin/fishing grounds and species composition of neritic tunas were examined and analyzed to warrant the status of tuna exploitation in the specific sea areas in the Southeast Asian region, as shown in **Fig. 2**.

Neritic Tuna Fisheries of Southeast Asia

In the Southeast Asian region, neritic tunas are caught commercially using three main fishing gears, namely: purse seines, ring nets (mainly in the Philippines), and drift gillnets. Three types of purse seine operations are adopted in many Southeast Asian countries such as purse seines with searching methods, those associated with fish aggregating devices (FADs), and with luring light methods. In Thailand as well as in other countries, such as Cambodia, Malaysia, Myanmar, Brunei Darussalam, and Indonesia, the purse seine used must have evolved from the Chinese purse seine which became widely used after 1957. This purse seine has been developed with a unique style of seining appropriate to conditions in the waters of Thailand, although such gear was initially intended to catch small pelagic fishes other than tunas. Targeting the small tunas using the Thai purse seine fishery started in 1982 with the expansion of the country's tuna canning industry. The Thai purse seine fishery is labor-intensive requiring 30-40 crew members to work on vessels with sizes that range from 25 to 30 m. The length of the nets range from 800 to 1,250 m while the nets' depths range from 70 to 120 m and mesh sizes from 2.5 to 9.7 cm. Recently, modern purse seiners are equipped with radar, depth sounder, sonar transceiver, and satellite navigational instruments. Compared with purse seine operations nowadays, drift gillnets have also played an important role in neritic tuna fisheries, especially in the early period of development of small pelagic fisheries in many Southeast Asian countries. Specifically, drift gillnets are important for some countries such as in Vietnam where 37% of its total neritic tuna catch of 72,650 metric tons (mt) is produced using drift gillnets (Nguyen Ba Thong, 2013).

Status and Trends of Neritic Tuna Production

Based on the countries' statistical records, the main sources of neritic tuna production of Southeast Asia are Indonesia, Philippines, Vietnam, Malaysia, and Thailand. However, it should be noted that neritic tuna production of Vietnam has not been properly recorded in its national statistics, although the Research Institute of Marine Fisheries (RIMF) of Vietnam estimated the country's neritic tuna production in 2012 to be 72,650 mt. In addition, tuna production of Brunei Darussalam of less than 100 mt per year comprises mostly the eastern little tuna and skipjack tuna. The total production of neritic tuna in Southeast Asian waters in 2010 could therefore be estimated at about 857,440 mt (including the constant volume of from Vietnam as of 2012 and production from Brunei Darussalam). The trends of neritic tuna in four (4) countries during the period from 2004 to 2010 is shown in **Fig. 3** and specifically, it is shown in **Fig. 3(a)** that the region's total production of neritic tunas varied between 700,000 and 800,000 mt, even if production from

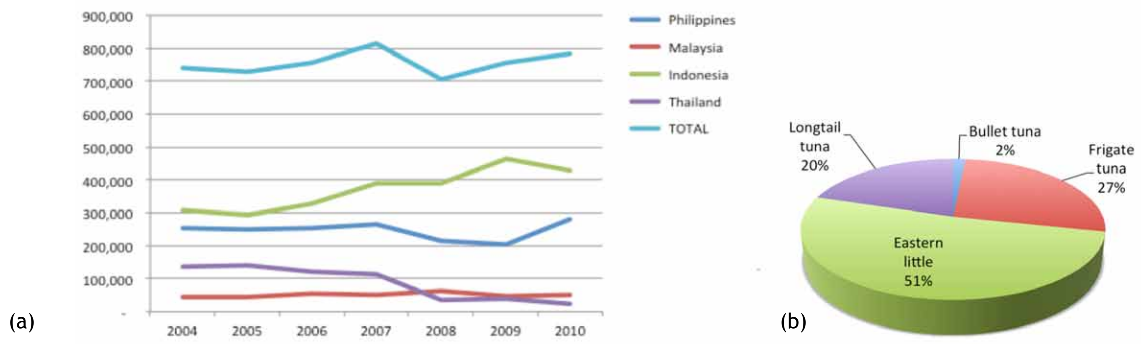

Fig. 3. Trends of neritic tuna production of the Southeast Asian countries in 2004-2010 (a); and species composition of neritic tuna catch in 2010 based on information from four main tuna producing countries of Southeast Asia (b)

Thailand seemed to decrease from 136,227 mt in 2004 to 23,896 mt in 2010, a matter that needs to be reckoned with.

In 2007-2008, the system of compiling national fisheries statistics of Thailand was improved in order to exclude the production data from import as well as those from outside the EEZ of Thai waters, *e.g.* south of the Gulf of Thailand (Malaysia and Indonesia), and north-south of the Andaman Sea (Malaysia and Myanmar). As a result, production of Thailand had changed from 112,000 mt in 2007 to 35,000 mt in 2008, while an increasing trend of neritic tuna production could be noted in the case of Indonesia, from 293,461 mt in 2005 to 464,016 mt in 2009, while in the case of Malaysia, the production slightly varies but within the average of 51,000 mt per year in 2004-2010, similar to the production trend of Thailand.

Species Composition of Neritic Tuna Production

As shown in **Fig. 3(b)**, eastern little tuna was the predominant neritic tuna species caught from the Southeast Asian waters in 2010, accounting for 51% of the overall neritic tuna production, followed by frigate tuna at 27%, longtail tuna at 20%, and bullet tuna of about 2%. However, the species composition of neritic tuna production by country in 2004-2010 (**Fig. 4**) indicated that in the Philippines, only two neritic tunas (eastern little tuna and frigate tuna) have been recorded from fishing areas in 10 locations, namely: (1) Western Luzon; (2) Central Visayas; (3) Northern Luzon; (4) Pacific Ocean; (5) Sulu Sea; (6) Autonomous Region of Muslim Mindanao (ARMM) Area; (7) Mindanao Sea; (8) Southern Luzon; (9) Northern Mindanao; and (10) Moro Gulf. For Indonesia, production of four neritic tunas recorded in its national fisheries statistics came from fishing grounds in 11 areas, namely: (1) West Sumatera; (2) South Java; (3) Malacca Strait; (4) East Sumatera; (5) North Java; (6) Bali-Nusatenggara; (7) South/West Kalimantan; (8) East Kalimantan; (9) South Sulawesi; (10) North Sulawesi; and (11) Maluku-Papua, although before 2004, neritic tuna was recorded as unidentified species. For Malaysia, only longtail tuna was recorded before 2003 but later the other two neritic tunas (bullet tuna and eastern little tuna) have already been included in its national statistics. The fishing areas for neritic tunas in the EEZ of Malaysian waters are in the: (1) West Coast Peninsular; (2) East Coast Peninsular; (3) off the coast of Sarawak; (4) off the coast of Sabah; and (5) Labuan. For Thailand, recording of four neritic tunas started in 2009 where the fishing areas are located in the Gulf of Thailand and Andaman Sea.

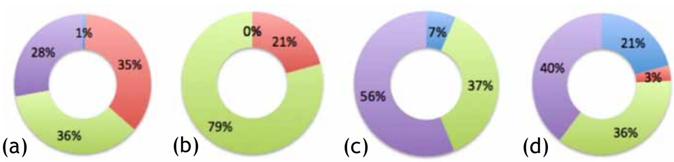

Fig. 4. Species composition of neritic tunas found in major tuna producing Southeast Asian countries: (a) Indonesia; (b) Philippines; (c) Malaysia; and (d) Thailand

Relative Abundance and Distribution

The relative abundance and distribution of the neritic tuna in the EEZ of Southeast Asian countries in 2010 (**Fig. 5**), includes production of neritic tuna from Vietnam in 2012 of about 72,650 mt, assuming that not much changes occurred in its catch of about 72,000-73,000 mt in 2010 and based on reports that most of the country's neritic tunas are caught from the southeast coast of Vietnam. Therefore, the total tuna exploitation based on specific sea areas can be estimated at: 121,376 mt in South China Sea; 126,672 mt in Natuna Sea, part of southern South China Sea; 144,100 mt in Sulu Sea; 88,600 mt in Celebes Sea; 90,000 mt in Banda Sea; 65,000 mt in the east coast of the Philippines; 58,300 mt in Indian Ocean (S-Java); 50,100 mt in West Sumatra; 50,000 mt in Andaman Sea; and 474 mt in the Gulf of Thailand.

Conclusion and Recommendations

Considering the distribution of neritic tunas in Southeast Asian waters (**Fig. 6**), it could be gleaned that almost 74% of longtail tuna are found in the Indonesian waters particularly in Natuna Sea down to the north Java and

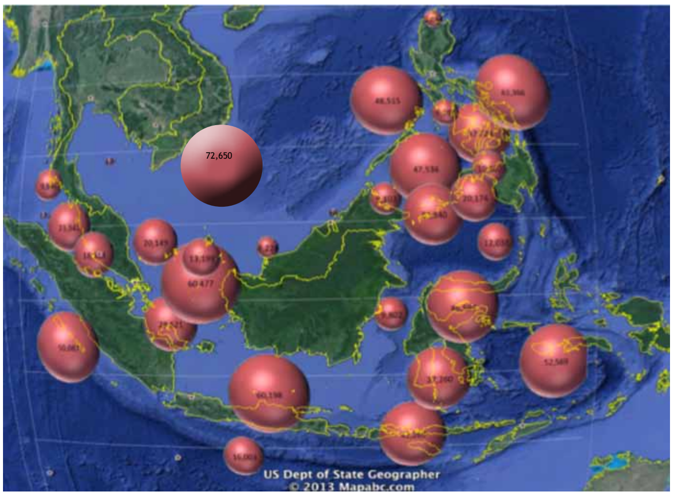

Fig. 5. Relative abundance and distribution of neritic tunas in Southeast Asian waters (as of 2010)

north Sulawesi Seas. Meanwhile, less than 20% could be found in the east and west coast of Peninsular Malaysia. For frigate tuna, 70% of the total exploitation also comes from Indonesian waters while another 30% are from Philippine waters.

While eastern little tuna represents about 55% of the Philippine tuna resources, the other 35% comes from Indonesian waters. For bullet tuna, about 30% each are from Indonesia and Malaysia, while the remaining 40% are from Thai waters (**Fig. 6**). In the Gulf of Thailand (GOT), neritic tuna production had been recorded from the EEZ of the Gulf of Thailand and from the east and south of the Gulf of Thailand outside the EEZ as shown in **Fig. 7**, leading to varying volumes, *i.e.* from 8,000 to 19,000 mt from 1998 to 2007, while production rapidly decreased from 10,000 mt in 2007 to 5,000 mt in 2008, and 474 mt in 2010.

Similalry, data on neritic tuna exploitation from outside of the EEZ in the east and south of the GOT indicated different volumes, *i.e.* 60,000 mt in 1998 increasing to 110,000 mt in 2005, but drastically decreased from 96,000 mt in 2006 to only 13,200 mt in 2010. This was a result of the improvement of data recording system from 2005 to 2010 when data on tuna exploitation within the EEZ and outside the EEZ of the Gulf of Thailand were segregated (**Fig. 7a**). Meanwhile, neritic tuna exploitation in the east coast of Peninsular Malaysia and off Sarawak during the same period from 2005 to 2010 varied from 20,000 mt to 33,000 mt, indicating that the resources had not declined. Such information makes it is necessary to identify the origin of neritic tunas exploited outside the EEZ of the GOT (**Fig. 7b**).

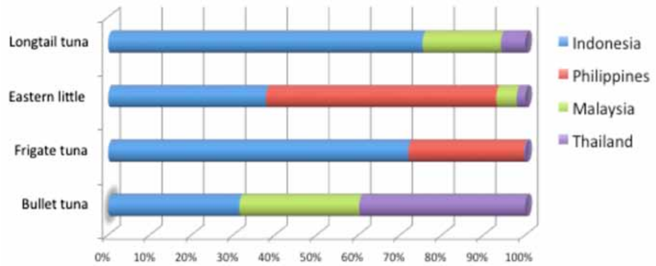

Fig. 6. Distribution of neritic tunas in Southeast Asian waters

As for the exploitation of neritic tunas in Indonesia during the same period from 1998 to 2010, production had increased gradually from 206,000 mt in 1998 to 464,000 mt in 2009. This trend ensures that the country's neritic tuna resources are still in good condition even though it is expected that the increasing production from Indonesian maybe linked to the decreasing trends of exploitation of Thailand particularly when the fishery policy on joint venture of these two countries was changed after 2007.

Way Forward for Sustainable Utilization of Neritic Tunas

Recognizing the need to develop a Regional Plan of Action on Sustainable Fisheries of Neritic Tunas in Southeast Asia, the 45th Meeting of the SEAFDEC Council endorsed the proposal of SEAFDEC Secretariat to conduct regular stakeholders' consultations for the development of the Regional Plan of Action for Sustainable Neritic Tuna Fisheries (RPOA-Neritic Tuna). Thus, SEAFDEC with funding support from the SEAFDEC-Sweden Project together with ASEAN-SEAFDEC Member Countries organized the "Consultative Meeting on Regional Cooperation Sustainable Neritic Tuna Fisheries in Southeast Asian Waters" in October 2013 in Songkhla

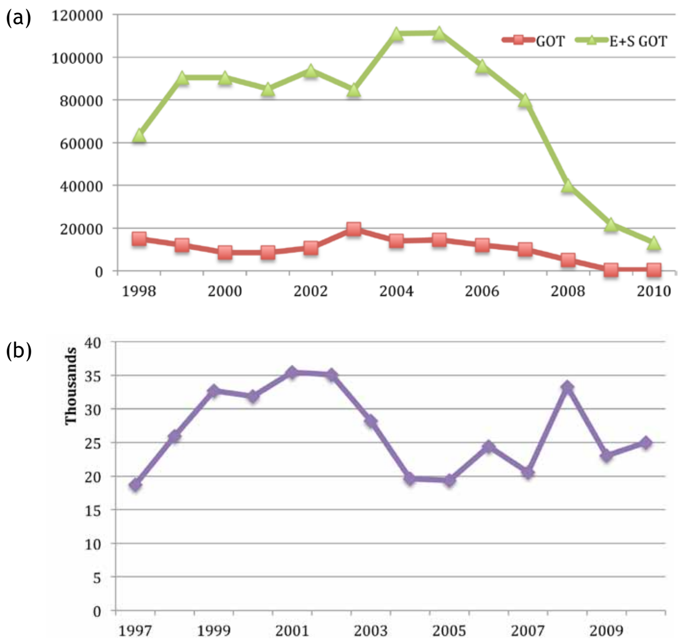

Fig. 7. Neritic tuna exploitation in the EEZ and outside EEZ of the Gulf of Thailand during 1998-2010 (a); and neritic tuna exploitation in east coast of Peninsular Malaysia and off Sarawak during 1998-2010 (b)

Box 1. Prioritized issues to be considered for developing the RPOA-Neritic Tuna

At National Level
- Open access, management of fishing capacity necessary
- Undetermined resources, status and trend of neritic tuna need regular updating
- Insufficient data/information, data collection systems should be improved
- IUU Fishing
- Transshipment of catch
- Double flagging, poaching
- Post-harvest losses
- Appropriate technology of fishing gears and devices should be promoted
- Infrastructure of fishing port/landing sites inadequate
- Unfair benefits allocation, working conditions and labor issues should be settled
- Supporting policy from Government should be assured
- Capacity building necessary

At Regional Level
- Sub-regional fisheries management for neritic tuna should be developed
- Assessment of the status and trends of neritic tuna at sub-regional level should be carried out through the establishment of working groups
- Intra-regional trade should be enhanced through harmonized standard catch documentation systems
- Sharing of data and information necessary, *e.g.* through the development of list of fishing vessels, etc.
- Cooperation with other sub-regional, regional, international organizations should be sought

Box 2. Expected outputs of the RPOA-Neritic Tuna

Result 1: Generation and uptake of demand driven fisheries technologies and innovations facilitated
Result 2: Policy options for enhancing the performance of the fisheries subsectors in the Southeast Asian region facilitated
Result 3: Capacity for fisheries research development in Southeast Asia strengthened, and
Result 4: Availability of information on fisheries innovation enhanced

Province, Thailand. The Meeting had provided the platform to initiate and coordinate a process of promoting dialogue and cooperation on "regional" (neritic) tuna resources, while information on the status of neritic tuna in the region and sub-regions were revealed and shared as well as experiences of SEAFDEC and partner organizations at regional and sub-regional level. Issues related to neritic tuna fisheries and trade were also discussed taking into account the current problems/challenges in different sub-regional areas/fishing grounds, *i.e.* South China Sea, Gulf of Thailand and Andaman Sea, and Sulu-Sulawesi Seas.

The need to update the status and trend of neritic tuna resources and improve collection of data/information was highlighted due to inadequacy of data collection systems in many countries. In addition, it was also suggested during the October 2013 Consultative Meeting that sub-regional management of neritic tuna should be established through cooperation among countries and with sub-regional, regional, international organizations.

Box 3. Scope of interventions corresponding to program level strategic results for the development of the RPOA-Neritic Tuna

i. **Improving fisheries productivity:** this is meant to address productivity constraints at system levels by applying effective fisheries management tools which include management of fishing capacity and reduction of IUU fishing-related activities in tuna fisheries such as transshipment, double flagging, etc.
ii. **Improving access to markets:** a key issue to be addressed in order to support access of fisheries to market, is traceability system by enhancing regional standard/catch documentation system, while also addressing the need to enhance intra-regional and international trading of tuna in the region.
iii. **Improving data collection and development of key indicators:** this is meant to better understand the status and trends of tuna resources in the region. Assessment of tuna stocks at national and sub-regional areas would be promoted through the establishment of stock assessment working groups so that existing science-based fisheries management for long-term impacts is ensured. Research programs could also cover onboard fish handling practices to avoid post-harvest losses.
iv. **Improving sustainable interaction between fisheries and the marine ecosystem:** Appropriate technology of fishing gears and devices to be promoted for harvesting neritic tunas to reduce by-catch species.

Furthermore, prioritized issues were identified during the October 2013 Consultative Meeting (**Box 1**), which could be used for drafting the Plan of Action Sustainable Neritic Tuna Fisheries (RPOA-Neritic Tuna) in Southeast Asian Waters at national and sub-regional levels.

The October 2013 Consultative Meeting also agreed that the scope and goals of the RPOA-Neritic Tuna should enhance sustainable fisheries of neritic tunas through the integration of fisheries management and ecosystem interventions in order to attain the outputs as planned (**Box 2**). Moreover, the scope of interventions should be able to contribute to the attainment of the four program level strategic results as shown in **Box 3**.

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Management of Trawl Fisheries in Southeast Asia and Coral Triangle Region: the REBYC-II CTI Project

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The Coral Triangle and Southeast Asia are the world's most biologically diverse and economically productive regions. Of the regions' about 600 million people representing nearly 9% of the world's total population, at least 120 million are directly dependent upon marine resources for livelihoods and food security. In 2009, the regions' production from marine capture fisheries was reported to be approximately 12 million metric tons (mt) or 18.1% of world's marine fisheries production (FAO, 2011). Specifically, the Coral Triangle region which embraces Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste, has the most diverse coral species (605 species) accounting for 76% of the world's coral species (798 species). It is therefore very obvious that these regions are also among the most potentially vulnerable marine zones of the world.

As a result of increasing population and exploitation pressures, growing threats from pollution and major ecosystem changes are particularly the most crucial concerns in the Coral Triangle (CT) region and in Southeast Asia. As with the global context, issues related to the capture of untargeted fish species and non-fish species also commonly known as by-catch and discards are on the rise. Specifically, problems associated with by-catch include the capture of juveniles of ecologically-important and economically-valuable species, non-reporting of retained catches and discarded catches (**Box 1**). Trawl and longline fisheries have the tendency to retain by-catch not only for human consumption but also for utilization as aquafeeds and fertilizers. In an effort to sustain the pelagic fisheries resources especially for tuna long-line fisheries, the use of circle hooks instead of J-hooks had been advocated to commercial and artisanal fisheries, and proved effective. However, the design and scale of multi-species diverse trawl net used in trawl fisheries remains a complex issue that requires integrated policies and involves technical and community support measures.

By-catch Management in Trawl Fisheries

SEAFDEC had successfully implemented Phase I of the FAO/UNEP/GEF Project on *Reduction of Environmental Impact from Tropical Shrimp Trawling through the Introduction of By-catch Reduction Technologies and Change of Management* (REBYC) in 2002-2008, which had relatively strong focus on technology and development of selective gear. While Phase I generated significant results, but experience showed that more effort is needed to successfully address the complex issues related to by-catch reduction in trawl fishing operations. This is particularly the case in multi-species trawl fisheries of the type found in Southeast Asia and the Pacific region where trawler fleets are diverse in terms of type and scale. In addition, since the overall management seems rather weak, by-catch is largely utilized and considered part of the total catch. Solutions that include gear modification should be supported by appropriate legal and incentive frameworks to become effective. Although gear modifications are important but these are not always the most appropriate tools as such approach should be combined with other management measures.

Moreover, the socio-economic drivers behind by-catch and livelihoods in the context of poverty alleviation need to be understood and considered. While initially this holistic approach may be more costly and require more efforts, it is cost-effective in the longer-term because of

Box 1. Regional definitions of some terminologies (SEAFDEC, 1999)

By-catch: A general term for the component of the catch anticipated to be caught during industrial fishing operations, in addition to the target catch

Incidental Catch: A general term for the catch not anticipated to be caught during fishing operations but are incidentally caught

Retained Catch: Portion of the catch landed at fishing bases or distributed to the markets

Total Catch: Catch on board fishing vessels, which is synonymous with "Retained Catch in the Fishing Gear"

Discarded Catch or Waste: Portion of the catch returned to the sea (or otherwise thrown away) due to economic considerations - deemed to have none or even negative value to the catchers

Selective Fishing Gear: Fishing gear designed to exclude/reduce the capture of unwanted sizes and species of fish as well as incidental catch, and released from fishing gear with high survival rate

Destructive Fishing Gear and Practices: Fishing gear and practices that have destructive effect on ecosystems including the environment and fishery resources sustainability of the results. Thus, the follow up three-year project on *Strategies for trawl fisheries by-catch management* (REBYC-II CTI) which took off in late 2012, is generally aimed at mitigating the problems associated with by-catch in fisheries within the Coral Triangle region of Southeast Asia. The project will focus on multi-species trawling, where by-catch issues are among the most serious, with potentially significant effects on the ecosystems and livelihoods. Specifically, the project will address these challenges by promoting sustainable fishing and the adoption of best fishing practices, and providing a rational approach to delivering benefits from landed by-catch. Appropriate technological practices will be identified and management plans developed in partnership with the private sector at both national and regional levels, and the "guidelines for best practice in fishing operations" will be crafted. In order to attain sustainability of fisheries resources and healthier marine ecosystems in the project area, it is necessary to: minimize the catch of juveniles, minimize the risk of species from trawling, minimize discards where such catch takes place, avoid negative impacts on the habitats, improve utilization of catch by value-adding, and increase resilience of coastal livelihoods. In this regard, the project aims to champion the necessary changes by seeking a balance between environmental and human well-being (**Box 2**).

Box 2. Overall objectives of REBYC-II CTI

The global environment objective of the project is ***to promote responsible trawl fisheries that will result in sustainable fisheries resources and healthy marine ecosystems in the Coral Triangle and Southeast Asian waters by reducing by-catch, discards and fishing impact on biodiversity and the environment***.

The project development objective is ***to promote effective public and private sector partnership for improved trawl and by-catch management and practices that support fishery dependent incomes and sustainable livelihoods***.

The Project is executed by the governments of five participating countries (**Fig. 1**), namely: Indonesia, Papua New Guinea, Philippines, Thailand, and Vietnam. The Southeast Asian Fisheries Development Center (SEAFDEC) based in Samut Prakan, Thailand assumes the role as Regional Project Facilitator in partnership with the private sector and relevant national, regional and international organizations, *e.g.* Sida (now Sweden), IFFO, SPF, WWF. The Food and Agriculture Organization of the United Nations (FAO) is the Global Environment Facility (GEF) agency for the project which is being funded jointly by GEF and the implementing and executing partners.

Implementation of the Project is structured around four interrelated components (**Box 3**), namely: (1) Policy, Legal and Institutional Frameworks; (2) Resource Management and Fishing Operations; (3) Information Management and Communication; and (4) Awareness and Knowledge on trawl fisheries by-catch management. These were developed during the initial activities of the Project, such as: FAO/GEF Inception Workshop on By-catch Management and Reduction of Discards in Trawl Fisheries organized by FAO and SEAFDEC in Samut Prakan, Thailand, 3-6 November 2009; FAO/GEF Regional Workshop on Strategies for Fisheries By-catch Management REBYC-II CTI Project: CTI Log-frame/Project Planning Workshop, organized by FAO and SEAFDEC/TD in Samut Prakan, Thailand, 4–7 May 2010; Fishing Industry Round-Table Meeting in Bangkok, Thailand, 30 April 2012; the FAO/GEF Project Inception Workshop Organized by FAO and SEAFDEC in Bangkok, Thailand, 1-4 May 2012; and the FAO/GEF Regional Workshop for Work Planning-Year1 organized by FAO and SEAFDEC in Bangkok, Thailand, 6-9 November 2012.

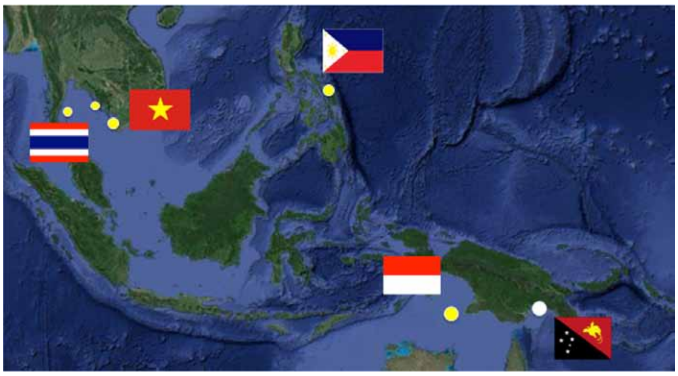

Fig. 1. Participating countries and corresponding project sites for the REBYC-II CTI Project
- **Indonesia:** Arafura Sea (Maluku-Papua)
- **Papua New Guinea (PNG):** Gulf of Papua
- **Philippines:** Samar Sea for small-scale trawlers; whole country large-scale trawlers
- **Thailand:** Gulf of Thailand (Chumporn-Trat Province)
- **Vietnam:** Southern part of Vietnam (Kien Giang Province)

The benefits of reduced catch of trash fish and juveniles could include improved productive potential of fish stocks, and lowered operational costs. This is considering that improved catch in the future from both commercial scale and small-scale sector and catch of larger size of economic fish would lead to increased economic gains/incomes, improved food security, and enhanced positive public attitude which consequently lead to new marketing opportunities. Moreover, reduced operational costs could be attained through improved catch quality and value, reduced fuel cost by trawl net fishing and sorting time of catch, reduced number of crew, and increased catch per unit of effort (CPUE). More specifically, the long-term outcomes and impact indicators of the Project are indicated in **Box 4**.

Box 3. Components of REBYC-II CTI Project

Policy, Legal and Institutional Frameworks: establishment of national or area specific trawl fisheries by-catch management plans and building institutional capacity for their implementation

Activities in Year 1

- Establish National Working Groups/Technical Support (Working) Group/Advisory Group, and organize relevant meetings/workshops (*all participating countries*)
- Review policy, legal, institutional frameworks and management plans of each project area (*all participating countries*)
- Establish Advisory Groups, National Working Group, and identify stakeholders to participate in the project (*all participating countries*)
- Develop monitoring and data collection mechanisms (additional, specific for *PNG*)
- Develop national circular for trawl fishery management and submit first drafted circular to relevant authorities, fishing industries, and local stakeholders for consultation, and convene national workshop to review and evaluate drafted circular (additional, specific for *Vietnam*)

Resource Management and Fishing Operations: promotion of the adoption of more selective fishing gear and practices, as basis for implementing zoning of fishing areas and developing spatial-temporal closure management measures, and generation of better data on number of vessels and recommendations for fishing effort and capacity management

Activities in Year 1

- Identify, develop, test and assess the appropriate selective fishing gear/practices to reduce by-catch and juveniles in trawl fisheries (*all participating countries*)
- Investigate the priorities for fishing closed area/season (*all participating countries*)
- Identify and map critical areas; review existing vessel registry systems; and identify potential incentives packages (additional, specific for *Indonesia*)
- Review current VMS registry and license conditions of trawl fleets; and conduct research to assess the status of fisheries resources within 3-mile area (additional, specific for *PNG*)
- Conduct fish larval survey and map critical habitats; and train field officers on inventory procedures as well as on registration/licensing, registry/database systems (additional, specific for the *Philippines*)
- Allow consultancy work to validate existing data and inventory of trawl fishing fleets in the project areas (additional, specific for *Thailand*)
- Review the status of trawl fisheries and vessel registration system in Kien Giang (additional, specific for *Vietnam*)

Information Management and Communications: by-catch data collection, mapping of fishing grounds, establishment of socio-economic monitoring procedures, and development of means for communicating by-catch data and information, where the standardized methods for by-catch data collection will be promoted in the participating countries

Activities in Year 1

- Develop national project webpage (*all participating countries*)
- Standardize data collection; and train enumerators/observers to collect data both onboard and landing sites (additional, specific for *Indonesia*)
- Review/revise Observer Programs and develop protocols/forms for trawl fishery data collection; develop trawl fisheries database; and review and revise Logbooks, sampling forms/species guides (additional, specific for *PNG*)
- Strengthen coordination with collaborators in preparing for data collections; and train enumerators for trawl catch/by-catch landing surveys (additional, specific for the *Philippines*)
- Improve data collection, analysis, size composition, proportion of catch, by-catch from mesh size expansion and zonation (additional, specific for *Thailand*)
- Develop protocols/forms for trawl fishery data collection; and implement port sampling and trawl fishery logbook data collection program (additional, specific for *Vietnam*)

Awareness and Knowledge Issues: addressing the awareness of and knowledge on trawl fisheries by-catch management issues and on how these relate to sustainability, and development of measures that are available to make fishing more responsible, by allowing the private sector/fishers, policy makers, fisheries managers, officials, extension officers, and NGOs to conduct activities that would enhance their knowledge on best management practices and responsible fisheries

Activities in Year 1

- Build the awareness of project staff through their participation in regional workshops that aim to develop a regional guidelines on by-catch management and reduction of discards organized by REBYC-RFU and SEAFDEC/TD (*all participating countries*)
- Conduct consultative meetings/workshops for stakeholders, fishing communities and resource owners to introduce the project, and encourage their participation in order to promote responsible trawl fishing and practices (*all participating countries*)
- Carry out training needs assessment to enhance participation of fishers to project; and Identify national policy and decision makers for sensitization (additional, specific for *Indonesia*)
- Convene consultative workshops for stakeholders, fishing communities, and resource owners to introduce project's information and enhance awareness of relevant stakeholders in government fishery agencies (additional, specific for *PNG*)
- Conduct training/seminar on By-catch Reduction Devices (BRDs) and other similar management measures (additional, specific for the *Philippines*)
- Convene an inception workshop to introduce the project to local stakeholders in project areas (additional, specific for *Thailand*)
- Convene an inception workshop to introduce the project and enhance awareness of relevant stakeholders in project area of Kien Giang, this will be combined with activity to disseminate project information through mass media and brochures on by-catch management activities (additional, specific for *Vietnam*)

Box 4. Expected outcomes and impact indicators of the Project

- Agreed regional by-catch policy/strategy, which is in line with the forthcoming International Guidelines on By-catch Management and Reduction of Discards, is adopted by at least one relevant organization in the project region, and national or area specific trawl fisheries by-catch management plans are adopted covering at least a third of all trawlers in the participating countries
- Measures that manage by-catch and reduce discards that improve fisheries resources, are implemented by 25% of all trawlers in the participating countries, and in these fisheries (covered by improved by-catch management measures), by-catch has been reduced by 20% compared to the baseline data in Year 1 of the project
- Standardized data on at least 3 key by-catch and habitat indicators are available in the participating countries, and disseminated to trawl fisheries and by-catch management planning for implementation at national and regional levels
- Enhanced understanding of responsible fishing by private sector/fishers, fisheries managers and decision-makers are supporting participatory management arrangements in the participating countries
- Institutional arrangements and processes for public and private sector partnerships are in place, and supporting trawl fisheries by-catch management in the participating countries
- Role of by-catch in trawl profitability is understood and measures on how to ensure long-term economic sustainability of trawl fisheries are identified and incorporated into the trawl fisheries by-catch management plans in participating countries
- Incentives for trawl operators to reduce by-catch are defined and implemented in participating countries and best practices communicated within relevant regional frameworks

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Analyzing the Catch Rate and Species Diversity Index of Deep-water Shrimps for Sustainable Fisheries Development and Management: Philippine Perspective

Laureana T. Nepomuceno, Remar P. Asuncion and *Rafael V. Ramiscal*

During the collaborative deep-sea survey activities conducted by BFAR and foreign researchers in 2008 onboard the M.V. DA-BFAR to census the status of marine life in the Philippines, deep-water shrimps belonging to Family **Pandalidae** was found to flourish in the continental slopes of Western Luzon in the Philippines, and thus, was considered potential deep-sea resource that could be sustainably utilized. Considering the abundant catch of the shrimps using traps, exploratory fishing surveys were pursued to assess their potential for fisheries development. Belonging to Infraorder Caridea, Pandalidae is characterized by having five (5) pairs of well-developed legs with the third pair bearing with or without pincers, with an expanded pear-shaped abdominal pleuron overlapping the posterior part of the first and the anterior of third pleura. Both sexes lacks large copulatory organ on the first pair of pleopods and females usually carry eggs on the abdomen until hatching (FAO, 1998). In other countries in the Pacific, these shrimps are exploited commercially, particularly the genus Heterocarpus, using baited traps and trawls (King, undated). In the Philippines this resource is undeveloped primarily because local fisherfolk do not have the capacity of to explore the offshore areas while very little is known about the economic importance of these deep-water shrimps.

Based on the initial findings of the deep-sea survey activities using the M.V. DA-BFAR on the abundance of deep-water shrimps in Philippine waters, BFAR conducted a study to determine the factors that affect the catch rate of deep-water shrimps in West Philippine Sea using traps. The study was also aimed at understanding the zonation of these shrimp species based on abundance, distribution and diversity index at different fishing zones and water columns. Results of the analysis could be used as basis for the development of management framework for the sustainable utilization of the resource. Moreover, the study also aimed to determine the probable influence of soaking period of the traps in the catch rate of the shrimps. For the study, 25 trap fishing stations were established in West Philippine Sea (**Fig. 1**). Specifically, the study sites included the sea waters in Verde Island in Batangas and Mindoro up to northern Ilocos Region. The traps used were cylindrical in shape and made of polyethylene screen with flat bars used as the frame. Each trap measures 65 cm in length and 30 cm in diameter, and comes in three variations, namely: fully-covered, partially covered, and uncovered (**Fig. 2**). About 30-46 traps were deployed for every fishing operation, immersed for 5-19 hours. Chopped sardines (*Sardinella* spp.), scads (*Decapterus* spp.) and lizard fish (*Saurida* spp.) were used as baits.

As shown in **Fig. 1**, the study area was divided into six (6) zones, namely: Ilocos waters, Pangasinan/La Union waters, Zambales waters, Bataan waters, Approaches of Manila Bay, and Mindoro/Batangas waters. Comparative analyses of the catch rate (CPUE) and species diversity index (SDI) of the shrimps in terms of fishing zone and

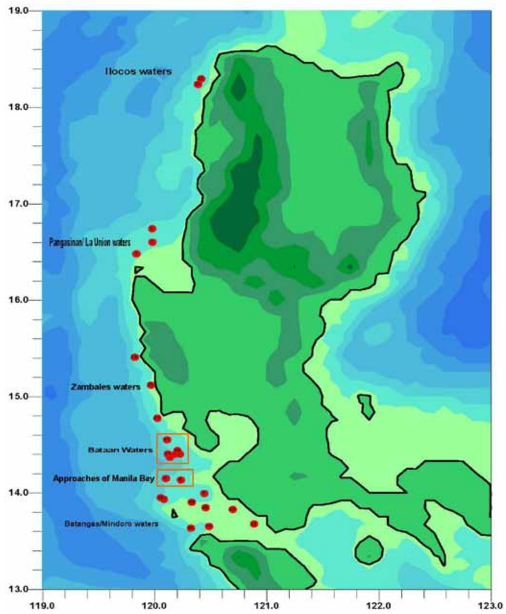


Fig. 1. Northern part of the Philippines showing the trap fishing stations

Fig. 2. Three variations of traps used in the fishing operations for deep-water shrimps

sampling column were carried out to determine the effect of zonation on the shrimp catch. The relevance of soaking time on the catch rate was also compiled and analyzed for its effect. The catch rate was computed using the formula:

$$\text{CPUE}_{(100\ \text{traps})} = \frac{\text{Total Shrimps Caught (Kg)}}{\text{Total No. of Traps Deployed}} \times 100$$

Meanwhile the species diversity index was determined using the Simpson's Diversity Index (D), where

$$D = \frac{\sum n\,(n-1)}{N\,(N-1)}$$

n = total number of particular species observed
N = total number of all species observed

Discussions

A total of more than 7,500 Pandalid shrimps were recorded from the trap fishing operations, yielding a total catch of 72.0 kg with mean CPUE of 6.7 kg/100 traps. Abundant catch was recorded in Zambales waters with mean catch rate of 16.2 kg/100 traps while the lowest was in Pangasinan/La Union waters with mean catch of 3.7 kg/100 traps (**Fig. 3** and **Fig. 4**).

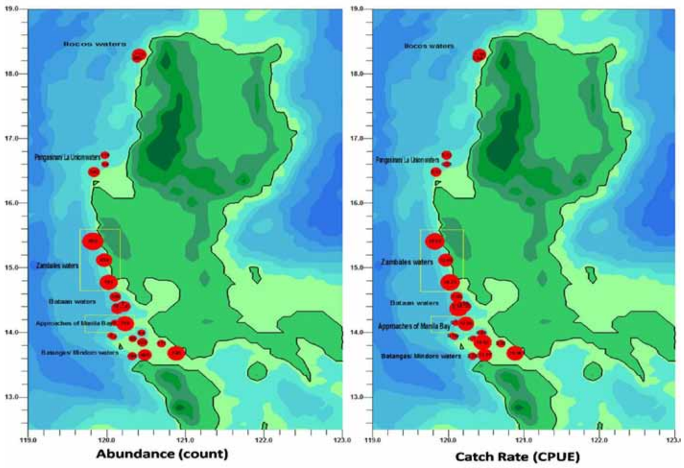


Fig. 3. Abundance and catch rate of Pandalid shrimps in different sampling stations in West Philippine Sea

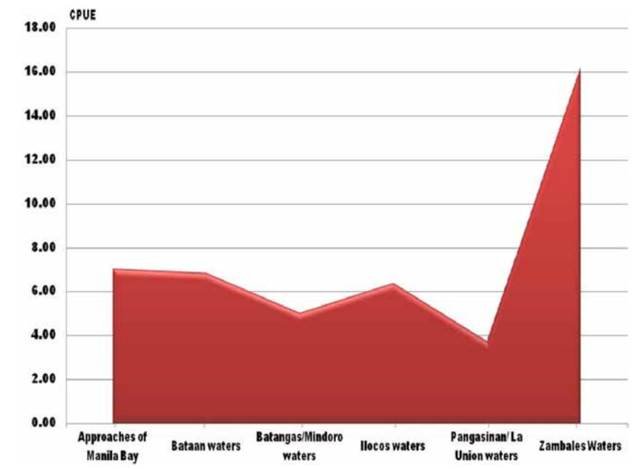
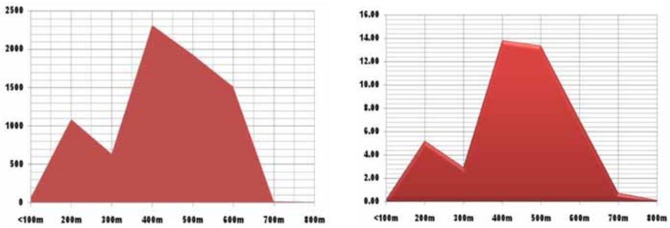


Fig. 4. Catch rate of Pandalid shrimps from various fishing zones in West Philippine Sea

Moreover, abundant catch was recorded in depths of 400-500 m but slid down at 700-800 m, while low catch was recorded at depths of <100 m (**Fig. 5**). Analysis of the relevance of shrimp counts with respect to CPUE brings about very high relationship as shown in **Fig. 6**, implying that the catch rate was dependent on the abundance of the shrimps.



Catch *CPUE*

Fig. 5. Distribution of catch from various sampling depths

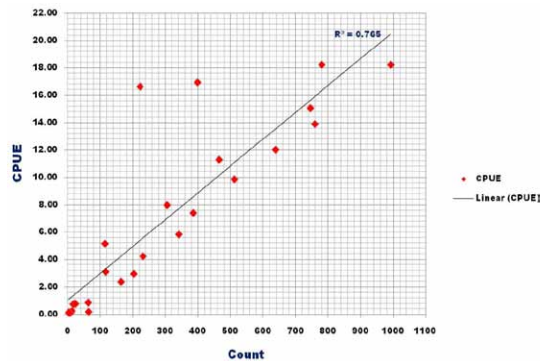


Fig. 6. Relationship between abundance and catch rate

Meanwhile, the analysis of the soaking period and catch rate correlation showed a negligible value of R^2 = 0.15 (**Fig. 7**). In terms of species composition, the total catch was classified into two (2) genus, *i.e.* Heterocarpus and Plesionika, and 10 possible species, namely: *Heterocarpus dorsalis* (Bate, 1888), *H. gibbosus* (Bate, 1888), *H. hayashii* (Crosnier 1988), *H. laevigatus* (Bate, 1888), *H. parvispina* (Crosnier 1988), *H. sibogae* (De Man, 1917), *H. woodmasoni* (Alcock, 1901), *Heterocarpus* spp., *Plesionika edwardsii* (Brant 1851), and *Plesionika* spp., although only three species were found to be well-distributed in the study

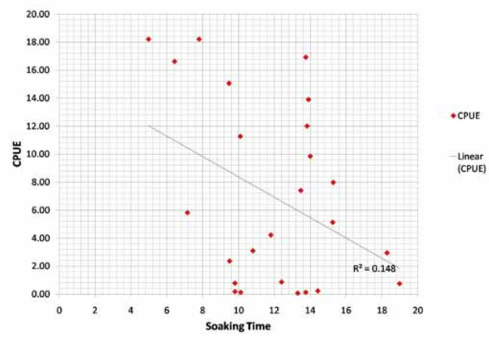


Fig. 7. Relationship between catch rate and soaking period (hours)

area. These are: *Heterocarpus hayashii*, *H. dorsalis* and *H. laevigatus*.

The computed SDI value reflects moderately high diversity with moderately low evenness, suggesting further about four (4) dominant species in the overall catch (**Fig. 8**). Relative to their abundance in the total samples (**Fig. 9**), the four dominant species were *Heterocarpus hayashii* (37.3%), *H. dorsalis* (27.6%), *H. gibbosus* (14.8%), and *Plesionika* spp. (10.7%).

The species composition and abundance at different fishing zones and columns are shown in **Fig. 10**. Specifically, *Plesionika* spp. was the major species found in Batangas/Mindoro waters, *Heterocarpus dorsalis* at the Approaches of Manila Bay and Bataan, and *H. hayashii* in Zambales, Pangasinan/La Union and Ilocos waters. With regards to species distribution by depth, *Plesionika* spp. dominates in waters <100 to 200 m, *H. hayashii* from 300 to 500 m, and *H. dorsalis* at 600-800 m. It was also noted that *H. parvispina* and *H. woodmasoni* peak at 200 m, *Plesionika edwardsii* at 300 m, *H. laevigatus* at 400 m, *H. gibbosus* at 400-500 m and *H. sibogae* at 600 m.

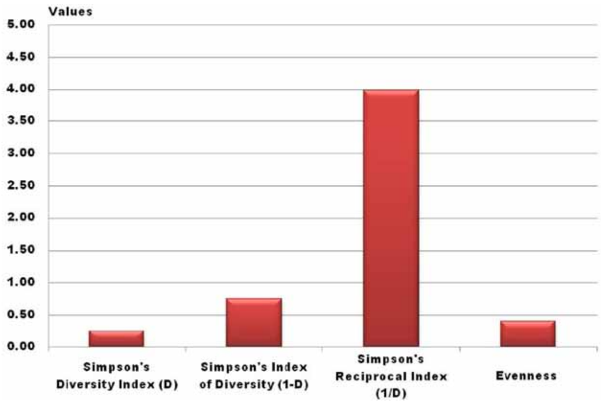


Fig. 8. SDI of Pandalidae species in West Philippine Sea

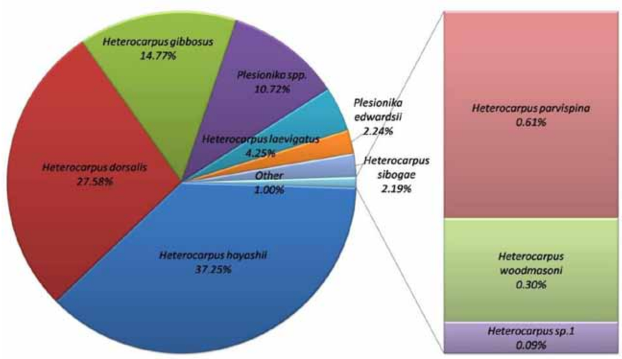


Fig. 9. Relative composition (%) of Padalidae species catch

The species diversity index analysis at different fishing zones revealed high in Batangas/Mindoro waters with about four (4) dominant species (*Plesionika* spp., *Heterocarpus dorsalis*, *H. hayashii*, and *H. laevigatus*) but lowest in Pangasinan/La Union waters with at least two (2) dominant species (*H. hayashii* and *H. dorsalis*). In terms of water depth, highest diversity was observed at 400-500 m with about three (3) dominant species (*H. hayashii*, *H. gibbosus* and *H. dorsalis*) and lowest at <100 m and 600 m with only one (1) species (*Plesionika* spp. and *H. dorsalis*) dominating, respectively (**Fig. 11**).

A possible reason for the higher species diversity in Batangas/Mindoro waters could be the wider depth range of the area as indicated in **Fig. 12**. The particular dominant species in certain fishing area could have also been contributed by the incidence of sampling and the depth deployment (zonation).

Conclusion

Based on the results of the study, the recorded catch rate of deep-water shrimps in West Philippine Sea was influenced by the zonation of the species. The observed high catch rate in Zambales waters was brought about by the depth deployment of traps along this area (400-500 m) which was at the column observed with the highest

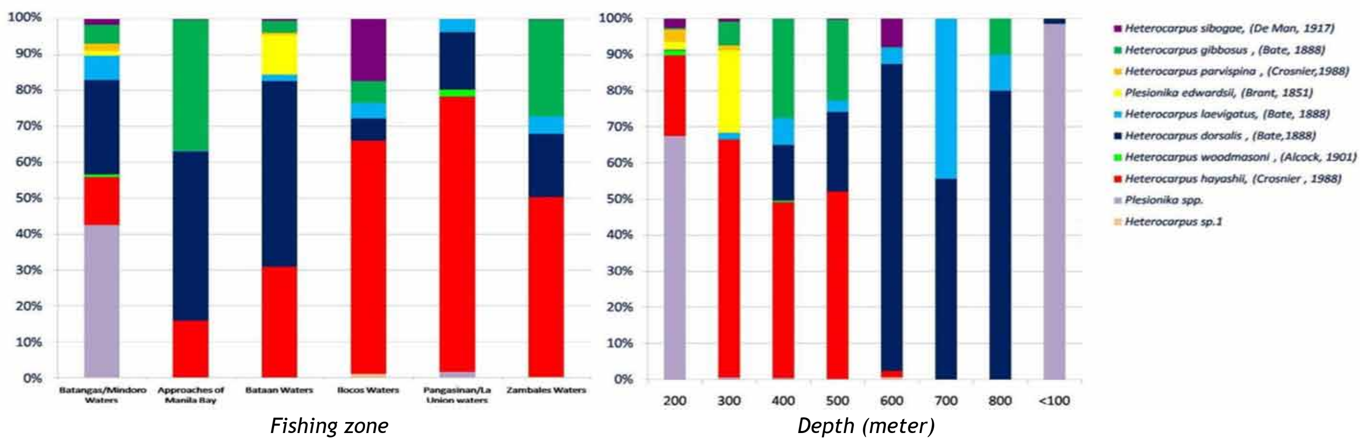


Fig. 10. Composition, percentage abundance, and distribution of Pandalid shrimps at various fishing zones and depths

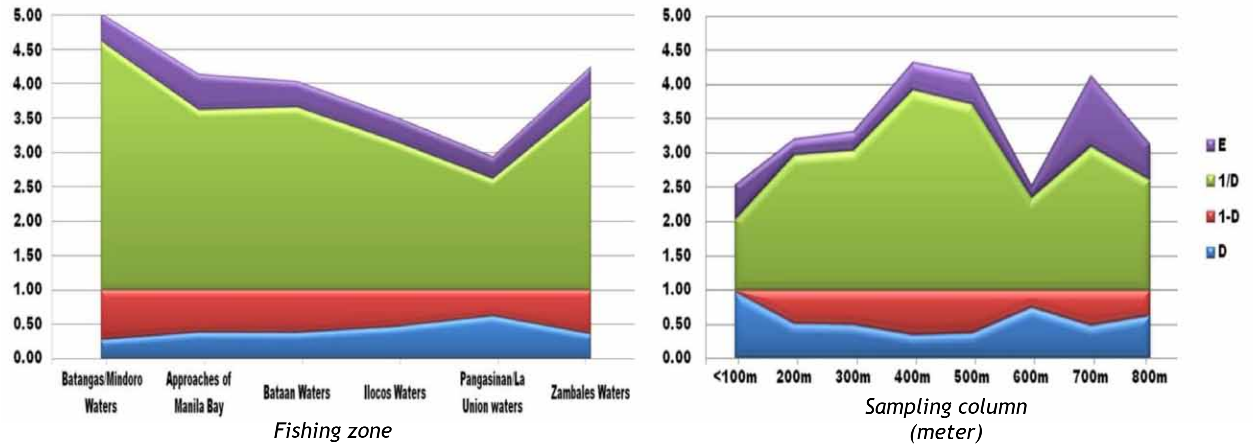


Fig. 11. Species diversity indices of Pandalid shrimp species at fishing zones and sampling columns

species diversity index. The species observed to abound at these layers were also larger compared to those recorded at shallower depths (<100-300 m). Nevertheless, in spite of the observed decreasing trend of catch rate when immersion time was prolonged, the resulting correlation value indicated negligible relationship. Therefore, catch rate was largely influenced by the abundance of the shrimps according to their zonation. Thus, given the appropriate depth deployment, good catch could be achieved.

Way Forward

Deep-water shrimp (Pandalidae) has a great potential for fisheries development in West Philippine Sea. Nonetheless, an appropriate and concrete framework should be designed to sustainably manage this resource. It should be noted that these shrimps are deep-water species with different biology from the cultured species such as the *Penaeus* spp., so that exploitation that goes beyond their capacity to reproduce could lead to extinction. Furthermore, prior to possible introduction of deep-water shrimps to the market, the biochemical composition (*e.g.* nutritive value and possible allergen content) of the species should be assessed while techniques for post-harvest handling should be developed to prolong the shelf life of this species of shrimps.

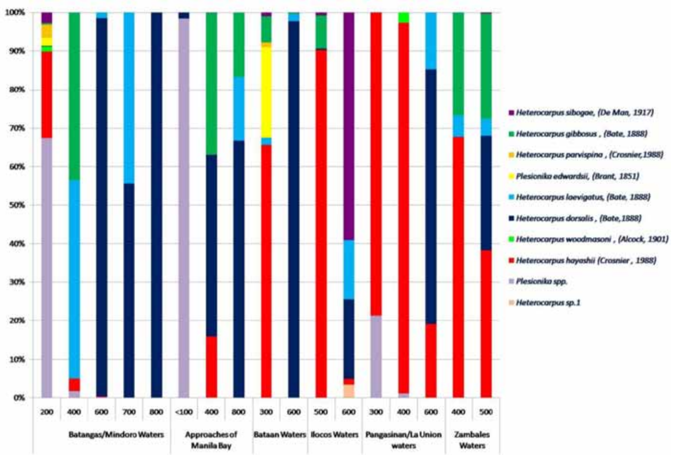


Fig. 12. Relative abundance (%) of the species monitored from sampling depths in the different fishing zones

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Appropriate Fishing Depths for Squid Longline Fishery in the Gulf of Tonkin, Vietnam

Nguyen Quoc Khanh, Tran Duc Phu, Nguyen Trong Luong and *Audrey A. Opoku-Acheampong*

Introduced before the end of 2012, squid longline fishery is a new industry in the Gulf of Tonkin of Vietnam, harvesting as much as 68 kg of the highly priced species per single set of longlines. The main products of this fishery are the cuttlefish (65%), squid (33%), and others (2%). Facing the northern part of the country, the Gulf of Tonkin which has a total area of 126,250 km^2 is shared between Vietnam and China, and is one of the most productive fishing grounds of Vietnam.

Vietnam has a coastline of 3,260 km and its Exclusive Economic Zone spans over an area of more than 1.0 million km^2. Based on its natural characteristics, the sea area of Vietnam is divided into four regions, namely: northern, central, southeast and southwest region (SEAFDEC, 2002). The northern region is most suitable for bottom trawl fisheries, while the central region with very narrow trawlable area is suitable for pelagic fisheries using purse seines, long lines and gillnets. The southeast and southwest regions are similar to that of the northern region, thus, are also suitable for bottom trawl fisheries that exploit pelagic and demersal fishes.

Marine Capture Fisheries of Vietnam

The total fisheries production of Vietnam in 2011 accounted for 16% of the total fisheries production of the Southeast Asian region, and seemed to continue increasing during the five-year period from 2007 to 2011 (**Table 1**). However, such fisheries data have been compiled without classifying by species, so that the country's actual production of cuttlefish and squid could not be determined.

Gulf of Tonkin

The marine fishing areas of Vietnam (SEAFDEC, 2008) are under Area 71 (Pacific, Western Central) and Area 61 (Pacific, Northwest), and the Gulf of Tonkin which embraces the northern region of the country's sea waters is under marine fishing areas 61a and 61b. Shared with China, the Gulf of Tonkin's total area of 126,250 km^2 is divided into two areas: the 67,203 km^2 area belongs to Vietnam (about 53% of the total area) while China owns the remaining 47% or 59,047 km^2 (National Assembly, 2004). This sharing was based on the Agreement on the Delimitation of the Territorial Seas, Exclusive Economic Zones and Continental Shelves in the Gulf of Tonkin between the People's Republic of China and the Socialist Republic of Vietnam signed on 25 December 2000. Ten provinces of Vietnam border the Gulf of Tonkin, namely: Quang Ninh, Hai Phong, Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, and Quang Tri (**Fig. 1**).

The Gulf of Tonkin is bordered in the west by the northern coastline of Vietnam, in the north by China's Guangxi Province and to the east by China's Leizhou Peninsula and Hainan Island. It is also considered as a northern arm of the South China Sea. The Gulf of Tonkin envelops more than 1,960 islands, and with the Red and Thai Binh Rivers emptying into the Gulf, an abundant biodiversity area is created with living and non-living marine resources (RIMF, 2006). Previous research indicated the existence of 960 fish species in this area belonging to 475 genus and 162 families and comprising about 80% demersal and 20% pelagic fishes. Although some fishes (20%) inhabit only the offshore areas

Table 1. Fisheries production of Vietnam (in mt)

	2007	2008	2009	2010	2011
Fisheries Production of Vietnam	**4,315,500**	**4,559,720**	**4,782,400**	**5,127,600**	**5,432,900**
Marine capture fisheries	1,987,400	1,946,600	2,098,300	2,226,600	2,300,000
Inland capture fisheries	133,600	144,800	144,800	194,200	202,500
Aquaculture	2,194,500	2,468,320	2,539,300	2,706,800	2,930,400
Fisheries Production of Southeast Asia	**25,302,870**	**27,207,826**	**28,917,096**	**31,438,435**	**34,036,431**
Marine capture fisheries	14,056,983	13,814,368	14,140,387	14,874,445	15,095,450
Inland capture fisheries	2,008,301	2,329,524	2,397,273	2,377,253	2,641,094
Aquaculture	9,237,586	11,063,934	12,379,436	14,186,737	16,299,887
Percent of Vietnam's Production to the region's	**17.1**	**16.8**	**16.5**	**16.3**	**16.0**

Source: *Fishery Statistical Bulletin of Southeast Asia 2011 (SEAFDEC, 2013)*

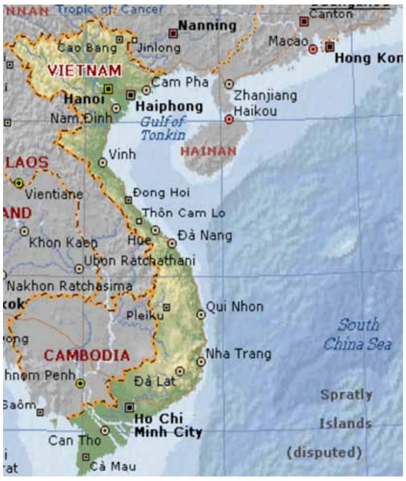

Fig. 1. Gulf of Tonkin shared by Vietnam and China

most fishes (80%) are found in coastal areas (RIMF, 2006). As a major fishing ground in Vietnam, the Gulf of Tonkin is known to hold a total marine fishery resources of about 681,200 metric tons (mt), of which the annual allowable catch is 272,500 mt including about 4,700 mt of squid and cuttlefish (Đặng Văn Thi, 2006). The number of fishing boats in the ten provinces that border the Gulf of Tonkin was recorded at 36,965 with total horse power (hp) of 1,240,383.

The average horse power per fishing boat of only 33.6 hp/boat implies that small-scale fisheries are a typical feature of these provinces. However, this area hosts multiple fisheries comprising 24 types, where trawl represents about 46%, gillnet accounts for 38%, stick-held falling net 11%, and other fisheries accounting for the remaining 5% (Trung and Tinh 2012). The Gulf of Tonkin is also the main fishing ground of longline fishers to capture of squid and cuttlefish especially around Bạch Long Vĩ Island, a common fishery zone between Vietnam and China. The main fishing seasons for squid and cuttlefish are in December to April (north season) and June to September known as south season (Đặng Văn Thi, 2006).

Squid Longline Fishery in Vietnam

Squid and cuttlefish are very sensitive to changes in environmental conditions such as weather, hydrography and light, and are usually submerged in seabeds during the day but surface at night depending on temperature and available light (FAO, 1986). Squid longline fishery practiced by fishers in Ba Ria-Vung Tau, Kien Giang and Ca Mau Provinces in Southeast Vietnam since 2009, was found to be highly profitable to fishers, earning for them an average income of 12.7-17.0 million VND/person/month (1 USD = 20,920 VND), a considerably huge amount for many fishers. Moreover, squid longline fishery requires low cost investment and utilizes simple fishing technology and few boat crew members while fishing can be done both day and night. The main target species are cuttlefish and squid, which are highly economic value species and commonly consumed domestically. Squid longlining is a highly selective fishery, so it contributes to fisheries resources protection and conservation (Hoàng Văn Tính, 2012). However, squid longlining is still new to the northern region of Vietnam having been introduced for the first time in the Gulf of Tonkin at the end of 2012 (Quang Ninh SDCFRP, 2013), thus, the method is still being improved by fishers in the Gulf.

The Survey

In order to determine the suitable fishing depths for squid longlining to improve fishing efficiency and increase the catch of cuttlefish and squid, a survey was conducted in the Gulf of Tonkin (**Fig. 2**) from October to December 2012. The survey was aimed at identifying the relationship between fishing depths and yields in squid longline fishery in the Gulf. Changes in tide patterns and the uneven seabeds of the Gulf of Tonkin were taken into account during the survey, so that the "fishing depth" was calculated from the seabed to the surface. Two fishing boats that exploit the southern part of Bạch Long Vĩ Island, served as the sample units (**Box 1**).

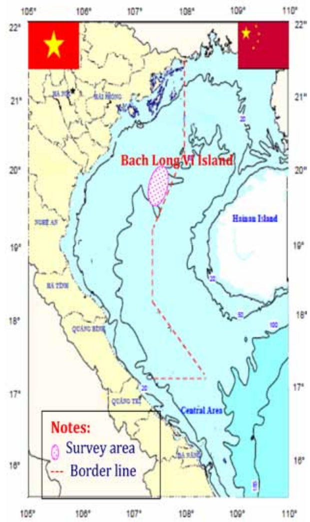

Fig. 2. Gulf of Tonkin showing the survey area

Box 1. Characteristics of the fishing boats sampled in the Gulf of Tonkin

	Fishing Boat 1	Fishing Boat 2
Basic features of fishing boats		
- Registration number	QN90183TS	QN90256TS
- Length of boat (m)	13.0	14.5
- Breadth of boat (m)	4.1	4.2
- Depth of boat (m)	1.6	1.75
- Engine capacity (hp)	130	90
- Number of crew	5	5
Information on longline used		
- Length of main line (m)	20,000; Material: PA ϕ 1.0	20,000; Material: PA ϕ 1.0
- Length of branch line (m)	25; Material: PA ϕ 0.8	25; Material: PA ϕ 0.8
- Number of artificial bait	1,200	1,200
- Length of brail line (m)	25; Material: PE ϕ 2.0	25; Material: PE ϕ 2.0
-Number of buoys	1,200; Material: PVC	1,200; Material: PVC

With 95% confidence interval, the total number of sampling was calculated, using the equation: $n = \frac{C}{(\Delta/\sigma)^2}$ (Israel, 2000), where n = the number of samples, C = constant that is identified from error I and II, Δ = acceptable error, and σ = standard deviation (SD). With acceptable error Δ = 4 kg (about 5% products of a single longline set), σ = 13.45 and Power = 95%.

Using R software (Nguyễn Văn Tuấn, 2008), n was calculated by: $n = \frac{C}{(\Delta/\sigma)^2} = 148$ (samples),

and to improve confidence of the research, 10% sampling numbers was added 148 + 10% x148 = 162 samples.

Since the survey was carried out at different depths, the lengths of the brail and branch lines were so-determined that their total lengths were equal to the sea depths. Using Echo-

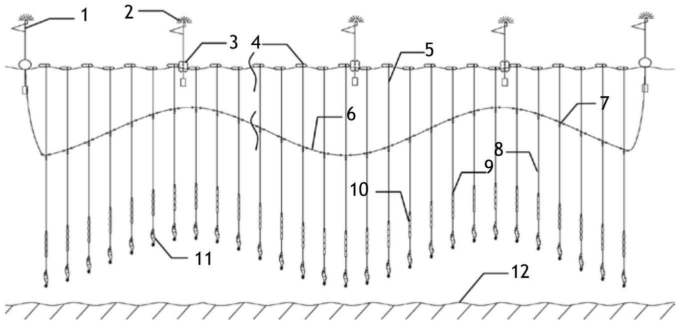

Fig. 3. Set up of the squid longline: (1 - flag pole; 2 - light pole; 3 - buoy flag; 4 - buoys; 5 - brail line; 6 - main line; 7 - swivel snap; 8 - branch line; 9 - swivels; 10 - sinker; 11 - artificial bait; 12 - sea bed)

sounder, the depths at each fishing time were determined and based on such fishing depths, the suitable depths of the artificial bait were adjusted (**Fig. 3**). Branch lines were fixed while brail line and adjusted so that squid longline had a sinusoidal shape (**Fig. 3**). The first artificial bait was placed at a distance of 1.0 m from the seabed and the eighth artificial bait at the farthest or 8.0 m from the seabed. Each fishing depth was color-coded to facilitate easy counting of the number of individual species caught.

Measuring the length of squid and cuttlefish

The cuttlefish and squid were weighed and measured while the corresponding fishing depths from where they were caught were also recorded, and the relationship between the catch, length of cuttlefish and squid caught, and fishing depth was determined. Using a special ruler, the lengths of squid and cuttlefish were measured for their lengths expressed in terms of mantle lengths (**Fig. 4**).

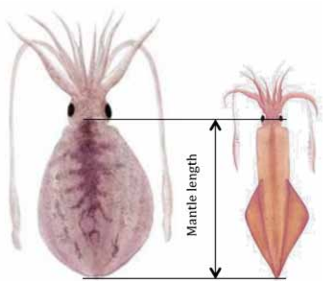

Fig. 4. Measuring cuttlefish (left) and squid (right)

In accordance with Vietnam's Circular No 02/2006/TT-BTS, the minimum allowable landing sizes of cuttlefish and squid should be 120 mm and 200 mm, respectively (Tạ Quang Ngọc, 2006). The 162 catches sampled from a single set and the corresponding fishing depths are shown in **Table 2**. At the end of the survey using 162 single set of squid longline, the results indicated that the main target species caught were cuttlefish (64%), squid (33%), and other species (3%), and that cuttlefish and squid are distributed at depths between 1.0 to 3.0 m (from the seabed).

Considering the biological characteristics of cuttlefish and squid that swim upward the water surface at night and downward to the seabed during the day, high quantity (average 28.0 kg/single set) was caught at fishing depth of 2.0 m while at 6.0 m no cuttlefish and squid were caught. The standard deviation of the catch ranging from 0.0 to ± 4.84 implies that there were no differences in catch in the survey areas, which is favorable for the development of squid longline fishery in the Gulf of Tonkin. Nevertheless, it should also be noted that the sizes of cuttlefish and squid caught also depend on the fishing depths (**Table 3**). The species caught farther from the seabed were small in size, in accordance with the biological characteristics of cuttlefish and squid (FAO, 1986). The length of cuttlefish caught

Table 3. Relationship between length of squid and cuttlefish and fishing depths

Main species / Fishing depth (m)	Cuttlefish		Squid	
	Average length (mm)	Number of sampling (individual)	Average length (mm)	Number of sampling (individual)
0	0		0	
1	150.92 ± 14.2	537	241.60 ± 18.1	180
2	149.68 ± 16.1	724	239.71 ± 17.6	151
3	148.71 ± 16.4	417	237.84 ± 16.8	148
4	101.03 ± 13.4	318	160. 82 ± 15.6	111
5	92.01 ± 0.7	202	140.21 ± 16.1	12
6	0	-	0	-

Table 2. Catch of cuttlefish and squid in different fishing depths (kg/single set) during the survey

Fishing depth (m)	Cuttlefish					Squid					Others		Total average catch (kg)
	Max. catch (kg)	Average catch (kg)	Min. catch (kg)	SD	Rate (%)	Max. catch (kg)	Average catch (kg)	Min. catch (kg)	SD	Rate (%)	Average catch (kg)	Rate (%)	
0	0.00	0.00	0.00	± 0.00	0.00	0.00	0.00	0.00	± 0.00	0.00	0.00	0.00	0.00
1	20.00	12.49	7.00	± 2.39	66.19	11.00	6.33	2.00	± 2.09	33.54	0.05	0.26	18.87
2	28.00	18.91	11.00	± 4.07	67.18	16.00	8.64	1.00	± 3.18	30.69	0.60	2.13	28.14
3	18.00	9.70	2.00	± 4.84	62.76	13.00	5.45	1.00	± 2.65	35.30	0.30	1.94	15.45
4	6.00	2.13	0.00	± 1.58	56.53	7.00	1.24	0.00	± 1.87	32.84	0.40	10.62	3.76
5	2.00	0.60	0.00	± 0.50	42.26	4.00	0.48	0.00	± 0.81	33.79	0.34	23.95	1.42
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	100	0.28
Total	**74.00**	**43.83**	**20.00**	**-**	**64.51**	**51.00**	**22.14**	**4.00**	**-**	**32.59**	**1.97**	**2.90**	**67.92**

during the survey ranged from 92.0 to 151.0 mm, of which 90% were longer than 120.0 mm, the minimum allowable landing size. Meanwhile, the average length of squid caught ranged from 140.0 to 241.0 mm, of which about 88% were longer than the minimum allowable landing size of 200.0 mm. Although squid longlining is a highly selective fishery, the fishers should comply with the allowable catch for squid and cuttlefish in accordance with the applicable regulations of the Ministry of Agricultural and Rural Development (Tạ Quang Ngọc, 2006).

Discussion and Conclusion

Although the potential of squid fishery in the Gulf of Tonkin appears good, the resources had not yet been properly exploited since squid longlining is still new in the north of Vietnam. While fishers continue to use non-selective fishing gear, such as trawl, drop net and stick-held falling net to capture such economically-important species, the country's fisheries management departments in particular and the Government of Vietnam in general, should craft and implement policies for the development of squid longline fishery in the Gulf of Tonkin to address the impacts of the fishery on the squid and cuttlefish resources, and promote the resources' protection and conservation. Many fishers reported that the sudden swarming of globefishes or puffer fishes in the Gulf of Tonkin had caused damages to the main and branch lines of the longline sets as the globefishes keep on biting the lines due to the twinkling and attractiveness of the artificial baits. During the survey, each single set was constantly changed and supplemented with at least 50-60 new artificial baits, increasing the cost of fishing operations and resulting in wastage of time and manpower. It is therefore necessary to conduct a research to improve the structure of the squid longline and the operation techniques to make squid longline fishery suitable for various types of fishing grounds especially in the Gulf of Tonkin as well as minimizing the cost of fishing while improving the efficiency, taking into consideration the fact that squid longlining is highly selective, and present practices result in the catch of about 90% that were greater than the minimum allowable fishing size (120 mm for cuttlefish and 200 mm for squid). Nevertheless, the almost uniform catches of squid and cuttlefish in the survey areas could mean that cuttlefish and squid densities are almost evenly distributed in the offshore areas of the Gulf of Tonkin. As observed, farther up from the seabed, the sizes of squid and cuttlefish seem to decrease, while cuttlefish and squid surround the seabed during the day, therefore, the most suitable fishing depth is at a distance of 1.0 to 3.0 m from the seabed, although the fishing depths could fluctuate between 1.0 and 3.0 m from seabed to the water surface. It should also be considered that it was at fishing depth of 2.0 m where the maximum catch of 24.2 kg/single set of the high-value species, was produced during the survey.

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Monitoring the Undulated Surf Clam Resources of Thailand for Sustainable Fisheries Management

Isara Chanrachkij

Undulated surf clam, *Paphia* spp. (Born, 1778) is one of the most economically-important marine resources of Thailand. Starting in 1973, the Department of Fisheries (DOF) of Thailand has been reporting the harvest of undulated surf calm in its fishery statistics. Although in the early days, undulated surf clam was not among the favorite marine seafood of Thai consumers, but after the emergence of processed products since 1977, *e.g.* canned and frozen clams in domestic and export markets, the demand of undulated surf clam increased not only as local seafood but also as raw materials for the clam processing industry of Thailand. Statistical reports indicated that in 2009, Thailand produced 17,763 metric tons (mt) of undulated surf clam valued at approximately USD 7.0 million, while the export value of processed clam products amounted to USD 20.0 million.

In the past, undulated surf clam was harvested in the Gulf of Thailand by manual collection, diving, and digging including the use of a hand dredge with pole without fishing boats. As fishing technology for the undulated clam resources developed in the mid 1900s, the hand dredge was replaced with iron dredge using motorized fishing boats. This development led to the expansion of undulated surf clam fisheries not only in the Gulf of Thailand but also in the Andaman Sea of Thailand, and to the enhanced efficiency of dredge fishing as the number of fishing boats increased as well as the size of boat engines. The expanded size of dredges came with it the reduced intervals of the dredges' slit.

The most serious problem of undulated surf clam fisheries of Thailand at present is the fluctuations in landings to supply the needed raw materials for processing. This is brought about by massive damage of parental stocks and harvest of pre-juvenile clams for raw materials in canneries, causing severe impacts on the consumers as well. Aside from the negative impacts of dredge fishing operations on the marine ecosystem and environment, conflicts between undulated surf clam dredge fishers and local fishers who harvest other fisheries resources in the same fishing ground had also occurred. As a consequence, the social and economic impacts on the coastal fishers had worsened and management of the fisheries resource has become difficult to undertake. In order to develop measures for sustainable dredge fisheries management, a review of the fisheries of undulated surf clam in Thailand was carried out, including the fishing grounds and fishing techniques. Results of such study could supplement other studies related to the environmental impacts of undulated surf clam fishing operations, as well as other efforts relevant to the development of management measures for dredge fisheries and effective coastal fisheries management.

Undulated Surf Clam Fisheries in Thailand

Face-to-face interview was carried out focusing on the details of the dredge fishing technology. With targeted fishing gears already recognized, the details related to the fishing practices, fishing seasons, fishing grounds, and cost of dredge fishing gear were gathered during the interview with master fishers, fishers and fishing boat owners in the coastal provinces of Samut Prakan, Samut Sakhon, and Petchaburi (**Fig. 1**) in the Gulf of Thailand. The construction and design of the iron dredge were also examined including the materials and fishing techniques used, through actual observation in fishing ports and fishing boats (Isara *et al*., 2009).

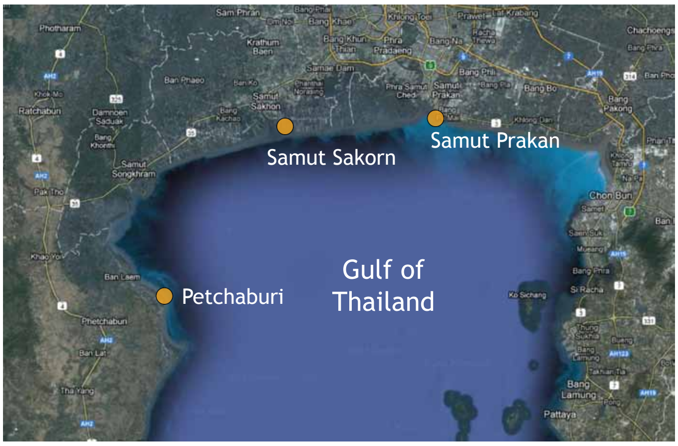


Fig. 1. Interview sites in the Upper Gulf of Thailand

Undulated surf clam species in Thailand

The species of undulated surf clam in Thailand (**Fig. 2**) are also referred to as undulated clam, short-necked surf clam, surf clam, carpet clam, and Venus shell, although processing industries call it by its commercial name "baby clam", and *asari* for the export product as recorded by the Customs Department of Thailand. Specifically, the three main species are: *Paphia undulata* (Born, 1778), *P.*

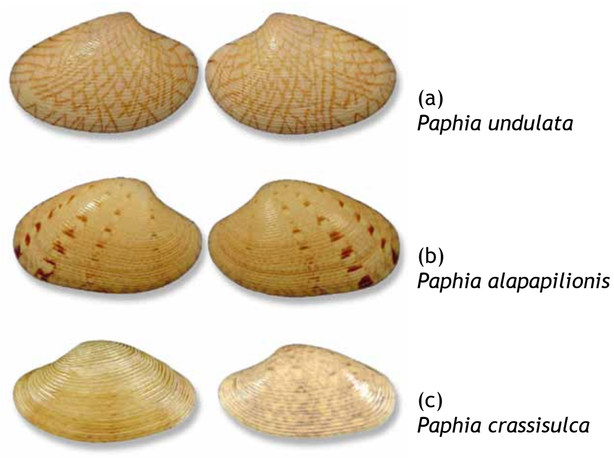


Fig. 2. Common undulated surf clam in Thailand
Sources: (a) and (b) R. Vega-Luz (2005); (c) G. Poope and P. Poope (2012)

alapapilionis (Röding, 1798) and *P. crassisulca* (Lamarck, 1818), and the most dominant economic species in the country, the *P. undulata* (Born, 1778).

General physiological and biological characteristics of undulated surf clam in Thailand

The shell of undulated surf clam is egged-shape, brownish in color, thin and symmetrical between the upper and lower shell. Undulated surf clams are plankton feeders and are suspended-feeder species, feeding on plankton, suspended solids and other microorganisms. As filter feeders, water and food are suctioned through their filter organs. Undulated surf clams have gills called lamellibranch for efficiency in filtering food and exchanging gas. Growth and reproductive biological studies revealed different biological, growth and reproductive information on the undulated surf clam species found in Thailand, varying by type of habitats (Bumrungsak, 1983; Pairaw and Sunan, 1993; Jintana, 2000). The highest growth coefficient of 1.74 per year was recorded in Surat Thani Province but in the other areas growth coefficient was almost 0.90 per year as shown in **Table 1**.

Table 1. Growth coefficients (K) and maximum length of undulated surf clam (L_∞)

Fishing ground	K	L_∞	Source
Ao Trat Bay, Trat Province	0.94	6.35	Bumrungsak (1983)
Mahachai Bay, Samut Sakhon Province	0.98	5.90	Jintana (2000)
Ban-don Bay, Surat Thani Province	1.74	5.30	Jintana (2000)
Phangnga Bay, Phangnga Province	0.92	6.30	Pairaw and Sunan (1993)

Moreover, the length of the first maturity (L_0) measured by the length of shell showed that the L_0 of undulated surf clams in Thailand collected around Trat Province had the highest at 40.1 mm in male and 42.5 mm in female. The

Table 2. Comparison of the length at first maturity (L_0) of undulated surf clam found in Thailand

Fishing ground	Length at first maturity (mm)		Source
	Male	Female	
Trat Province	40.1	42.5	Bumrungsak (1983)
Mahachai Bay, Samut Sakhon Province	23.0	23.8	Jintana (2000)
Ban-don Bay, Surat Thani Province	29.1	30.6	Jintana (2000)
Phangnga Bay, Phangnga Province	14.3 (not classified by sex)		Pairaw and Sunan (1993)

shortest at 23.0 mm in male and 23.8 mm in female was recorded in Ao Mahachai Bay of Samut Sakhon Province (**Table 2**).

Furthermore, the reproductive season of the undulated surf clams in Thailand has two periods, namely: February-May and August-November (**Table 3**), although Jintana (2000) reported that the undulated surf clam habitat around Ao Mahachai Bay of Samut Sakhon Province has only one reproductive period, *i.e.* August-October. In the other habitats sampled, different reproductive seasons were recorded although some researchers presumed that the phenomenon of Ao Mahachai Bay of Samut Sakhon Province occurs due to the massive freshwater runoff from Tachin River annually in November causing mass mortality of the undulated surf clams, while the remaining parental stocks may not be sufficient enough to reproduce during the period from February to May (**Table 3**).

Although undulated surf clam is not yet commercially cultured in Thailand, studies on breeding and nursery had been carried out by the DOF of Thailand. Nuanmanee (1988) specifically established that the development after fertilization to swimming blastula stage (cilia development) takes 2:30 hours (**Fig. 3**). The development after fertilization to trochophore stage takes 5 hours, while from fertilization to D-shape stage takes 12 hours, and to umbo stage at 120 hours (5 days). The development after fertilization to pediveliger stage (foot is developed for

Table 3. Reproductive seasons of undulated surf clam in the Gulf of Thailand and Andaman Sea

Fishing ground	Reproductive Season		Source
	First period	Second period	
Trat Province	April-May	August-November	Bumrungsak (1983)
Mahachai Bay, Samut Sakhon Province	None	August-October	Jintana (2000)
Ban-don Bay, Surat Thani Province	January-March	September-November	Sunan *et al.* (1987)
Phangnga Bay, Phangnga Province	March-May	August-November	Pairaw and Sunan (1993)

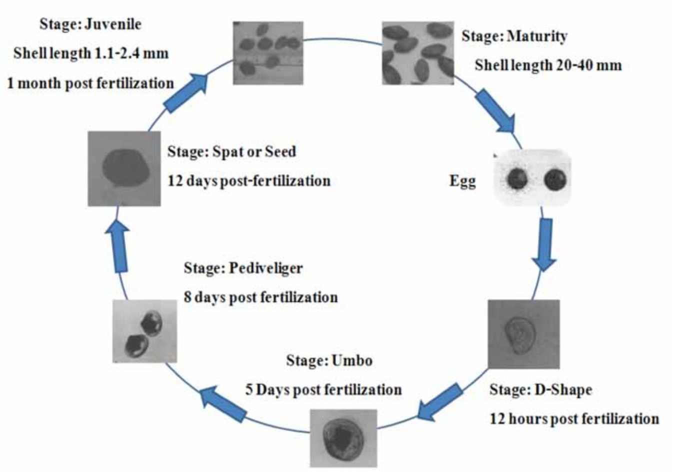


Fig. 3. Life cycle of undulated surf clam
Source: Redrawn from Nuanmanee (1988)

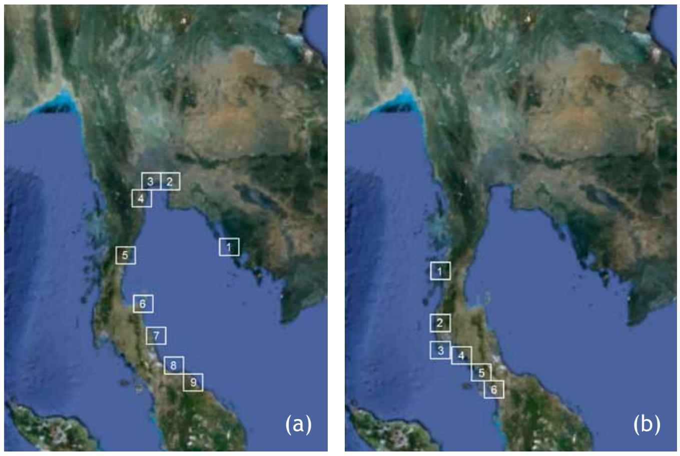


Fig. 4. Major fishing grounds for undulated surf clam in the Gulf of Thailand (a); and the Andaman Sea (b)

crawling in sea beds) takes 8 days, while after fertilization through metamorphosis process to spat or seed stage takes about 12 days. The length of juveniles at about 1 month old is 1.7-2.4 mm (average 2.4 mm) and at 3 months is 7.0-13.0 mm (average 10 mm). The size most suitable for releasing to natural waters is 10-30 mm in shell length.

Fishing grounds for undulated surf clam in Thailand

Undulated surf clam is a benthic organism that lives from the bottom surface to 20 cm deep under the bottom surface, where the sea bottom is characterized is soft-muddy (Jittima, 2001). In Thailand, undulated surf clam habitats are found around estuaries and river mouths at sea depth ranging from 3 to 15 m. In an analysis of the sediment samples of undulated surf clam fishing ground in Trat Province, Sunan *et al.* (1987) revealed that the bottom sediment inhabited by the undulated surf clam is high in nutrients, with average total organic matter (TOM) of 2.06-3.23% (Natural TOM is 2.0-2.5%) and the composition of bottom sediments is about 44.4% silt, 38.3% clay, and 17.3% sand.

Results of catch landing and exploration surveys of the fishing grounds for undulated surf clam in the Gulf of Thailand and Andaman Sea were compiled by the DOF of Thailand (1992 and 2003) and summarized in **Box 1** and **Box 2**, respectively. Nine major fishing grounds for the undulated surf clam have been identified in the Gulf of Thailand, specifically in the Provinces of (1) Trat, (2) Samut Prakan, (3) Samut Sakhon, (4) Samut Songkhram, (5) Prachuap Khiri Khan, (6) Surat Thani, (7) Nakhon Si Thammarat, (8) Songkhla, and (9) Pattani (**Fig. 4a**). In the Andaman Sea, the six major fishing grounds are found in the Provinces of (1) Ranong, (2) Phangnga, (3) Phuket, (4) Krabi, (5) Trang, and (6) Satun (**Fig. 4b**).

Physico-chemical information on the habitats of undulated surf clam in Thailand

Sea surface temperature and water salinity

Aneg *et al.* (2007) explained that salinity of the Gulf of Thailand is influenced by monsoon, freshwater runoff and seasonal current, and that the salinity range in the Gulf of Thailand could range from 22.1 to 36.5 parts per thousand (ppt) with an average of 31.2±1.3 ppt. Results of laboratory experiments conducted by Chalanda (2009) revealed that clams started dying at sea temperature of 39°C and all clams died at 42°C. Results of other studies (Munprasit and Sasaki, 1991) on the salinity tolerance of undulated surf clam also showed that clams with average size of 3.4 cm in shell length and 3.9 g in weight, showed 50% survival in 21.0 ppt salinity, while those with average size of 4.5

Table 4. Sea surface temperature and salinity of important undulated surf clam habitats in Thailand

Undulated surf clam habitats	Range of sea surface temperature (°C)		Range of salinity (ppt)	
	Min	Max	Min	Max
Ao Trat Bay, Trat Province	22.0	33.0	13.0	35.0
Klong-darn District, Samut Prakan Province	26.4	32.1	17.0	33.1
Mahachai Bay, Samut Sakhon Province	24.0	34.0	10.1	32.1
Pranburi Estuary, Prachuap Khiri Khan Province	29.3	32.4	27.5	30.5
Ban-don Bay, Surat Thani Province	26.0	31.2	30.0	33.0
Moo Koh Ang-thong Archipelago, Surat Thani Province	30.2	31.0	34.0	35.0

Sources: *Summarized from DOF of Thailand (1992) and PCD-Thailand (2007)*

Box 1. Fishing grounds for the undulated surf clam: Gulf of Thailand
Trat Province: With total area of approximately 132.0 km², the fishing ground in Trat Province is separated into three areas, namely: Ao Trat Bay; front of Klong-yai District which is contiguous with Ao Trat Bay; and a new fishing ground in Laem Ngob District. SEAFDEC/TD (2007) also observed the presence of dredge fishing gear for undulated surf clam in Koh Kong Island of Cambodia and presumed that the fishing ground around Trat Province is contiguous into the Cambodian Exclusive Economic Zone (EEZ) but clam fishing is conducted by Cambodian fishers in Koh Kong Island. Tien *et al*. (1983) reported that catch of undulated surf clam could be landed during two periods, *i.e.* January to April, and September. The average catch per unit effort (CPUE) ranged from 630 to 1,312 kg/day/fishing boat, with February having the highest catch rate at 1,312 kg/day/fishing boat and the lowest in September at 630 kg/day/fishing boat. In Laem Ngob District, a catch rate of approximately 1,500 kg/day/fishing boat was recorded in 1988. Report of the DOF of Thailand (1992) on the status of undulated surf clam resources survey around Ao Trat Bay in 1987 and 1989, showed a deterioration of the fishing ground conditions due to heavy harvesting during the fishing season in 1986 and 1988. In Ao Trat Bay, the resource had decreased by about 1.4 kg/km² in 1987 and by 38.7 kg/km² in 1989. Similarly, in Klong-yai District deterioration of the fishing ground condition was noted, and the resource decreased by 27.0 kg/km² in 1987 and by 75.6 kg/km² in 1989. The fishing ground in Kho Hua-maew which had not been exploited by commercial dredgers until 1986, the resource was about 1,624.5 kg/km².
Samut Prakan: The fishing ground around Samut Prakan Province covers the area from Bang-pra-kong Estuary to Chaophraya Estuary, and a total area of approximately 144 km² with sea depth that ranges from 3 to 12 m. Results of DOF of Thailand survey in 1987 and 1988 indicated that the CPUE in shallower waters less than 4.0 m deep was 15 kg/hr and in waters between 4 and10 m deep was 5-15 kg/hr. The survey conducted in 1988-1990 showed that the highest CPUE was 1,000-4,975 kg/day/fishing boat recorded in January to February, while the lowest CPUE recorded in May to June was 228-590 kg/day/fishing boat.
Samut Sakhon: The fishing ground around Samut Sakhon Province covers from the western of Chaophraya Estuary to Ao Mahachai Bay, with total area of approximately 32 km², and depth between 3 and 12 m. Results of surveys by the DOF of Thailand on undulated surf clam resources in 1987 and 1988, showed that the CPUE in shallow fishing grounds 4-6 m deep on the western of Samut Sakhon was approximately 10-15 kg/hr and in fishing ground 6-8 m deep on the narrow area in front of Ban Saha-korn at approximately 15.0-20.0 kg/hr but at the same depth in the eastern part, the CPUE was less than 5.0 kg/hr. Fishing ground in front of Ban-mai, depth between 8 and 10 m, was approximately 10.0-15.0 kg/hr. Since Ao Mahachai Bay area is a nursery ground of this bivalve, dredge fishing by iron dredge has been prohibited as declared by the Ministry of Agriculture and Cooperatives on 17 June 1975. The regulation prohibits the use of iron dredges and all look-alike fishing methods with motorized vessel for the collection of all bivalve species in the area.
Samut Songkhram: The fishing ground around Samut Songkhram Province covers the area of approximately 56 km² from Mae Klong Estuary to Hard Chao-sam-ran Beach. Samut Songkhram is one of the undulated surf clam important landing sites of Thailand. Results of landing survey of undulated surf clam resources in Samut Songkhram and Petchaburi Provinces in 1988-1990 indicated that the highest CPUE was112-2,720 kg/day/fishing boat recorded from January to February, with the lowest CPUE of 80-115 kg/day/fishing boat recorded from March to May.
Prachuap Khiri Khan: DOF of Thailand (1992) demarcated the fishing ground around Prachuap Khiri Khan Province from Paknam Pranburi Estuary to Southern of Sattakud Island, for a total area of 61.5 km². Isara (2007) estimated that the density of undulated surf clam around Paknam Pranburi of Prachuap Khiri Khan Province during the pre-clam fishing season of 2007 was 2.5 mt/km², and the density of clam resources had reduced due the use of destructive dredging by 4.8 mt/km² around the fish ground and by 14.5 mt/km² around the conservation area of Paknam Pranburi coastal community. Restocking parental stock that had been destroyed would need at least 3 year to recover.
Surat Thani: The fishing ground around Surat Thani Province is vast with total area of 180.8 km². The area covered Moo Koh Angthong Archipelago, Tachana District, and Chiya District. Investigations by the DOF of Thailand showed that the CPUE in 1987 and 1988 around Ao Bandon Bay was less than 15 kg/hr in 1987. The CPUE increased to 46.8 kg/hr around Tachana District and 65.4 kg/hr around the central of Ao Bandon Bay. The DOF of Thailand also reported that the maximum and minimum production of undulated surf clam of fishing vessels from 1985-1991 was between 1,944 and 4,831 kg/day/fishing boat. Maximum production was recorded in March 1986 and 1987, October 1988, August 1990 and January 1991, while minimum production of 358-1,790 kg/day/fishing boat was noted in December of every survey year. In 2010, Surat Thani Provincial Office announced the zoning of the fishing ground around Surat Thani Province for sustainable management and utilization of the bivalves.
Nakhon Si Thammarat: DOF of Thailand (1992) demarcated the fishing grounds around Nakhon Si Thammarat Province that covers the area of Ao Nakhon Si Thammarat Bay and off Laem Talumpuk Cape, the distance from the coastline of which is 2-5 km and depth of 10-14 m, and total area of about 80 km². Results of investigation on the CPUE in 1986 by the DOF of Thailand in Ao Nakhon Si Thammarat Bay (from Ta-sa-la Disrtict to Pak-pa-ying District) revealed that the resource has been definitely deteriorating due to dredge fishing operations. However in 1987, DOF of Thailand discovered a new fishing ground off off Laem Talumpuk Cape, with a depth of 10-12 m and CPUE of less than 1.0 kg/hr. The investigation in 1990 indicated an increase in CPUE to 25.2 kg/hr and 51.6 kg/hr in 1991. A source of conflicts between local fishers and undulated surf clam dredge fishers, occurred during the months of September 2007 to January 2008.
Songkhla: The fishing ground around Songkhla Province is in the lower Gulf of Thailand covering the area from Satingpra District to Singha Nakhon District, about 5-7 km from the coastline and sea depth of 10-14 m, and total area of about 48 km². Results of resources survey by DOF of Thailand around northern Koh Maew Island revealed a CPUE of 2.5 kg/hr. Fishing activities using iron dredges started in 1991 but later, all fishing activities were stopped because of conflicts with local fishers.
Pattani: The fishing ground around Pattani Province covers the area around Ao Pana-re Bay, about 1-3 km from the coastline, 7-14 m deep and total area of about 15 km². There had been no fishing activities in this area because of conflict between local fishers and dredge fishers. No other records had compiled so far.

cm in shell length and 10.2 g in weight had 50% survival in 20.0 ppt. The average survival rate was 89% in 16 ppt salinity after 29 hours. While the sea surface temperature of the clam habitats ranges from 22°C to 34°C, the water salinity ranges between 10.1 and 35.0 ppt (**Table 4**).

Acidity and alkalinity (pH)

Variation of pH around coastal areas is influenced by photosynthesis of microorganisms (phytoplankton), reducing carbon dioxide (CO_2) and increasing pH, consistent with the concentration of dissolved oxygen (Manuwadee, 1989) and Aneg *et al*. (2007) explained that

Box 2. Information on fishing grounds for the undulated surf clam in Thailand: **Andaman Sea**
Ranong: The fishing ground around Ranong Province covers the area around western of Koh-kam Island of Ka-pur District, with a total area of about 8 km^2. No records on the fishing season and abundance of undulated surf clam resources have been compiled for this fishing ground.
Phangnga: Pairaw and Sunan (1993) reported that fishing activities using iron dredge were uncovered in 1982-1983 around Koh Plong Island and Koh Yaw Island, with sea depth of 1.8-3.6 m and total area of approximately 10.2 km^2. In 1984-1989, the fishing ground expanded to the area around the Islands of Ko Mark, Koh Batang, Koh Boy, and Koh Roy with a total area of 56.2 km^2. The CPUE in southern Koh Batang Island, western Koh Roy Island and eastern Koh Thong Island was 16.0-20.0 kg/hr and abundance of approximately 4,000-5,100 kg/km^2. The resource surveys of the fishing grounds of Hin Mod Deang Rock, western Koh Batang Island, northern Koh Boiy Noi Island and northern Koh Yaw Noi Island, showed CPUE of 20.6-39.4 kg/hr and abundance of approximately 5,150-9,850 kg/km^2. On the eastern part of Ao Phangna Bay, Koh Pha-nak Island, Koh Yai Island eastern and western of Koh Mark island and northern of Koh Yaw Noi Island, the CPUE was less that 0.4 kg/hr and abundance was approximately 975-2,262 kg/km^2. Around the western of Koh Yaw Yai Island, Laem Here Cape, Koh Soub Island, Koh Labu Island, abundance was low at 3.8-99.3 kg/km^2 and CPUE of 0.04-9.05 kg/hr. The survey around Chong Lard Striate (between Koh Yaw Noi Island and Koh Yaw Yai Island) after the habitat was made to recover in 1987, found the CPUE at 0.2-3.4 kg/hr and resources abundance of approximately 49.5-850.0 kg/km^2.
Phuket: As reported by Pairaw and Sunan (1993), the fishing ground along the coast of Phangnga Bay around Phuket Island covers the northern area of Laem Yang Cape, Ao Ta Rau Bay (or Ao Sapum bay), Laem Abu Cape, Koh Ma Praw Island and Laem Nga Cape (Koh Si-re Island). With sea depth of 1.8-4.8 m, the fishing ground has total area of approximately 6.5 km^2. The CPUE was 0.1-1.3 kg/hr and abundance of approximately 13.2-315.9 kg/km^2. No data on production was recorded as well as on fishing season and abundance of undulated surf clam resources in this fishing ground.
Krabi: Pairaw and Sunan (1993) also reported on the use of iron dredge in 1983 in the fishing ground along the coast of Phangnga Bay, around Koh Ngai Island and Koh Lanta Yai Island. With total area of approximately 20.5 km^2, the fishing ground in 1984 was around Koh Kulong Island, Koh Nhui Island and Koh Por Island, and with total area of approximately 24.3 km^2, the fishing ground in 1985-1991 was around Koh Por Island, Koh Klang Island and off Klong Phon canal. Results of survey around the Cape of Laem Daeng, Koh Talu Island and Koh Bongbong Island showed CPUE of 0.1-1.8 kg/hr and resources abundance of approximately 12.3-441.0 kg/km^2. The fishing ground around Koh Klui Island, Leam Sak District had CPUE of 9.3-19.0 kg/hr and abundance of about 2,336.3-4,750.0 kg/km^2. However, undulated surf clam production from Krabi Province had been reduced by 1,000 kg in 1984-1988 but increased to 234,000 kg in 1989.
Trang and Satun: Pairaw and Sunan (1993) again reported on the use of iron dredge in 1984 around the fishing ground of Koh Petra Island and Koh Tabai Island, Trang Province, where sea depth is 10-14 m. Another fishing ground is between Koh Tong-ku Island and Koh Bu-lon-le Island, Satun Province with sea depth of 15-17 m, and a total area of approximately 18.0 km^2. Although the undulated surf clam production is much lower than in other fishing grounds but size of the clam is much bigger. SEAFDEC/TD (1989) reported the appearance of iron dredge for harvesting undulated surf clam at Perlis Estuary of Perlis State of Malaysia. DOF of Thailand (1992) also reported that the fishing ground of undulated surf clam is contiguous with the area around Langkawi Island, Kedah State and around Payak Island, Perlis State and area of Triburi State which are part of the Malaysian EEZ.

the trend of pH in the Gulf of Thailand could differ with the months and areas. The DOF of Thailand (2003) revealed that pH in the Gulf of Thailand ranges from 7.2 to 8.9 with an average of 8.1±0.2. Meanwhile, pH of the undulated surf clam habitats ranges from 7.3 to 8.5 (**Table 5**).

Dissolved oxygen (DO)

Aneg *et al*. (2007) explained that the concentration of dissolved oxygen (DO) in the Gulf of Thailand could be influenced by monsoon and freshwater runoffs, and the Gulf has low concentration of DO during the rainy season. Freshwater runoffs carry and enhance the deposit of organic matters into the estuary. DO is consumed to decompose these organic matters and change into inorganic matters. The survey conducted by DOF of Thailand (2003) showed that DO in the Gulf of Thailand ranges from 1.94 to 9.59 mg/l with average concentration of 5.80±1.07 mg/l. The undulated surf clam habitats had a DO range of 0.03-9.0 mg/l (**Table 5**).

Table 5. Ranges of pH and dissolved oxygen in the habitats of the undulated surf clam in Thailand

Undulated surf clam habitat	Range of pH		Range of dissolved oxygen (mg/l)	
	Min	Max	Min	Max
Ao Trat Bay, Trat Province	7.6	8.5	4.0	9.0
Klong-darn District, Samut Prakan Province	7.34	8.5	3.5	6.9
Mahachai Bay, Samut Sakhon Province	7.3	8.5	0.03	7.2
Pranburi Estuary, Prachuap Khiri Khan Province	7.0	8.5	5.5	7.4
Ban-don Bay, Surat Thani Province	7.98	8.4	5.5	6.6
Moo Koh Ang-thong Archipelago, Surat Thani Province	7.6	8.5	6.8	8.2

Sources: *Summarized from DOF of Thailand (1992) and PCD-Thailand (2007)*

Total suspended solids

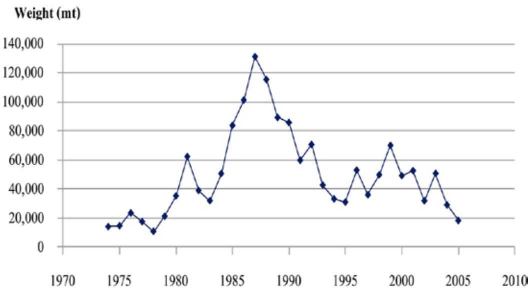
The quantity of total suspended solids (TSS) is affected by season so that in early rainy season, freshwater runoffs carry organic matters and suspended solids from rivers to estuaries, but the quantity carried decrease after the middle of the rainy season. In an opposite phenomenon, the nutrients concentration increased after the mid-rainy season. In the undulated surf clam habitats, TSS ranges from 8.0 to 487.0 mg/l.

Utilization of Undulated Surf Clam in Thailand

Undulated surf clam in Thailand is utilized for domestic consumption as well as for raw materials in export product processing industries. Domestic consumption is limited to fresh and live clams that are marketed without processing. Raungrai *et al*. (1985) and Bumrungsak (1983) reported that the undulated surf clam in Thailand shares 29-80% for raw materials in processing industries, 16-57% for domestic consumption, and 4-14% post-harvest handling losses. For domestic consumption, the clams are sold either as fresh-live, steamed or frozen in domestic markets and in various sizes: less than 180 clams/kg, 181-280 clams/kg, 281-320 clams/kg, and more than 320 clams/kg. In processing industries that produce canned products for export, the clams are used without shells where the ratio of fresh clam and clam without shell is about 6.3-8.5 kg (fresh or live clam to boiled clam). The canned products come in the form of salted, smoked or crispy clam. However, the country's canning industry has been confronted with concerns on the uncertainty of raw materials as well as on the demand and market price of canned products which depend on consumption by importing countries (Sanith *et al*., 1985).

Fisheries Statistics of Undulated Surf Clam of Thailand

Thailand's production of marine mollusks before 1974 was not classified into species, utilization and processing, but starting in 1974, the said data were classified into species but without source of production. However, the data were separated into source of production starting in 1985, *i.e.* Gulf of Thailand and Andaman Sea (Isara, 2007). Although the country's mollusks production was not classified by fishing gear used, it is presumed that most undulated surf clam production came from dredge fisheries. DOF of Thailand (1997) reported that although iron dredge is the only commercial fishing gear used for harvesting undulated surf clam resources, it is possible that this gear was also used to harvest the country's blood cockle resources. The fisheries statistics in 1974-2003 compiled by the Department of Fisheries indicated that undulated surf clam production had fluctuated from 13,806 mt in 1974 to 23,300 mt in 1976, but decreased in 1978 to 10,600 mt and rose again to 62,220 mt in 1981. Production in 1983 decreased to 31,823 mt but increased to its maximum of 130,000 mt in 1987. Since then, clam production has continuously decreased and reached 30,860 mt in 1995, but rose to 52,889 mt in 1996 and decreased to 35,852 in 1997. Clam production in 1998-2000, which was between 50,000-70,000 mt, gradually decreased to 29,000 mt in 2003 (**Fig. 5**). In view of the fluctuating production, Thailand had been importing undulated surf clam from neighboring countries to be used as raw materials for its canneries.



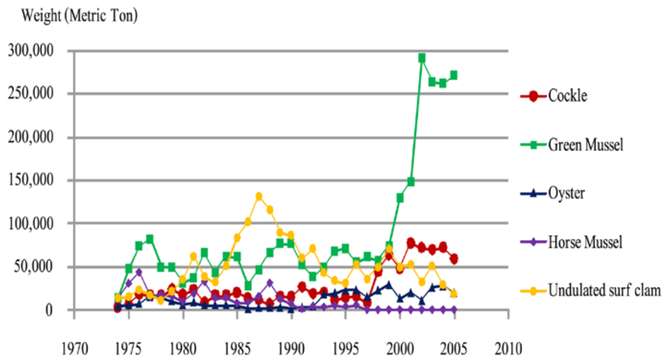


Fig. 5. Thailand's production of undulated surf clam (above) compared with its total mollusk production (below)
Source: *DOF of Thailand (1976-2008)*

Fishing Gear Technology: Dredges

Dredge fishing gear

Dredges are fishing gears which are dragged along the bottom to catch shellfish, consisting of a mouth frame to which a holding bag constructed of metal rings and meshes are attached (FAO, 1990). The dredges come as heavy dredge towed by boats (boat dredges), and light dredge operated by hand in shallow waters (hand dredges). Hand dredges are small with a mouth frame attached to a holding bag constructed of metal rings or meshes. No specific equipment is required for fishing operation and a boat is seldom used or sometimes only small undecked boats are employed. Boat dredges consist of a mouth frame to which a holding bag constructed of metal rings or meshes is attached, and are designed to either scrape the surface of the bottom (surface dredges) or penetrate the sea bottom to a depth of 30 cm or more to harvest macro-infauna (infaunal dredges). Surface dredges include rakes or teeth to penetrate the top layer of the sea substrate and capture the animals inhabiting the sea bed. Infaunal dredges can be further classified into those that penetrate the substrate by mechanical force (*i.e.* long teeth) and those that use water jets to fluidize the sediments (hydraulic jet dredges).

Most dredges are heavy and require winches and sometimes cranes for handling, and are mostly mechanized for

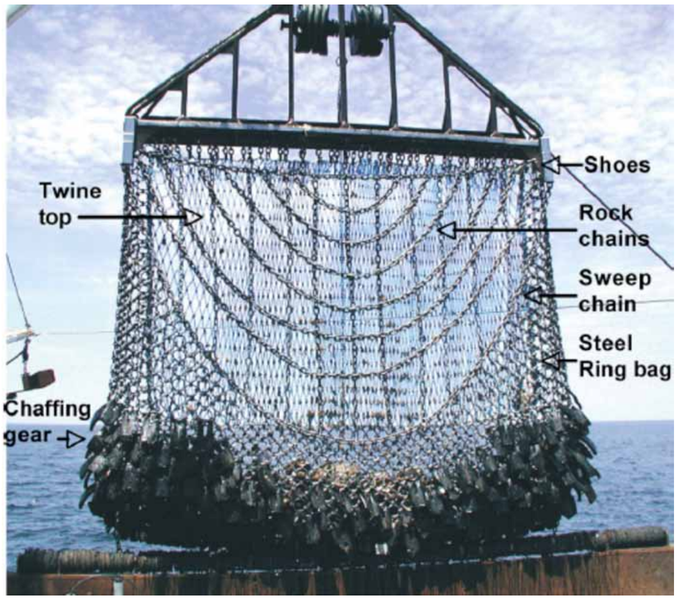


Fig. 6. Scallop dredge: 4.5 m wide weighing about 1870 kg
Source: *Stokesbury and Harris (2006)*

transporting the catch by pumps or conveyor belts to the deck for sorting. Hydraulic jet dredges are mechanized dredges used to dig and to wash out mollusks that have buried themselves in the seabed. Some dredges have been improvised that the prey is not only dug out or stirred up and collected in a bag, but is also conveyed on board the vessel by the same gear. Therefore, such gear that combines digging and hauling could be considered a harvesting machine. This is especially true in cases where mechanical shellfish diggers are combined with suction pumps, escalators or conveyors. **Fig. 6** shows an example of mechanized dredge.

Evolution of dredges in Thailand

Before 1943, Thai fishers harvested marine mollusks, *e.g.* cockles, undulated surf clams, and Venus shells from shallow waters by hand collection and diving. The DOF of Thailand (1969) reported that the use of handy dredge ("*La-mor*" or "*Cha-nor*" in Thai) started in 1943 by mobilizing manpower or current force or wind force with non-motorized boat (**Fig. 7**). Undulated surf clam commercial fisheries using iron dredge was not recorded before 1957. The first recorded information was in 1969 (DOF of Thailand, 1969) and the gear had since then been widely used after 1971 (DOF of Thailand, 1971). Information collected through the interview of dredge fishers revealed that iron dredge was first observed in the eastern part of the Gulf of Thailand, especially in Trat Province, although there is no reference to support such observation.

Dredge fishing gear in Thailand

The DOF of Thailand classified a boat dredge into dredge category considering that it looks like a big sieve. Rectangular in shape, it is operated as tow dredges into the sea bed. Since dredges scrape or dig into the sea bed, macro benthos living on the sea bed are trapped into the dredge, although such organisms and other small objects are released through the dredge slit. The DOF of Thailand (1997) classified dredges into three major types depending on the target species, *i.e.* short-necked surf clam dredge or undulated surf clam dredge, blood cockle dredge, and other dredges. The DOF of Thailand (1971) reported that the iron dredge fishing gear has iron frame rectangular in shape, where the front side is slightly higher that rear side. The iron frame is an iron bar 10.0 mm in diameter, with the front side which is 60 cm wide, 160 cm long and 12-13 cm high. Dredge slits are made of iron wire No. 16, arranged at 0.8-1.5 cm intervals. However, the intervals depend on the target size of the clams, so that the target catch of dredge with 1.2 cm slit is undulated surf clams of sizes that give more than 200 clams per kg.

A dredge slit interval of 8.0 mm is used to harvest undulated surf clams of smaller sizes that give less than 300 clams per kg. The dredge has three main parts, namely: opening or entrance or mouth of dredge, front frame, and rear frame (**Fig. 8**). The opening or entrance side is made of iron plate 60 cm long, 10 cm wide and 0.7 cm thick, which is attached with the frame of dredge in 30 degree angle to make the dredge opening wider at 68 cm and higher at 22 cm. Both sides of the front are attached with towing warp. The front frame is attached with an opening (or entrance) made of 10

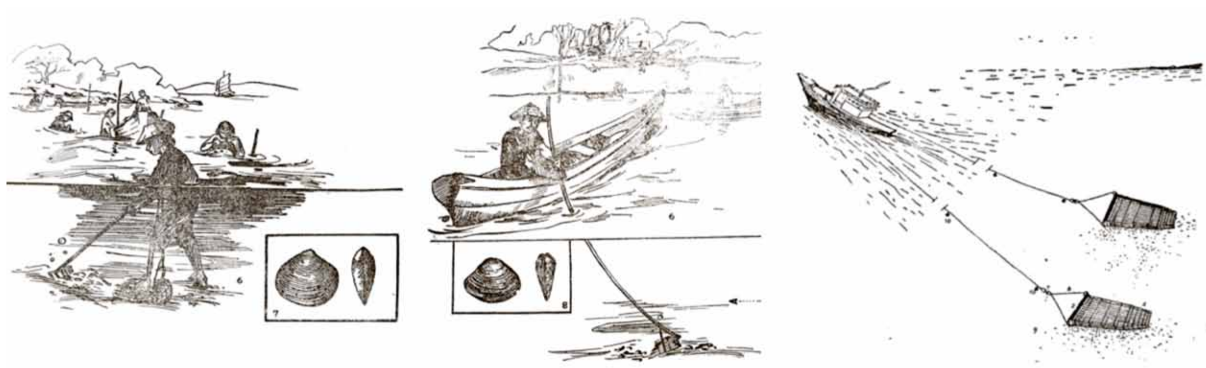


Fig. 7. Development of dredge fishing gear from 1943 to 1969
Source: *DOF of Thailand (1969)*

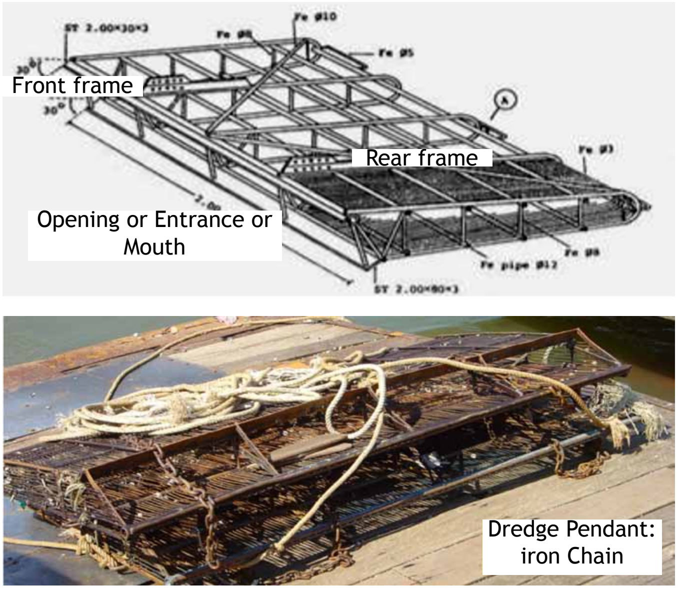


Fig. 8. Construction of iron dredge

mm diameter iron bar. The front side is 60 cm wide, 90 cm long and 13 cm high. The rear frame is made of the same material as the front frame, where the front side is 60 cm wide, 72 cm long and 13 cm high. At the rear part, the frame is 30 cm making the rear frame look like a trapezoidal box.

Moreover, two (2) pieces of dredge pendants made of 40 mm iron chain diameter, 100 cm long are fixed with each side of the entrance. The other end of the chain is connected to a big swivel. Towing warp is a 20 mm diameter nylon rope, Z-twist, 4 strands and 60 m in length. Few concrete weights are fixed with the towing warp to prevent the dredge entrance from moving obliquely with the sea surface. Although present iron dredges use the same principle and design as before, changes were observed in terms of dimension and shape. The dredge design has been developed for increased swept area by expanding the width at the front side, making it longer than the distance between the front and rear sides, and constructed into the same piece of dredge. The dredge frames are made of 8-10 mm diameter iron pipes, 3 mm thick. An iron plate, the length of which should be equal to the width of dredge entrance (plate is 8-10 mm wide and 3 mm thick), is fixed with the entrance of the dredge, in an oblique angle about 30-40 degrees. Two pendant iron chains are fixed with the upper side of the dredge near left and right corner.

Three sizes of dredges are operated in Thailand, namely: small size, medium size, and large size. The smallest size dredge is 120 cm in width (length of entrance), 70 cm long (from entrance to rear side) and 12 cm high (**Fig. 9**). These are used to collect clam spat, not only undulated surf clam but also spat of cockles. This dredge is also operated as harvesting gear in cockle farms.

Medium size dredge is 180-240 cm wide (length of entrance), 100-110 cm long (from entrance to rear side) and 12-16 cm high (**Fig. 10**), weighing approximately 80 kg, with dredge pendants made by iron chain. Dredge warp is made of polypropylene (PP) rope, 4 strands Z twist and 24 mm in diameter. Warp length is 2-3 times the sea depth. The dredge is used to harvest undulated surf clams and cockles. The price of medium size dredge, 180-240 cm, is about 8,000-12,000 Thai Baht. The largest dredge size is between 300-350 cm wide (length of entrance), 120-130 cm in length (from entrance to rear side) and 12-16 cm high, weighing approximately 120 kg (**Fig. 11**). Dredge pendants are made by iron chain, dredge warp is made by iron wire, 6 strands and 14 mm diameter. Warp length is 2-3 times the sea depth. This dredge is used to harvest undulated surf clams and cockles. Dredge price, size 300-320 cm, is 12,000-15,000 Thai Baht.

Most fishers prefer iron dredges that are not bigger than 3.5 m, for two main reasons: the Announcement by Ministry of Agriculture and Cooperatives (effective 8 March 1990) prohibiting the use of dredge with entrance size bigger than 350 cm to control fishing capacity, and fishing boats less than 18 m (LOA) are allowed to install not more than

Fig. 9. Small size iron dredge in an outboard engine fishing boat
Photo: Isara Chanrachkij

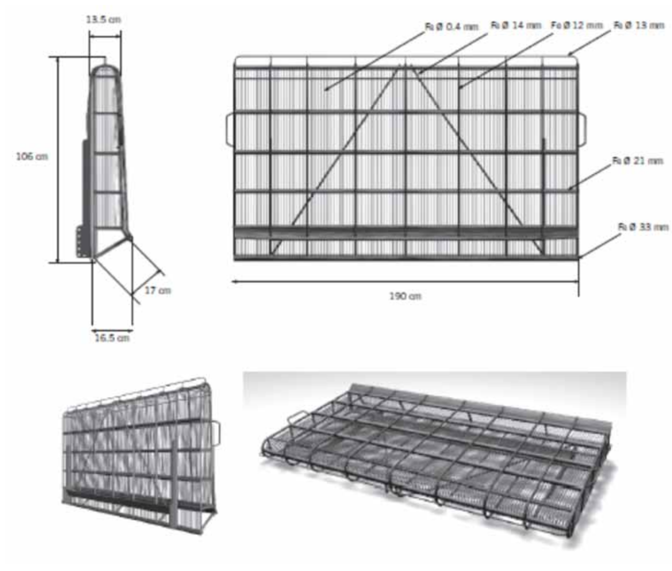


Fig. 10. Construction of medium-size iron dredge, entrance 190 m
Source: Modified from SEAFDEC/TD (2546)

Fig. 11. Big-size iron dredge, entrance size 320 m
Photo: *Isara Chanrachkij*

2 sets of dredges; and dredge entrance bigger than 350 cm could be easily damaged when hit by hard underwater objects, and such dredge is easy to bend but difficult to repair compared with those with 350 cm entrance. "The lifespan of bigger dredge is shorter than the smaller dredge" *(Interview of dredge fisher, Mr. Prasit Lumyong from Tumbon Bangtaboon Subistrict, Ban-laem District, Petchaburi Province)*.

Many fishers have modified their dredges by expanding the size to increase fishing capacity, which also necessitated expanding their fishing boats to suitable size. For convenience, therefore, beam trawlers have been modified by constructing special platform for sorting the catch and storing the iron dredges.

Gear selectivity of dredges

Fishing gear selectivity of dredge depends on the interval or distance of the slit. Results of experiments conducted by Mickmin (2010) in Laem-ngob District in Trat Province and Klong-darn District in Samut Prakan Province using three (3) slit sizes, namely: 8, 10, and 12 mm, showed that slit size 8 mm trapped 50% (LC_{50}) of clams with shell length between 2.61 cm and 2.47 cm, LC_{50} for 10 mm slit size was from 3.00 cm to 3.09 cm, and LC_{50} for 12 mm slit size was from 3.39 cm to 3.97 cm. In Petchaburi and Samut Songkhram Provinces, Mala and Jintana (2005) established that 12 mm iron dredge slit gave LC_{50} of clams with average shell length of 3.70 cm. Mickmin (2010) therefore, concluded that the appropriate slit of iron dredge should consider the biological information such as the length of clams at first maturity. Since the length at first maturity (**Table 2**) of undulated surf clam collected from Surat Thani Province is 29.1 mm for male and 30.6 mm for female, from Trat Province is 40.1 mm for male and 42.5 mm for female, and Upper Gulf of Thailand is 32.0 mm (without sex separation), therefore the most appropriate slit size of dredge should be 12 mm for the sustainable utilization of undulated surf clam. From this result, the DOF of Thailand issued a regulation to control the dredge slit which must be bigger than 12 mm although some dredge fishers were found to have violated the regulation by using 8.0 mm dredge slit to target premature clams smaller than 300 clams per kg, especially fishers operating in the area of around the Upper Gulf of Thailand such as off Tachin Estuary in Samut Sakhon and Bangprakong Estuary in Chachoengsao Province. Fishers claim that clams are harvested before massive mortality occurs due to freshwater runoff from the river, especially in October and November every year. Moreover, thinking that the resources would recover several months later, fishers continue to harvest premature clams because these are accepted as raw materials for canning. Nevertheless, in harvesting clams that are meant for local consumption, fishers change the slit of the iron dredge to 12 mm and harvest only the clams that make 200 clams/kg.

Dredge Fishing Boats

The DOF of Thailand (1969) reported that a dredge fishing boat during the 60s was wooden and installed with 10-90 hourse power (hp) inboard engine, 10-12 m lengthy overall (LOA), with the stern deck expanded to form small platform for working and storing the dredges. Two (2) poles are fixed at the stern deck for tightening the towing warp, and at each side is a dredge. During the fishing operation, fishers use both dredges alternately with the towing. In the 90s, dredge fishing boat was still wooden but installed with 10-250 hp inboard engine, 6-18 m LOA, with the stern deck expanded to serve as small platform, rectangular in shape (1.5 x 2.0 m) for sorting clam and storing the dredges. Two (2) poles fixed at stern deck are used for tightening the towing warp, with a dredge at each side.

Nowadays, dredge fishing boats could be classified into three sizes with respect to the size of the dredge used. Small size dredge fishing boats are outboard engine boats modified and installed a boom, portside and starboard size. Modified from a small truck engine 85-100 hp, the outboard engine is installed at the stern as in the long-tail fishing boat design. Medium size dredge fishing boats operate medium size iron dredges, the opening of which is 1.8-2.4 m long. Re-installed with inboard engine 200-300 hp, the boats are 12-14 m LOA with limited deck machinery. Fishing operation employs 10-12 crew members. The capstan winch is mainly used not for fishing operation but to heave up the anchor. These dredge fishing boats are equipped with Echo Sounder, Global Positioning System (GPS) and radio communications. In some fishing grounds, local fishers modify other types of local fishing boats, *e.g.* squid cast net and bottom gillnet to be used for dredging operations.

From top to bottom: Outboard (long-tail) engine fishing boat with small-size iron dredge; Medium-scale fishing boat, length over all (LOA) 12-14 m., operating without deck machinery; and Large-scale fishing boat, LOA 18 m. without deck machinery
Photos: *Isara Chanrachkij*

Usually fishing boats are modified for the dredging season while other dredge fishing boats from other areas start dredging around their local fishing grounds. Such modified fishing boats measure 12-14 m LOA. Large size dredge fishing boats operate the largest size iron dredge, with opening of 3.0-3.2 m long. These fishing boats are installed with inboard engine 300-500 hp, employ 10-12 crew members, and operate with capstan winch, hoist and winch. A towing warp hauled by the capstan winch is installed in front of the wheel house. Two derricks with blocks are installed above the stern deck to hang the dredge while removing the catch. During fishing operations, fishers use both dredges but alternately towing the individual iron dredge. While one dredge is hauled to remove the catch on the platform, the other is launched into the seabed for consecutive dredging. Fishers also prepare a spare dredge (third) to be used in case any of the dredges is damaged while fishing. Dredge fishing boats equipped with Echo Sounder, Global Positioning System (GPS) and radio communications, are manufactured in the Provinces of Samut Prakan, Samut Sakhon, Samut Songkhram, and Petchaburi Province

The DOF of Thailand had been encountering difficulties to monitor the country's dredge fishing boats especially those that have been modified, since the number changes with respect to the fishing season, fishing ground and abundance of the resources. Thus, studies on the abundance and catch per unit effort could not be conducted accurately while efficiency of resource management could not be assessed. However, resource surveys conducted by the DOF of Thailand may not give good results because of inadequate skills of officers as well as that of fishers. Although landing survey could help improve the data collection, undulated surf clam is usually not landed at public or municipal fishing ports. The harvest is oftentimes landed at private ports of canneries where the raw materials are immediately processed (boiling and shell sorting) into canned or frozen products.

The DOF of Thailand had issued a legislation to control fishing capacity of clam fishing through the Announcement of the Ministry of Agriculture and Cooperatives dated 18 February 1969 demarcating the conservation area from shore to 3000 m, and the Announcement of the Ministry of Agriculture and Cooperatives dated 8 March 1990 specifying the dredge size, dredge slit, number of dredges, and fishing boats. Focus of such Announcements was on the number of dredges installed onboard which should be not more than 3 units/fishing boat, dredge entrance not wider than 350 cm and dredge slit not narrower than 1.2 cm, and LOA of fishing boats not longer than 18 m (Mala and Jintana, 2005).

Conclusion and Way Forward

While production of undulated surf clam had been reported in the Provinces of Trat, Samut Prakan, Samut Sakhon, Samut Songkhram, Petchaburi, Surat Thani, Trang, and Satun, but there are fishing grounds with less fishing activities due to conflicts between local fishers and dredge fishers, *i.e.* in Prachuap Khiri Khan and Nakhon Si Thammarat Provinces. Meanwhile, there are other fishing grounds that do not report any statistical data, *e.g.* Provinces of Ranong, Phangnga, Songkhla and Pattani. Therefore, it could be assumed that clams produced from these fishing grounds may have been sold for local consumption without recording.

Notwithstanding such factor, the maximum production of undulated surf clam in Thailand recorded in 1987 was 130,000 mt while minimum production was 21,000 mt in 1978. Such trend of undulated surf clam production had been fluctuating due to overfishing in many undulated surf clam fishing grounds. Nowadays, production of undulated surf clam comes mainly from fishing grounds in upper Gulf of Thailand as well as in Trat, Surat Thani and Satun Provinces. While before fishers harvested surf clam by diving and hand groping, the fisheries had developed after the introduction of the hand dredge mobilized manually or using water current or wind force with non-motorized boats. Starting in 1969, iron dredge was used in undulated surf clam commercial fisheries, which had since then spread widely after 1971. While iron dredges at present make use of the same principle and design as those of 40 years ago, modifications have been made to make the dredge slit narrower from 12 mm to 8 mm, leading to major depletions of undulated surf clam resources including immature clams. The massive dredge fishing operations in major fishing grounds have also resulted in the overfishing of undulated surf clam resources which could take years to recover.

The development of undulated surf clam fisheries had been enhanced since 1977 because of the demand of raw materials for processed clam for export. However, the situation of the market/product chain of undulated surf clam as well as the trend of export production should be a priority for urgent investigation. Although the DOF of Thailand has legislated management measures to control fishing capacity with respect to specific fishing methods and fishing grounds, fishers are able to modify their fishing boats to be able to operate in near-shore fishing grounds. For this reason, the number of dredge fishing boats in Thailand could not be accounted for and their management becomes less effective. Moreover, undulated surf clam resource survey should be regularly conducted in order to understand the season, restocking period and fisheries biology of the clam, as well as survey of the country's fishing grounds based on landing surveys. Data from research dredge fishing boats including dredging techniques and dredging capacity should also be compiled as their data could give the real and virtual situation of the resources. The development of fishing gear design and construction should be carefully monitored by local fisheries officers, fishing gear technologists and scientists. Fisheries management applied for coastal fishing zone management based on scientific evidence including co-management practices should be applied to reduce conflict of utilization of the coastal fisheries resources. Since undulated surf clams have also been imported by Thailand for raw materials of its processing industry from Vietnam, Cambodia and Myanmar, efforts of these countries to conduct their respective undulated surf clam resource surveys should be supported by Thailand. In this regard, the survey methodology used in Thailand with stock assessment methodology could be introduced to these countries in order to standardize procedures and come up with harmonized results. This could also help in sustaining the supply of imported undulated surf clams to be used as raw materials for the processing industry of Thailand.

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Improving Community-based Fisheries Management in Coastal Areas: Policy Recommendations

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In recent years, fishers in most Southeast Asian countries have continuously experienced diminishing volume and value of fish catch greatly affecting their livelihoods. Although this has generated anxiety among the fishers, it has also provoked them to undergo positive change. The fishers have resolved that a solution to such problem does not lie on the central government alone but on the need for proactive engagement in the management of the fishery resources.

Thailand is one of the top producers of fish and fishery products in the world, but its marine sub-sector has exhibited decreasing catch rate due to numerous issues such as overfishing and use of destructive fishing methods. To address such issues, the Government of Thailand implements a Marine Management Strategy that focuses on fish conservation and management plans, by increasing conservation areas, rehabilitating the aquatic environment, assisting the fishers to increase their daily incomes, and focusing the implementation of these plans on the provincial level. Cambodia on the other hand, boasts of a productive freshwater fisheries sector due to the presence of large floodplains, but its marine fisheries production pales compared with that of inland fisheries probably due to limited fishing area. Cambodia is also confronted with issues on degradation of its marine aquatic resources including its rich mangrove forests. Thus, the Cambodian Government has utilized several management tools to protect these resources, such as the use of permits and licenses for local and foreign fishing boats/gears, establishment of fish sanctuaries, and protection and enhancement of existing mangrove areas, among others.

The concept of Community-Based Fisheries Management (CBFM) is widely adopted in many Southeast Asian countries, *i.e.* Philippines, Indonesia, Thailand, and other. CBFM provides the coastal communities with the principal obligation to administer their own resources, with emphasis on localized participative approach involving constant coordination among the fishers in terms of planning, monitoring and managing these resources. The CBFM approaches implemented in the coastal areas of Chanthaburi and Trat in Thailand, and Koh Kong in Cambodia differed but the result could be seen from the highly successful projects in their respective communities.

Chanthaburi Province in the eastern part of Thailand has a total area of 6,338 km^2 and population of 516,855 in 2011. It is rich in natural water resources along the eastern coastline, where the total area of 4,695 ha is devoted to fish culture with an annual yield of approximately 67,000 metric tons. Fish and fisheries products account for 60% of province's production while the total number of fishing vessels is 2,124 comprising of 1,039 registered and 1,085 non-registered with 16,517 fishers. The fishing gears used are mostly gillnets and traps (DOF Thailand, 2012). Two significant local institutions working on fisheries development include the Chanthaburi Campus of Burapha University and Kung Krabaen Bay Royal Development Study Center. The faculty of Marine Technology at the Chanthaburi Campus is conducting various research activities on marine technology as well as aquaculture development utilizing environment-friendly and natural resources management techniques.

Researches involve Geo-informatics and Remote Sensing Program (GIS-RP) and Ocean Atmosphere System Research Program (OASIS), where the GIS-RP provides the useful tool for environmental and natural resources management, while the OASIS is meant for collecting data on the atmosphere and the sea surface water such as temperature, pressure, wind direction and speed, humidity and other parameters to be used in monitoring oceanographic status, managing the natural environment, and adapting to climate change. Aquaculture development research focuses on domestication of shrimp broodstock and disease surveillance.

The Kung Krabaen Royal Development Study Center was established in 1981 and as conceptualized by His Majesty

SEAFDEC officials with representatives from Burapha University, Chanthaburi Campus, Thailand

Discussion between SEAFDEC officials and officers from the Provincial Fisheries Office of Trat, Thailand

the King Bhumibol, it has two objectives: "*to consider a suitable area for development of fisheries and agricultural activities and to select deforested area or public land where a Royal Development Study Center could be established*". The main purpose of the Center is to promote the dissemination of knowledge, skills and appropriate techniques on aquaculture, coastal environmental protection and conservation, and agriculture and animal husbandry through the use of "*demonstration projects*".

Trat province is located in the easternmost part of Thailand and borders with Koh Kong Province of Cambodia. With total area is 2,819 km^2, its coastline is 165 km with 52 large and small islands, which is rich in natural marine resources. This province has much potential for fisheries development both in capture fisheries and coastal aquaculture. Swimming crab is one of the main target species in Trat because of its high market demand and is usually caught by crab gillnet and crab trap. However, its crab resources had been decreasing due to increased number of fishers, and use of destructive fishing gears and illegal fishing activities. Recognizing the importance of the crab resources, the Trat Provincial Fishery Office promotes various programs on effective fisheries management to enhance the existing crab resources in the area, such as the Crab Bank which aims to increase the swimming crab population in the coastal area of the province and is managed by the fisheries communities of Trat.

Sorting fish catch at Chalalai Fishing Port, Klong Yai District, Trat Province, Thailand

Koh Kong Province is in the southwestern part of Cambodia on the coast of the Gulf of Thailand. The area of the province is 11,160 km^2 and its coastline is about 237 km long. It is one of four coastal provinces of Cambodia, and has the biggest mangrove area, where approximately 73% of the total mangrove area in the country is found (SEAFDEC, 2007). A total of 68,409 ha of community fisheries are under the protection and management of 26 villages that have been organized into 10 fisheries community organizations. Specifically, CBFM is practiced in Peam Krasob and Chroy Pras.

The Peam Krasob Wildlife Sanctuary was established and is home to several small communes, where livelihoods rely on the natural resources of the surrounding mangrove forest, especially dependent highly on green mussel cultivation, fishing and aquaculture. Currently, around 341 households are involved in fishing activities using trawls, push nets, gillnets (mackerel net), crab traps, among others. Other occupations are general labour, motorbike driving and animal husbandry. Numerous fishing boats (about 1,000) from other provinces such as Kampot, Kep and Preh Sihanouk provinces, and neighboring countries are operating in Peam Krasob resulting in conflicts between large- and small-scale fishing (Sun Kong *et al*, 2013).

The Chroy Pras commune has 197 households relying on small-scale fisheries activities, such as catching swimming crab and mud crab using crab traps and gillnets with long-tail motorized boats. Due to the presence of many illegal fishing activities, several programs on fisheries management has been implemented by various groups. Established since 2002, the community fisheries had been responsible for the management of 11,085 ha, of which 1,052 ha is mangrove area and 2,198 ha of seagrass beds. The United Nations Development Program (UNDP) supported the communities by deploying artificial reefs and demarcating the community fisheries management areas. Two types of artificial reefs had been installed, concrete reef boxes and poles covering 1,103 ha, and based on their experiences, pole artificial reefs should be used because of the characteristics of the seagrass bed and the muddy bottom. Catching swimming crab is also one of their main sources of livelihoods in Chroy Pras. Since its crab resources have been declining for the past years, the commune established in January of 2008, a Crab Bank to arrest the decreasing crab population. Moreover, in order to improve the livelihood and augment the incomes of villagers, the commune council of Chroy Pras has encouraged the women to form Women's Saving Groups. Presently, there are three Women's Saving Groups in the commune with their established corresponding internal regulations with assistance from a Non Government Organization (NGO).

Dialogue between SEAFDEC officials and members of local community of Peam Krasob, Cambodia

Way Forward

Considering that the coastal fisheries resources in these selected areas have declined substantially, and the coastal fishing community suffers from overfishing, there is a strong need to implement a sustainable approach to manage the fisheries resources using several tools, which could include establishment of Marine Protected Areas (MPA), National Marine Park, and Wildlife Sanctuary, as well as CBFM schemes which have proved to be the most effective tool to improve livelihoods and manage the fisheries resources.

However, the implementation of the CBFM requires addressing some concerns such as the conflict among the small-scale and large-scale fisheries, the use of destructive fishing gear and practices such as trawls and push nets, and the illegal operation of fishing boats from other provinces and neighboring countries. Although the responsibility of managing CBFM is primarily shouldered upon the local communities, it is important to note that the implementation of CBFM should be unique to each area and situation, and should incorporate awareness, willingness, cooperation, involvement and flexibility among the community members to work together for the collective good and long-term benefits. It is also important for these communities to have a common understanding on the importance of self-governance dictated not by financial gains but by promoting stewardship and conservation practices.

Box 1. Ways on how to sustain and improve the current practice of CBFM

- Increase the awareness among the local communities on fisheries management
- Capacitate local communities and government officers to develop, agree upon, monitor, and enforce regulations
- Strengthen technological, legal and financial ability to control and manage fishing grounds or fishery resources
- Develop strong social capacity, including effective organization, trust within the community, community rules and networks
- Seek sustainable financing for longer-term program and at the same time make the local community self-sufficient to be able to manage and augment their financial condition
- Seek government support, including a legal framework that legitimizes local rules
- Enhance the participation of various institutions including local government fisheries agencies, donors, NGOs, local universities, and community organizations

The suggested ways in sustaining and improving the current practices of CBFM are shown in **Box 1**. Considering that CBFM is an effective approach to manage fisheries in the long-term, based on several key performance indicators such as fish production, resource sustainability and the fishers well-being, community-based fisheries management, it should be promoted for adoption in other countries, by fully involving local communities, the government and other stakeholders in the process to build up true fisheries management.

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer(s)
		2013	
19-21 November	Kota Kinabalu, Malaysia	6th RPOA Coordination Committee Meeting	RPOA-IUU
25 Nov-4 Dec	Iloilo, Philippines	Training on Community-based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia	SEAFDEC/AQD
25-27 Nov	Penang, Malaysia	36th Meeting of SEAFDEC Program Committee	SEAFDEC Sec. -MFRDMD
27-29 November	Bangkok, Thailand	FAO/APFIC/NACA RTC on Aquaculture Planning and Management Toolkit and Its Adoption in Asia and the Pacific	APFIC
28-29 Nov	Penang, Malaysia	16th Meeting of Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	SEAFDEC Secretariat
2-5 December	Bangkok, Thailand	International Symposium on Small-scale Freshwater Aquaculture Extension	JICA, NACA & Thai DOF
3-4 December	Thailand	Regional Workshop on Offshore Fisheries in Southeast Asian Waters	SEAFDEC/TD
9-13 December	Jakarta, Indonesia	Training Course and Workshop on Offshore and High Sea Fisheries Management in Indonesia (and discussion about data sharing to Regional Vessel record)	SEAFDEC/TD
11-12 December	Bangkok, Thailand	ASEAN-FAO-WOCAN-GIZ Regional Workshop on Gender and Climate Smart Agriculture in ASEAN	ASEAN, FAO, WOCAN, GIZ
11-12 December	Bangkok, Thailand	BOBLME-ICSF Dialogue on Labour, Migration and Fisheries Management	BOBLME & ICSF
11-13 December	General Santos, Philippines	Regional Training Course on Improvement of Tuna Handling	SEAFDEC/TD
18-19 December	Bangkok, Thailand	4th Meeting of the Gulf of Thailand Sub-region	SEAFDEC-Sweden Project
		2014	
14-16 January	Selangor, Malaysia	On-site Training Course on Facilitating Fisheries Information Gathering Through Introduction of Community-based Fisheries Management	SEAFDEC/TD
20-22 January	Bangkok, Thailand	1st Regional Focal Points Meeting on Development of the Full Program of the SEAFDEC/UNEP/GEF/SCS on Establishment of the Fishery *Refugia* System in the South China Sea and the Gulf of Thailand	SEAFDEC/TD
20-30 January	Samut Prakan, Thailand	Regional Training Courses on Essential Ecosystem Approaches for Fisheries Management (EAFM) and Training of Trainers	REBYC-II CTI Project & SEAFDEC
23 January	Bangkok, Thailand	Mini-Symposium on "10-years Achievements and Onward Cooperation between SEAFDEC and Fisheries Research Agency (FRA) of Japan"	SEAFDEC Secretariat
3-7 February	Rome, Italy	Resumed Session of the Technical Consultation on International Guidelines on Securing Sustainable Small-Scale Fisheries	FAO
4-6 February	Perlis, Malaysia	On-site Training Workshop on Offshore and High Sea Fisheries Management and Reducing IUU Activities	SEAFDEC/TD
18-21 February	Phnom Penh, Cambodia	ASEAN Regional Workshop for Facilitating Community-based Resource Management in Coastal and Inland Fisheries	SEAFDEC/TD
18-21 February	Vientiane, Lao PDR	25th Session of the Asia and Pacific Commission on Agricultural Statistics	APFIC
24-28 February	Bergen, Norway	14th Session of FAO Sub Committee on Fish Trade	FAO
27 February	Bangkok, Thailand	1st Regional Technical Meeting on Information Gathering of Eel Resources and Aquaculture Productions in the Southeast Asia	SEAFDEC Secretariat
5-7 March	Iloilo, Philippines	RESA 2014: International Workshop on Resource Enhancement and Sustainable Aquaculture Practices in Southeast Asia	SEAFDEC/AQD
17-21 March	Vietnam	Training Course and Sample Survey on GT Measurement for Small-scale Fishing Vessels in Vietnam	SEAFDEC/TD
24-28 March	Lao PDR	Annual Meeting of NACA Governing Council	NACA
1-4 April	Singapore	46th Meeting of the SEAFDEC Council	SEAFDEC & Singapore
9-13 June	Rome, Italy	31st Session of Committee on Fisheries (COFI)	FAO

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia.

Mandate

To develop and manage the fisheries potential of the region by rational utilization of the resources for providing food security and safety to the people and alleviating poverty through transfer of new technologies, research and information dissemination activities

Objectives

- To promote rational and sustainable use of fisheries resources in the region
- To enhance the capability of fisheries sector to address emerging international issues and for greater access to international trade
- To alleviate poverty among the fisheries communities in Southeast Asia
- To enhance the contribution of fisheries to food security and livelihood in the region

SEAFDEC Program Thrusts

- Developing and promoting responsible fisheries for poverty alleviation
- Enhancing capacity and competitiveness to facilitate international and intra-regional trade
- Improving management concepts and approaches for sustainable fisheries
- Providing policy and advisory services for planning and executing management of fisheries
- Addressing international fisheries related issues from a regional perspective


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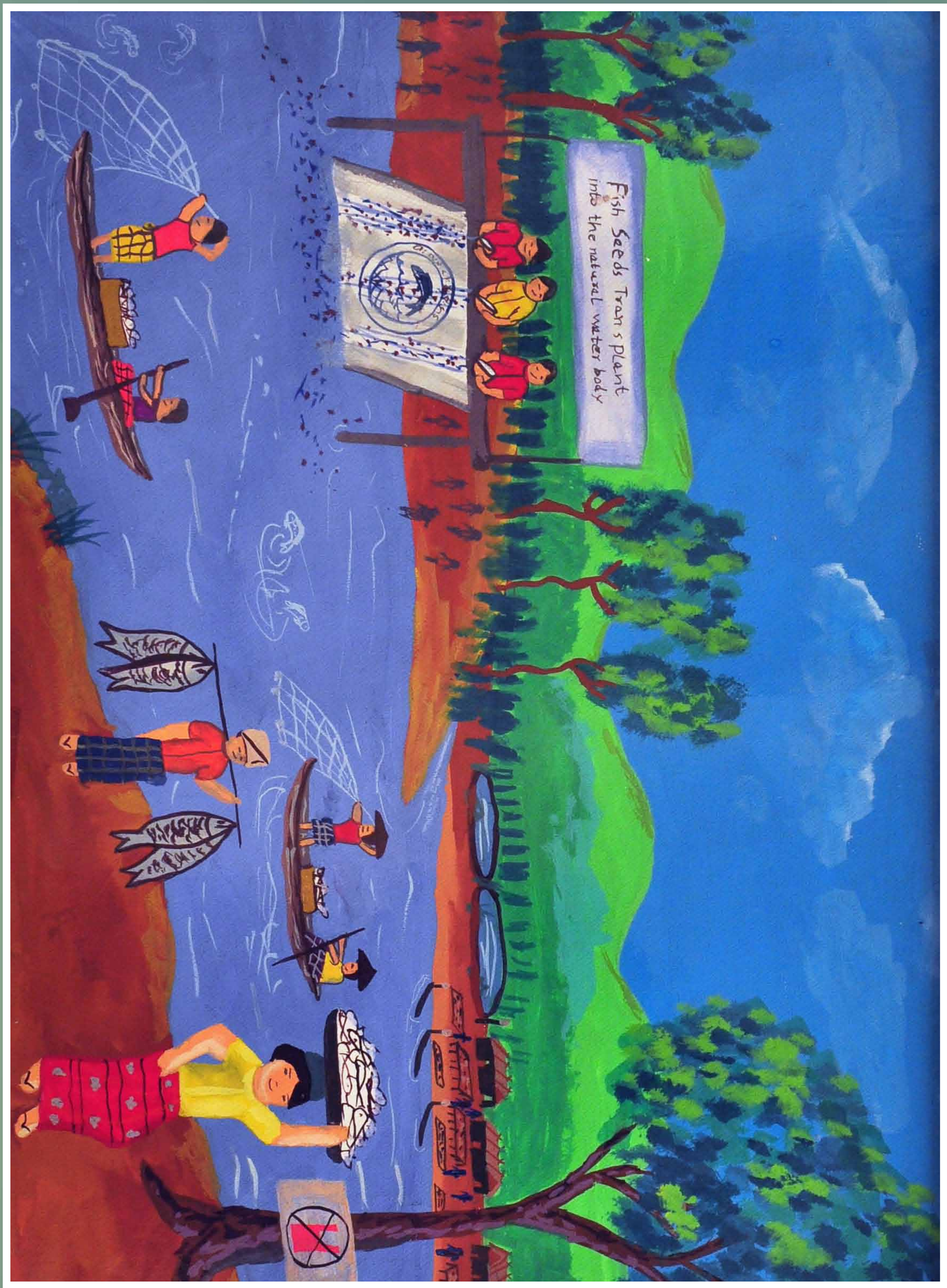

The first prize drawing winner, *Pyo Ko Ko,* from the national drawing contest in Myanmar

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conferene on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" held by ASEAN and SEAFDEC in June 2011 in Bangkok, Thailand, in order to create awareness on the importance of fisheries for food security and well-being of people in the region.