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TAGGING PROGRAM FOR ECONOMICALLY IMPORTANT SMALL PELAGIC SPECIES IN THE SOUTH CHINA SEA AND THE ANDAMAN SEA REGIONAL PROJECT TERMINAL REPORT

EXECUTIVE SUMMARY

COMPILED BY:

MAZALINA ALI
DR. MASAYA KATOH

2014

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
MARINE FISHERY RESOURCES DEVELOPMENT AND MANAGEMENT DEPARTMENT
TAMAN PERIKANAN CHENDERING, 21080 KUALA TERENGGANU, MALAYSIA

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PREFACE

In 2007, SEAFDEC/MFRDMD (Marine Fishery Resources Development and Management Department) initiated the activities of the project "Tagging for economically important pelagic species in the South China Sea and Andaman Sea" with SEAFDEC/TD (Training Department). The main objective of this six-year project was to ascertain existence of sub-populations based on their moving behaviors and migration routes information that could be obtained through tagged, released and re-captured of the fish throughout their distribution areas. SEAFDEC/MFRDMD had coordinated the project with SEAFDEC/TD and eight participating member countries namely Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Thailand and Vietnam. The target species were Indian mackerel (*Rastrelliger kanagurta*), Indo-pacific mackerel (*Rastrelliger brachysoma*), Shortfin scad (*Decapterus macrosoma*) and Japenese scad (*Decapterus maruadsi*), the major small pelagic fish species utilized by the fisheries in the region.

Because Indian mackerels and scads are very important small pelagic fishes in the Southeast Asian region, this executive summary will be a concise guide for fishery managers and scientists to understand small pelagic resources in the region. The publication presented here would not have been possible without the assistance of various agencies and colleagues from member countries. I particularly wish to acknowledge the funding support provide by Fishery Agency of Japan, as well as the technical support and cooperation of the participating institutions, namely: Department of Fisheries - Brunei Darussalam; Fisheries Administration - Cambodia; Ministry of Marine Affairs and Fisheries and Research Center for Capture Fisheries - Indonesia; Department of Fisheries and Department of Fisheries, Sabah - Malaysia; Department of Fisheries - Myanmar; Bureau of Fisheries and Aquatic Resources (BFAR) and National Fisheries Research and Development Institute (NFRDI) - the Philippines; Department of Fisheries - Thailand; and Fisheries Administration and the Research Institute for Marine Fisheries (RIMF) - Vietnam. I also wish to thank Ms. Mahyam Mohd Isa, Chief of SEAFDEC/MFRDMD and the SEAFDEC/MFRDMD and SEAFDEC/TD staff members who supported this project.

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REGIONAL SYNTHESIS REPORT ON TAGGING OF SMALL PELAGIC FISH IN THE SOUTH CHINA SEA AND THE ANDAMAN SEA, 2007-2012

INTRODUCTION

Fish stocks particularly small pelagic are important elements of marine ecosystems in linking lower and higher trophic levels (Sherman, 2008; Skjoldal & Misund, 2008). There are two important families of small pelagic fish in the Southeast Asian region i.e. the family of mackerels, tunas and bonitos (Scrombidae) and the family of jacks, pompanos and scads (Carangidae). The distribution of both pelagic fishes showed that scads (*Decapterus* spp.) are more dominant than mackerels (*Rastrelliger* spp.) in the South China Sea in all SEAFDEC Member Countries that have data except Thailand. On the other hand, in the Andaman Sea, scads are more dominant than mackerels only in Thailand.

Scads are caught mainly by purse seines in the Southeast Asian countries. The other gears are the ring net (Philippines) and gill net (Cambodia) but their contribution to the landings were rather small (Raja Bidin & Ku Kassim, 2007). Mackerels are caught by various types of fishing gears in the Southeast Asian waters. The three main gears are purse seine, trawls and drift/gill net but the contribution to the landing are varies among the countries. The catch of Scads (*Decapterus* spp.) and mackerels (*Rastrelliger* spp.) in Southeast Asia countries contributed to more than 38% of the total small pelagic or 11% to the total capture production in 2010 (SEAFDEC, 2012).

As a whole, the scads resources in Southeast Asian waters are considered declining as the catch rate declined from 99.04 MT/Fishing unit of purse seine in 2005 to 89.30 in 2010 and reduced CPUE values were recorded. The study conducted by SEAFDEC/MFRDMD and funded by the Japanese Trust Fund II from 2002 to 2006 estimated an average exploitation rate (E) in five countries bordering the South China Sea at 0.64 for *Decapterus maruadsi* and 0.71 for *D. macrosoma* (Raja Bidin & Ku Kassim, 2007). This study also estimated the E value for *Rastrelliger kanagurta* at 0.69 in four countries bordering the South China Sea and 0.66 for *R. brachysoma* in Malaysia and the Philippines.

This paper provides the findings obtained from the project entitled 'Tagging Program for Economically Important pelagic Species in the South China Sea and Andaman Sea' funded by the Japanese Trust Fund for five years. The main objectives of this project are to ascertain the migration route and existence sub-populations of small pelagic fish in the ASEAN region. This is important since effective management of shared stocks requires measures to be taken in the whole region even covering areas beyond national waters.

MATERIALS AND METHODS

The tagging programs were conducted at 13 sites in the South China Sea (SCS) and 6 sites in the Andaman Sea (AS) involving eight ASEAN-SEAFDEC member countries namely Brunei Darussalam (SCS), Cambodia (SCS), Indonesia (AS), Malaysia (SCS, AS), Myanmar (AS), the Philippines (SCS), Thailand (SCS, AS) and Vietnam (SCS). Two species of mackerels i.e. Short Mackerel (*R. brachysoma*) and Indian Mackerel (*R. kanagurta*) and two species scads, Shortfin scad (*D. macrosoma*) and Japanese scad (*D. maruadsi*) were chosen for this program.

The equipment and materials used for the fish tagging program are fishing or research/training vessels, holding cage, holding tank, aeration, scope net, measuring board, tag and applicator. Small to medium-sized fishing vessels of less than 25m in length or research/training vessels were used for the tagging operation with consideration to facilitate the release of tagged fishes and to minimize stress on the fishes. Only four countries namely Brunei Darussalam, Myanmar, the Philippines and Thailand used holding cages during the tagging operation to monitor the fish condition before transfer to the holding tanks onboard the tagging vessel in all sites except in Manila Bay and Bataan of the Philippines, and Satun, Thailand that directly tagged the fish from the holding cage.

The standardized tagging procedure (Abu Talib *et. al.,* 2013) was followed at all tagging sites in the eight countries. The tag was inserted at the dorso-lateral portion of the trunk of the fish, below the mid-point of the base of the first dorsal fin. Information and data that included data, time tagging site, release position, tag number, fork length and species of the tagged fishes were recorded in the 'Tagging Data sheet Form-Records of the tagged fishes' and transferred to the Tagging Database. A reward in cash money equivalent to USD5 for each tagged fish returned was paid to the individual who found and returned the fish. Publicity on the tagging activities conducted and the reward upon returning tagged fishes done in local language in the form of poster distribution, news dissemination through mass media and personal communication at the tagging areas. After that, calculation for the estimation of growth increment of recaptured fishes using the Gulland and Holt Plot (Gulland &Holt, 1959), coefficient of total mortality and coefficient of fishing as describe by Tanaka (1967) were estimated.

RESULTS AND DISCUSSIONS

Regionally, 48,115 fishes of the four selected species were tagged and released in the South China Sea and the Andaman Sea from 2008 to 2011, which 32,345 fishes were tagged in the South China Sea while 15,770 fishes were tagged in the Andaman Sea. The highest number of fish tagged in the South China Sea was *D. maruadsi* (14,579 tails or 45% of the total number of fishes tagged), followed by *R. kanagurta* (7,665 tails or 24% of the total number of fishes tagged), *R. brachysoma* (5,220 tails) and *D. macrosoma* (4,881 tails). The target fish for tagging in the Andaman Sea were actually the two species of mackerel but scads were also tagged by Thailand. *R. kanagurta* is the highest number of fishes tagged followed by *R. branchysoma*. Ranong is the only site where all the four selected species were tagged. In four sites only one species was tagged; in Banda Aceh and Bintulu only *R. kanagurta* was tagged; in Sihanouk Ville only *R. brachysoma* and in Bataan only *D. macrosoma*. The released tagged fishes then were regrouped by monsoon types (Northeast monsoon and Southwest monsoon) to relate environmental factors to the successful recovery of the fish.

A low recovery rate of 1.07% or 517 tagged fishes were recaptured or recovered until early 2012. Of these, 356 fishes were recovered in the South China Sea and 161 fishes in the Andaman Sea. Recovered tagged fishes were only obtained in Cambodia (1 tagging site), Malaysia (2 sites), Myanmar (2 sites), the Philippines (2 sites), Thailand (2 sites) and Vietnam (1 site). Eleven sites that included one site each in Indonesia and Brunei Darussalam recorded no recovery of the released tagged fishes. Most of these recoveries (61%) were made within 10 days at liberty and in the vicinity of the release locations. However, there were few fishes spent a relatively longer time at liberty before moving away from their release position. The longest time at liberty was a *D. maruadsi* that recaptured after 113 days at liberty only 30 km away from the release area. The fish that travelled furthest was a *D. macrosoma* which recaptured 113 km from the release site after 5 days at liberty.

The oceanographic parameters including sea surface temperature, chlorophyll a, currents and biological interaction are major processes that affect and influence the dynamics of pelagic stocks. The oceanographic conditions in the South China Sea and Andaman Sea are influenced by the two predominant monsoons, namely the Northeast Monsoon and the Southwest Monsoon. The recovery rates for the four selected fishes were highest during the Northeast Monsoon in 2009 both in the South China Sea and Andaman Sea except for Shortfin scad in the South China Sea where its highest recovery rate was during the Southwest Monsoon in 2009. During the Northeast Monsoon, movement of the recovered tagged fishes in the South China Sea was in two directions, towards the northwest and southeast but in the Andaman Sea, almost all recovered tagged fishes moved in the southwest direction.

CONCLUSION

Only a large-scale tagging experiment conducted over a larger area would permit a better understanding of the structure of the population and to quantify movements between areas. The low recovery rate of 1.07% or 517 recoveries of the tagged fish could not provide a clear indication of the migratory pattern. The result on growth indicated that more care is required in measuring live small pelagic fishes on-board fishing vessel before they are tagged. The result for tagging of small pelagic fish in the South China Sea and the Andaman Sea was failed to indicate sharing of the stocks among member countries.

The use of the tagging and recapture technique to confirm migration patterns, distribution and population structure for fast growing and short-lived small pelagic fish will not be easy particularly in the wide area of the South China Sea. Other possible methods such as the use of genetics at the molecular level could possibly be a better way to confirm the population structure and identity of the stocks that may be shared by the countries in this region.

The successful implementation of this five-year project proved that the regional approach using standardized methodology and involving all SEAFDEC member countries can be achieved. This is particularly important as the management of fisheries for shared stocks requires full participation and agreement of all the countries that share the stocks.

GENETIC SURVEY FOR POPULATION STRUCTURE OF INDIAN MACKEREL AND JAPANESE SCAD IN THE SOUTH CHINA SEA AND ANDAMAN SEA

INTRODUCTION

Pelagic fish belong to more or less clearly defined populations or stocks that are normally schooling in small or large aggregations and migratory seasonally and geographically in relation to the annual cycles of ocean productivity, their own life history patterns and reproductive cycles (Skjoldal *et. al.*, 2004), ocean currents and circulation (Skjoldal, 2004). Larval drift from spawning areas and feeding migrations by juveniles and adult fish are components of their life cycles that need to be closed by migrations of the mature fish back to their spawning areas. A population may exist with several spawning components and there may be also be overlap and exchange between neighbouring populations. The concept of metapopulations is therefore used to characterize situation where there are multiple spawning areas and population components in a geographical area. The survey conducted by SEAFDEC from 1996 – 1999 during the post monsoon period in the South China Sea indicated the occurrence of *Rastrelliger* spp. larvae in both the South China Sea and the Gulf of Thailand (UNDP 2007a & 2007b).

In the Southeast Asian region, two families of small pelagic fish i.e. Scombridae and Carangidae are important components of marine pelagic ecosystems and support important pelagic fisheries. They are fast-swimming schooling fish that feed voraciously on plankton and other small pelagic fishes as well as squid. Pelagic fish in general are generalists and opportunistic feeders that eat largely whatever prey is available to them in terms of size, catchability and abundance. They therefore play key roles in the marine ecosystems, linking production at lower trophic levels with consumers at higher trophic levels.

Rastrelliger kanagurta (Cuvier, 1816) or Indian mackerel (also Kembong borek as a valid local name) and *Decapterus maraudsi* (Temmink & Schlegel, 1843) or Japanese scad (also Selayang mata besar as a local name) were selected for this study on population genetics. The main objective of this study is to ascertain if sub-populations of these species exist in the South China Sea and Andaman Sea or there is just one panmictic population.

MATERIALS AND METHODS

Thirty five (35) tissue samples each of Indian mackerel (*R. kanagurta*) and Japanese scad (*D. maruadsi*) were collected from 14 selected representative sampling sites for the South China Sea and Andaman Sea. The samples from both species were taken from the South China Sea while only Indian mackerel in the Andaman Sea. The collection of tissues followed strictly the same standard operating procedure (Abu Talib *et. al.*, 2013). At the sampling site, small amounts of muscle tissue (approximately 1cm x 1cm x 0.5cm) from the dorsal part of the sampled fishes were taken and fixed in vials containing preservation buffer (20% DMSO). Then, the preserved tissues were couriered to SEAFDEC/MFRDMD for further analysis.

At SEAFDEC/MFRDMD Genetics Conservation Laboratory, the genomic DNA from the collected tissue samples was isolated and stored at -20^{o}C until further use. The DNA template of each sample was amplified using the PCR thermal cycler. The PCR products were then purified and quantified. PCR amplicons were sequenced one direction with an automated sequencer. The GenBank database (National Center for Biotechnology Information, USA: NCBI Homepage http://www.ncbi.nlm.nih.gov) was searched for similar sequences.

RESULT AND DISCUSSION

A total of 434 individuals of *R. kanagurta* were collected from 13 sampling sites and produced 323 haplotypes. While, 115 haplotypes were produced from 343 individuals of *D. maruadsi* that collected from 10 sampling sites. The out-group samples were from Pekalongan for Indian mackerel, and from Pekalongan and Ranong for Japanese scad. For Indian mackerel, 14 haplotypes were shared by more than one site and h5 was shared by the most number of sites (a total of 25 samples). For Japanese scad, 15 haplotypes were shared by more than one site and h1 was shared by the most number of sites (a total of 109 samples). The highest haplotype diversity for Indian mackerel and Japanese scad was observed among samples from Ranong (1.0000) and Kuantan (0.8958), respectively. While, the samples from Yangon (0.8706) and Ranong (0.2639) showed the lowest haplotype for Indian mackerel and Japanese scad, respectively.

The value of nucleotide diversity was ranged from 0.0064 (Kuantan) to 0.0884 (Songkla) for Indian mackerel and from 0.0003 (Ranong) to 0.0353 (Kuching) for the Japanese scad. These results clearly showed the high genetic variation among samples of both selected species that may be because of the migration behaviour of both species. Mitochondrial DNA is a good molecular marker for species identification and the determination of population genetic structure in a wide variety of aquatic taxa (Rohizan & Ismail, 2011). The relationship among samples of *R. kanagurta* in the South China Sea and the Andaman Sea showed panmixis except samples from Yangon, while Japanese scad indicated moderate admixture.

CONCLUSION

This study showed that the Indian mackerel (*R. kanagurta*) in the South China Sea and the Andaman Sea is shared or derived from the same stock with high genetic variation among the sampling sites except Yangon samples. Hence, for the management purpose this species can be regarded as a single unit stock except Yangon. Moreover, small numbers of distinctive haplotypes were present within *R. kanagurta*. Additional genetic surveys with morphological comparison will be required for *R. kanagurta*. Whilst, the Japanese scad (*D. maruadsi*) in the South China Sea is partially shared with moderate genetic variation among the sampling sites. Samples from more sites in this area and the Andaman Sea are required to confirm the Japanese scad population structure. However, geographic and water current patterns also need to be studied to find out the relationship between the genetic structure and behaviour of these migratory pelagic fish species.

SMALL PELAGIC TAGGING DATABASE

INTRODUCTION

SEAFDEC/MFRDMD and SEAFDEC/TD in collaboration with eight member countries conducted small pelagic tagging program from 2008 to 2012 using the agreed standard operating procedures. A "Small Pelagic Tagging Database" was developed by SEAFDEC/TD that allows the countries to input, edit and query data of tagged and recaptured fish from this single regional database.

DEVELOPMENT TOOLS

The tagging database was developed by using few hardware and software. Web server computer and computer desktop were used as host websites, data storage and design the graphical user interfaces as well as implement program. While the software used were PHP, MySQL and Apache. PHP is the open source general-purpose scripting language that can be used nearly all type of computer and operating system. MySQL is the open source database that runs as a server providing multi-user access for web applications. Apache is the web server software that available for a variety of operating systems.

CONTENTS

The database was developed as a multi-user system and user-based accessibility. Each member countries have their own user name and password to access to the database. There are 5 modules for this system which are tagging, recovery, tagging site, species and report. 'Tagging' module is for storing of tagging activity data and information. 'Recovery' module is for storing of recaptured tagged fish data and information. The recovery data must be linked to 'Tag number' of the fish. 'Tagging site' module of the database allows addition and editing on tagging site of tagging activities. 'Species' module provides field to add target species name and target number to be released in each year by the country. 'Report' module provides four types of reports that could be downloaded and save in spreadsheet files.

DATABASE DISSEMINATION

The User Guide Manual for the Small Pelagic Tagging Database was disseminated to the countries during the technical meeting and also through internet. The manual could be downloaded at http://map.seafdec.org/downloads/, document number 27 and 28.

COUNTRY REPORT FOR BRUNEI DARUSSALAM

INTRODUCTION

Pelagic fish density is highly influenced by both the fish behaviour and environmental factors such as monsoon season, feeding or breeding migration, El Nino, La Nina, global warming and climate change. In Brunei waters, the small pelagic is more dominant and one of the most important component of fishery resources in Brunei Darussalam. Small pelagic fish made up about 20% of the total fish landings of the commercial fishing vessels. The high densities of pelagic fishes was observed in June or mid-southwest monsoon period in the shallow areas around Magpie (off Seria) and the tongue of shallow waters along the Tutong-Jerudong coast going to Champion shoals. The dominant genera were *Dussumieria*, *Carangoides*, *Decapterus* and *Ariomma,* accounting for more 80% of standing stock. An overall pelagic biomass and the potential yield in the Brunei waters was estimated at 15,320 MT and 7,660 MT, respectively. The capture fisheries of Brunei Darussalam are divided into two categories, small scale and commercial scale. Sixty percent (60%) of the pelagic resource was exploited using commercial fishing vessels such as purse seiners. Other fishing gears catching this resource are ring nets and lift nets which are categorized as small scale fishery.

MATERIALS AND METHODS

Muara, one of important local commercial fish landing which located in the north-western side of Borneo Island, just below Sabah, Malaysia has been identified as one of the sampling sites for the Tagging Program for Economically Important Pelagic Species in the South China Sea. The project was targeted four small pelagic species, but for Brunei Darussalam only two (2) species i.e. *R. kanagurta* and *D. maruadsi* were studied. The tagging activities were conducted on-board Fisheries Department Research and Training Vessel, KP TENGGIRI. A smaller boat was used to transfer the live fish from the catcher boat to the holding cage which placed alongside the research vessel and kept for approximately 1.5 to 2 hours. The fish were acclimatized until stable and in healthy condition before transferred to the holding fibre glass tanks on the deck of tagging vessel.

The tagging activities was followed the standardized tagging procedure (Abu Talib *et. al.,* 2013). Immediately after tagging, the tagged fish was transferred back to the cages and released back to the sea after half an hour. All data and information during tagging activities and recovery of tagged fish was recorded in the 'Tagging and Recovery Data Sheet' and used for analysing the movement patterns, growth rates, seasonal variation and reasons for the migration of the small pelagic species. Catch reward in terms of cash money BND 5 were paid to the individual who found and returned the tagged fish to the nearest project office.

RESULTS AND DISCUSSIONS

Five tagging trips were conducted in July, 2008 until October, 2009, but only three trips were successful. A total of 2,347 fishes were tagged and recorded where 73.9% of the samples or 1,732 fishes were *R. kanagurta* and the 615 fishes (26.1%) were *D. maruadsi*. The range length sizes of tagged *D. maruadsi* were 100 – 230 mm with the most of it has size range between 150 – 160 mm. For *R. kanagurta,* the size of tagged was between 100 – 260 mm with the most tagged fish at the size of 185 – 195 mm. Overall, from 1,732 tagged *R. kanagurta,* 1,362 samples were tagged during the Southwest Monsoon while 370 were tagged during the Northeast Monsoon. While *D. maruadsi* was tagged only during the Southwest Monsoon. Unfortunately, both species had no recovery.

Out of 2,347 fishes that were tagged and released in the coastal waters of Brunei Darussalam, none was recaptured. This might be due to lengthy time gap between the time of catch and release of the tagged fish, the area where the tagged fish were released, predation, impact of seismic survey, high mortality rate of tagged fish, "trap shyness" syndrome and migration. Previous study on *R. kanagurta* showed that Brunei shared this stock with Labuan, Malaysia (Zohrah, 2003). Some tagged species of small pelagic in Brunei waters coming from the Sulu-Sulawesi area based on the tag marks. So, it is highly recommended to pursue further the DNA study to map all the pelagic species in the region and identify the extent of the fish stocks based on their migration patterns.

One of the key factors for tagging program to be successful was the publicity on the awareness to the fishermen and public. Publicity in Brunei Darussalam was conducted by poster distribution, news broadcasting and dissemination through mass media and letter distribution.

The questionnaire on small pelagic fishes including mackerel and scads, also perception of fishermen were also conducted during the tagging activities. The result of questionnaire showed that the productions of small pelagic fish were depends on its seasonality influences by northeast monsoon and southwest monsoon. The high season of small pelagic fishes occurs from March to July and from September to November. Despite more fishing efforts, the CPUE were reduced significantly as indications that the pelagic fish stocks are decrease as also observed for the demersal fish stocks.

The historical data on deployment of FADs for fishing was unavailable in Brunei Darussalam, so surveys among the senior fishermen from fishing villages were conducted. The traditional FADs are normally installed on shallow coastal waters, depth 5 – 20m by small scale fishers to catch small pelagic fish. While the commercial purse seine install the FADs in the deeper areas up to 1,000m targeting for large pelagic such as tuna.

There were two species *Sardinella* spp. were caught in Brunei waters i.e. *Sardinella fimbriata* and *Sardinella gibbosa*. Most of the sardines were catch by purse seine, small scale fisheries and accidental catches by trawl during hauling the net. The annual trend of *Sardinella* spp. production showed that the catches were increased from 22 MT in 2003 to 332 MT in 2006 but decreased to 130 MT in 2009 before it slightly increased again to 227 MT in 2010.

COUNTRY REPORT FOR CAMBODIA

INTRODUCTION

In Cambodia, fisheries play an important role in the national economy and contribute 16% of its GDP. In term of value, marine fisheries account for nearly 40% of the country's fisheries production. Mackerels play a very important role for supporting protein demands to local people in the whole country and for income to fisheries business in Cambodia and Southeast Asia region. In 2008, *R. brachysoma* and *R. kanagurta* was planned to be tagged in Cambodia. The objective of the project that supported under Japanese Trust Fund II was to find out fish migration route and its reasons.

MATERIALS AND METHODS

Tagging operation was conducted two trips per year in Sihanouk province in South China Sea following detail procedures as provided in Standard Operating Procedure (Abu Talib *et. al*., 2013). The tagging activities were conducted on the deck of purse seine fishing boat of 22 m length and 450 hp. The live fishes that caught by purse seine were transferred by scoop to the aerated holding tank on board the vessel before the tagging operation. After identification of species and healthy condition, the fish were tagged and released in running sea water that flow into the sea through a big PVC pipe. All data and information on tagging program was collected using 'Tagging Data Sheet' and 'Recovery Data Sheet'.

RESULTS AND DISCUSSIONS

Overall, a total of 3,408 fishes were tagged and recorded from 2008 – 2010 where 1,400 fishes were tagged during northeast monsoon and 2,008 fishes during southwest monsoon. Only 8 (0.6%) fishes were recaptured with the longest days of liberty was 31 days. During the project activities, 1,200 posters were produced in 2008 and three group meeting were conducted that participated by 30 local fishers for each meeting for dissemination and understand about the tagging program and reward equivalent to USD5 upon returning the tagged fish. In addition, three group interviews were conducted in 2011 to find recovered fish and disseminate fish tagging information.

The additional information on local knowledge through questionnaire was also conducted during the tagging activities to the local fishers. The result showed that higher catch of *R. brachysoma* and *R. kanagurta* occur from December to March but the spawner / big size fish were caught from January to March. The respondents were very agreeing that the small pelagic fish resource is declining and close season during the spawning will help to increase the resources. They also very agree that the measures taken by government only are not enough but responsibility to manage and conserve the fishery resources should be shared among government and fishers.

COUNTRY REPORT FOR INDONESIA

INTRODUCTION

The small pelagic fisheries in the South China Sea and Andaman Sea have been developed since 1970s (Hariati *et. al*., 2000; Wudianto *et. al*., 2007). There are several fishing ger types used to catch small pelagic fish such as purse seine, gill net and fish trawl with dominant species caught are scads (*Decapterus* spp.), mackerel (*Rastrelliger* spp.) and sardines (*Sardinella* spp.). Total catches of small pelagic landed from the South China Sea and Andaman Sea was 166,151 and 108,411 MT, respectively. Most of the pelagic fishes migrate within the ecosystem, either among area within one country or among countries in the region. The pelagic fish species make small school, usually shelter around FADs, and are attracted to light at night. So, most of the purse seine fishers improve the fishing efficiency by using FAD and light to aggregate fish before the fish being caught but it may result in over exploitation in certain waters. To undertake proper fisheries management, the identification of type or variety of stock population of fish resources should be known through the fish migration pattern and conduct the genetic analysis.

MATERIALS AND METHODS

Two fishing areas were initially selected namely Pemangkat (South China Sea) and Lampulo-Banda Aceh (Andaman Sea). However, the implementation of tagging was finally only done in the territorial waters of Banda Aceh at Lampulo Fishing Port due to logistic reason. Tagging operation in Banda Acheh was conducted using purse seine vessel length 18 – 20 m in board engine with 400 – 450 HP and equipped with lamps. Tagging equipments consist of cage net, holding tank, aeration, scoop net, measuring board, tag and tag applicator as shown in the SOP (Abu Talib *et. al*., 2013). Tagging operation in Banda Aceh was targeted for Indian Mackerel (*R. kanagurta*) and scads (*D. macarellus*). The live fish caught by purse seine were moved into net cage, then were acclimated into holding tanks before tagged and released carefully into the sea through water channel supply with running sea water. Publicity on tagged fish and reward for returning those tagged fish to the closest fishing port offices has been made to fishers, fishing port officers and fish landing place officers. Interviews with local fishermen, researchers and literature study from previous studies have been conducted to obtain data and information related to development of small pelagic fisheries and using of FADs while the data of sardine catches were obtained from Capture Fisheries Statistical Book.

RESULTS AND DISCUSSIONS

Two tagging activities were conducted i.e. a total of 148 fish, consisted of 133 Indian Mackerel and 15 scads were tagged during first trip and 356 Indian mackerel (*R. kanagurta*) were tagged during the second trip. The sizes of tagged Indian Mackerel were ranged between 112 – 237 mm of length with the dominant size between 121 – 160 mm, and scads sizes were between 123 – 195 mm. Unfortunately, there was no report from fishers related to recapture fish. This might due to the tagged fish are still small size, migrate to other places, fishers do not report and bad weather.

The results of questionnaire on local knowledge shown that March to May and September to November are the highest catch season for small pelagic in both South China Sea and Andaman Sea while month of July and October to December are the lowest catch season. Results also shown that June is the highest composition of big size fish for *D. macrosoma* (and *D. macarellus*) and March to June for *R. kanagurta*. Most of fishermen are very agreed or agreed that small pelagic fish resources are declining and both parties (government and fishermen) have to play role to manage the resources.

The traditional FADs had been started to use in the South China Sea together with the starting of purse seine in 1986, usually use combined with light fishing as fish aggregating. The major target species were *Decapterus* spp. and *Rastrelliger* spp.

The production of sardine that consists of *Dussumieris acuta, Sardinella fimbriata, S. gibbosa* and *S. longiceps* is relatively large in small pelagic group, i.e. the second largest after scad. The percentage of sardine production from South China Sea and Andaman Sea in 2008 is around 24% and 11%, respectively with dominant sardine species caught are *S. fimbriata* and *S. gibbosa*. The production trend of these species for both South China Sea and Andaman Sea were decreased sharply in 2004, from near 35,000 tons to 15,000 in the South China Sea and from 10,000 MT to 5,000 MT but then were stable until 2008.

CONCLUSSIONS

Tagging operation of *R. kanagurta* and *D. macarellus* in Andaman Sea was conducted two times i.e. in July 2008 and August 2010 with the number of fish tagged were 148 fishes and 356 fishes, respectively. Unfortunately, there was no recaptured fish reported. The Indian mackerel (*R. kanagurta*) is the dominant species caught in the South China Sea and Andaman Sea beside three species of sardines, i.e. *S. longiceps, S. fimbriata* and *S. gibbosa*.

COUNTRY REPORT FOR MALAYSIA

INTRODUCTION

In Malaysia, small pelagic fishes including mackerels and round scads are important food sources and targeted by the capture fisheries. According to Hadil and Richard (1991), *R. kanagurta* are more abundant offshore and *R. brachysoma* are found mostly inshore. The total landing of Indian mackerel, *R. kanagurta* and short mackerel, *R. brachysoma* in Malaysia are 4% (56,520 MT) and 9% (128,970 MT), respectively (Anon, 2009). Mackerel in Malaysia are caught mainly by purse seines except in Sarawak waters that caught mainly by trawlers. Three main gears that caught mackerel in 2008 are purse seines (43%), drift/gill nets (37%) and trawls (20%) in the Straits of Malacca; purse seine (45%), drift/gill nets (31%) and trawls 18% in the South China Sea; trawlers (63%), gill net (21 %) and purse seines (13 %) in Sarawak waters; purse seine (72%), trawl net (12%) and lift net (8%) in Sabah. The round scads contributed about 7% (92,016 MT) to the total marine fish production (Anon, 2009). Round scads from the Straits of Malacca and the South China Sea are exploited mainly by purse seiners. Contrary to the landing trend in the South China Sea, landing of round scads by purse seiners are still increasing and is more prominent in the Straits of Malacca.

The sustainable exploitation of this potential shared stock in the South China Sea and Andaman Sea requires the formulation of management plan. Therefore, information on the existence of sub-population in the region is essential for the preparation of the plan. Migratory behaviours of the fish ascertained through tagging and recapture approach are primary methods to confirm the existence of sub-population.

MATERIALS AND METHODS

The tagging operation of mackerels and round scads were conducted based on the standard operating procedures (SOP) for tagging of small pelagic species (Abu Talib *et al.,* 2013). There are four target species of small pelagic fishes but in Sabah, only three species were targeted i.e. Indian mackerel (*R. kanagurta*), Shortfin scad (*D. macrosoma*) and Japanese scad (*D. maruadsi*) only.

A purse seiner of the size between 30 and 70 GRT was used in areas beyond 15 nautical miles to conduct the tagging operations. The purse seiner normally operated two hauls and tagging of fish was carried out after the final haul to avoid the tagged fish from being caught in the following hauling. Two round HDPE water tanks with capacity of 450 litres each were used to hold sea water. Live fishes from the catch of purse seiner are scooped and kept in the aerated tank before the tagging operation. Only healthy live fishes were tagged and released immediately. The fish conditions were also monitored in the releasing process. All tagging information was recorded in the 'Tagging Data Sheet' and information regarding the recapture/recovery of the tagged fish was recorded in the 'Recovery Data Sheet'. Reward in terms of cash money (RM15.00 per tail) was paid to individual who found and returned tagged fish to the project official. The publicity of tagging programmes was conducted in the forms of poster distribution and news dissemination through mass media (radio, television, and newspaper) prior to the commencement of the project.

RESULT AND DISCUSSIONS

In Peninsular Malaysia, this was the first tagging project on small pelagic fishes that was conducted on both sides of the peninsular. In the east coast of Peninsular Malaysia, altogether 3,675 tails of fish (2,954 *D. maruadsi*, 86 *D. macrosoma* and 635 *R. kanagurta*) were tagged during the three years tagging activities. Overall, a total of 122 fishes consisted of 109 *D. maruadsi* and 13 *R. kanagurta* were recaptured during Northeast monsoon in the east coast of Peninsular Malaysia with the longest days of liberty are 97 and 32 days, respectively. This accounted for 3.3% of the total tagged fishes and the result shows that this method of tagging fishes was successful. There was no recovery of the 2,109 tagged fishes that consisted of 1,837 *R. kanagurta* and 272 *R. brachysoma* from the Andaman Sea. In overall, most of the recaptured fishes were *D. maruadsi* as they were also the highest numbers that were tagged. The results showed that most of the recaptured fish (117 or 96%) were found in the tag and release area (within 0.5 nautical miles) in the east coast of Peninsular Malaysia, but there were also fish that recaptured at about more than 60 nm. Most of the fish recaptured were found in northern part of tagging area.

In Sarawak, a total of three trips of tagging operation were conducted in two areas; Mukah and Bintulu off Sarawak waters from 2008 until 2011. Altogether 1,615 fishes consisted of 491 *R. kanagurta* and 1,124 *D. maruadsi* were successfully tagged and released during that period. There was no recovery yet of the tagged fish even after three years of liberty time. In Sabah, a total of 1,914 fishes were managed to be tagged during the tagging period. This consisted of 36 (2 %) *D. maruadsi*, 562 (28 %) of *D. macrosoma* and 1,316 (66 %) of *R. kanagurta.* During the study, only three *R. kanagurta* were recaptured; two *R. kanagurta* were recovered during Southwest monsoon after 2 days of liberty and one *R. kanagurta* were recaptured Northeast monsoon after 62 days of liberty in Sabah waters.

The highest growth recorded for the recaptured *D. maruadsi* and *R. kanagurta* were 23 mm after 21 days at liberty and 38 mm after 5 days at liberty, respectively. The gonad analysis showed that about 8% of the *D. maruadsi* recaptures but none of the recovered *R. kanagurta* was sexually matured. Sardine resources in Peninsular Malaysia are made up of *Sardinella fimbriata*, *S. sirm* and *Dusumeria acuta* that locally known as tamban. Sardines are mainly caught by purse seine and drift net. They formed around 8 % of the total catch composition by purse seines. Landings of sardine in the east coast of Peninsular Malaysia are higher than the west coast. In 2010, total landing in east coast amounted to 16,608 MT while the west coast recorded a much lower landing at 3,676 MT. Landings in the east coast fluctuated and are generally higher during the pre-monsoon season.

CONCLUSION

In the east coast of Peninsular Malaysia, altogether 122 fishes had been recovered from the 3,675 tagged fishes but there was no recovery of the 2,202 tagged fishes from Andaman Sea. In future, tagging program could be more successful by tagging bigger number of fish and conducted in various locations. This will increase the recovery percentage of tagged fish. In addition, more intensive publicity is needed to promote the tagging program among the fishing community.

COUNTRY REPORT FOR MYANMAR

INTRODUCTION

The continental shelf area of Myanmar has an area of 228,751 square kilometres whilst the Exclusive Economic Zone (EZZ) covers 200 nautical miles off shore from the baseline is 486,000 square kilometres and the territorial fishing zone is within 12 nautical miles from base line. Three main fishing areas i.e., < 200 m depth, from north to south are Rakhine with an area of 27,406 square kilometres, Ayeyawady an area of 103,525 square kilometres and Tanintharyi an area of 94,756 square kilometres. Local fishing vessels are allowed to do fishing in one or two fishing areas. While, foreign vessels are only allowed to do fishing outside the territorial waters in Area 1 or Area 2 or Area 4. The common fishing gears used by fishers are bottom trawl, purse seine, surrounding gill net, drift net, traps and long line.

Estimated biomass of pelagic species in Myanmar was 975,500 tonnes with total catch of Indian mackerel was 11,853 tonnes in 2011-2012. Mackerel species (*R. kanagurta* and *R. brachysoma*) are caught mostly by purse seines, surrounding gillnets and bottom trawls. There are two major fishing grounds for *R. kanagurta* which are in Rakhine and Tanintharyi coastal areas and one minor fishing ground is in Ayeyawady coastal area. The fishing season for Indian mackerel in Rakhine and Ayeyawady occurs between November to February and fishing season in Tanintharyi occurs between November to April.

MATERIALS AND METHODS

Two tagging sites were selected in Tanintharyi Division in the southern part of Myanmar to conduct the tagging program i.e. between Lagnan Kyun and Sin Kyun, Boke Pyin Township, and Shwe Kyun, Kaw Thaung Township. There were two target species for tagging in Myanmar which are Short mackerel (*R. brachysoma*) and Indian mackerel (*R. kanagurta*). Species identification was based on published book by SEAFDEC-MFRDMD/SP/2 entitled 'Field Guide to Important Commercial Marine Fishes of the South China Sea (Mansor *et al.*, 1998).

Light luring purse seine was the only type of catching gear using during the three years tagging operation. It comprised fishing vessel, light luring boat and carrier vessel. Live mackerels from the purse seine harvesting operation were selected and transfer to net cages. The active live fishes were then transferred using a scoop net to the well aerated half ton black plastic circular holding tanks. The scoop was made of polyethylene and covered with canvas to retain seawater during transfer of fish. Active live fishes were selected for tagging after standard body-length was measured. The tagged fishes were released to the sea through a PVC tunnel fixed next to the working table on-board. The fish behaviour was recorded once fish entered the seawater (Abu Talib *et al.*, 2013).

Data and information about tagging operation and recovery was input into internet database (http://map.seafdec.org/tagging) that was created by SEAFDEC/TD. The data were then imported into excel format for further analysis. Successful recovery of the tagged fish depends on how aware the public is of the tagging program. Therefore, posters in Myanmar language were distributed in fishing villages along the coastal area of the country informing about the tagging program and the reward to those returning tagged fish.

RESULT AND DISCUSSIONS

In 2008, tagging operations successes tagged 60% from the target of 2,800 fishes and increased 1.5 times higher than the target in 2009. However, in 2010 the team had only managed to tag half of the target number. As the whole, 7,393 from the targeted 8,400 fishes or 88% were tagged. Indian mackerel had better achievement at 97% as compared to short mackerel (79%).

Recovery of the 31 tagged fish was only recorded for short mackerel (*R. brachysoma*) in both tagging areas/sites during Northeast Monsoon. The overall recovery rate of short mackerel was higher during the Northeast Monsoon (1%) than during the Southeast Monsoon (0.33%). The longest days of liberty was 139 days in Boke Pyin township in the same monsoon. One of the recovered tagged fish in 2010, recorded 8 mm increased in fork length from 175 to 183 mm after 139 days at liberty.

One thousand posters in Myanmar language were distributed to fishing villages, fishing vessels, fishing landing areas, fish market and processing plant through Division and State Department of Fisheries Offices in Coastal Region informing about the tagging program and the reward to those returning tagged fish.

Additional information from the local knowledge that obtained through feedback on the questionnaire showed that there are two catch season every year for small pelagic fish i.e. January to February and May to December. Higher compositions of juvenile were in May until August and from November until December. The fishers also observed slight changes in the size of fish stock where the fish is getting smaller since the past 10 years. The fishers agreed that among the destructive fishing gears to small pelagic are purse seine with light luring, fishing with explosion and fishing gear using small mesh size. So, the government should impose close season during breeding season, control of fishing capacity and prevent encroachment of the purse seine and trawlers into inshore waters.

CONCLUSION

The Department of Fisheries of Myanmar in cooperation with the Purse Seine Fishing vessels owners had tried their utmost effort to achieve the targeted number of fish to be tagged. But the percentages of tagged and recovery were low and the recovered tagged fishes were also without complete information. Hence, the main objectives to ascertain the migration pattern and existence of sub-population were not achieved.

COUNTRY REPORT FOR THE PHILIPPINES

INTRODUCTION

Statistics show that from 2003 to 2007, a total of 10,721,748.7 MT was landed with small pelagic comprising the bulk of the marine fisheries production where 13% are from the round scads and 8% from the mackerels. During this period, the South China Sea Area has contributed an estimated 22% of the total production or 2,352,477.3 MT of landed fish species.

In order to determine sharing of these stocks in the Southeast Asian Region, tracing their migration path can be a basic but significant method. Hence, determining the migration pattern of these stocks is one way of conceiving a viable management option. In order to attain such, the tagging of small pelagic in the South China Sea had been launched last 2007 in various countries within the Southeast Asian Region to possibly determine if the stocks from these neighbouring countries are being shared which can be a basis of drafting a Regional Plan of Action (RPOA) for the management of the small pelagic. Therefore the continuation of the tagging activity to determine their migration routes and relative mixing among SEAFDEC member countries is imperative for the formulation of a regional management framework in order to conserve and effectively manage these resources.

This paper further includes data on Fish Aggregating Devices collected and surveyed in the Philippines during the onset of project implementation. It likewise includes data on small pelagic focused on sardines, as they are considered a major part of the fisheries in the Southeast Asia.

MATERIALS AND METHODS

Initially, South China Sea Area (SCS) areas in Manila Bay and Palawan have been selected as the tagging areas. The transfer of fishing boats in other not situated in the South China Sea made the continuation of tagging activities in Manila Bay impossible, tagging area were relocated to Bataan where live samples are more abundant aside from its strategic location.

Initially, species were identified but as experienced during the first year, difficulties in gathering samples have been observed. Hence, during the Second Core Expert Meeting at Kuala, Lumpur, Malaysia, it was proposed that *R. kanagurta* and *R. brachysoma* for mackerel samples, and *D. maruadsi* and *D. macrosoma* shall be considered to be tagged if present to maximize the number of tagged samples

The vessel used in catching samples during the Manila Bay tagging activities was a commercial ring net. However, the vessel used in Bataan is a municipal type inboard motorized with outrigger fishing vessel. The gear used in sampling collection was a skimming net aided with a Fish Aggregating Device (FAD). The case of Palawan is different as live samples came from small scale commercial bag-net fishing vessel ranging from 3-20 GT with inboard outrigger. At Bataan, samples were placed in a Hapa net, and scooped during tagging operations hence, holding tanks were not used. However, the samples in Palawan were placed in three units 50 liter capacity containers and each were aerated by three portable aerators each with two 4D batteries. This was adapted as the fishing boat has no available electricity for aeration purposes.

The tagging data were recorded on a 'Tagging Data Sheet' while recovered samples are compiled using the 'Recovery Data Sheet'. Data obtained from the recaptured of tagged fish forms are the fundamental information needed for understanding movement patterns, growth rates, seasonal variation and reasons for the migration of the small pelagic species under the study. Reward in terms of cash money will be paid to the individual who found and returned tagged fish to the project official. Therefore, publicity in the forms of poster distribution and news dissemination through mass media on the conduct of this tagging project is very important to create awareness among the general public.

RESULT AND DISCUSSION

A total of 3,110 fishes were tagged in the Philippines for the whole tagging sessions. Furthermore, 45.61% fishes were tagged in Bataan, 49.48% fishes were tagged in Palawan while 4.88% fishes were tagged in Manila Bay. With regards to the species tagged, 94% were *D. macrosoma*, 0.13% *R. brachysoma* and 5.3% *R. kanagurta.* The tagging activities revealed that only *D. macrosoma* tagged in Southwest monsoon season had recoveries. Bataan had the highest recovery rate of 6.1196% or a total of 88 individuals with 29 days being the maximum days at liberty after release. Likewise, Palawan had obtained a recovery rate of 0.863% or a total of 11 individuals recovered.

Result of analysis on the migration pattern in 2009 showed that majority of the recovered; 65% are bound in a Northwest direction. The longest distances travelled by *D. macrosoma* in Bataan were 12.4 kilometres also going to Northwest. However, data migration in 2010 revealed that majority of the recovered samples followed a Southwest migration pattern. Majority of the recovered tagged fishes at Bataan in 2009 are male with 56 while only 8 are females but all were observed to be males in 2010. Based on the analysis of the GSI in Bataan sampling site for 2009 and 2010, the recovered samples are sexually immature with stage 2 is the most dominant. Size ranges of 143 – 188 mm and 133 - 160 mm were observed in 2009 and 2010, respectively. The GSI of samples recovered in Palawan for 2010 depicts that majority or 70% of the recovered tagged fishes are sexually matured and male samples (60%) are observed to be more dominant.

In an attempt to increase awareness about the program and possibly attained higher recapture rates, a total of 1000 pieces size A4 posters were strategically posted in conspicuous areas such as fish ports and fish landing sites, city halls, major markets as well as fishing boats. The project also was featured in major national newspaper of regular circulation aside from being shown in national government television, BFAR website as well as BFAR Newsletter.

Additional information on local knowledge were obtained through standardize questionnaire among SEAFDEC member countries (Abu Talib *et al.*, 2013) revealed the respondent's experience of high catch in the months of May to July. It is further noted that June and July has the incidence of catching spawners in Bataan comprised mainly of round scads while July to August with round scads, mackerel and bigeye scads are the season for spawners for Palawan. Bataan and Palawan respondents are very agree that the small pelagic fishery resources are declining where the size of the catch for the past ten years is getting smaller. They also agree that the responsibility to manage and conserve the fishery resources should be shared between the government and the fishermen.

Various design and specifications of the payao as fish aggregating devices (FAD) exist in the Philippines; the most common are the steel and bamboo types in commercial fisheries and styropore and bamboo types for shallow water areas. Payaos in the Philippines are being harvested by various fishing gears such as handlines, troll lines, bagnet, ring nets and purse seine. Catches from payao are largely consisting of tuna and other pelagic fishes.

Common tunas in the Philippines belong to the Family Scombridae. Further, frigate tuna was the most dominant with 30.74% followed by Skipjack with 30.05%. Yellowfin tuna, Eastern little tuna and Bigeyed tuna had 26.52%, 11.41% and 1.54% respectively. With regards to the trend of production, frigate tuna shows a declining pattern while skipjack and eastern little tuna show an increasing trend.

Studies shows that at least 13 species of the sardine family are found in the Philippines with seven are commercially exploited. These are the *Sardinella brachysoma, S. albella, S. longiceps, S. melanura, S. fimbriata, S. gibbosa* and *Amblygaster sirm.* The two sardine species observed to be landed from the South China Sea Area, Philippines have varying trends. For Indian sardines, it approximately increased from 2003-2004 from 28,280MT to 32, 478.5 MT respectively. From there on, it showed a declining pattern until 2007, the lowest, with 24,891.9 MT. With regards to the Fimbriated sardines, it is observed to have a lower produce compared to Indian sardines with its production peak of 16,587.39MT in 2006 and having its lowest in 2003 with 7,894 MT. Interestingly, this species showed an increasing pattern from 2003 to 2006 but gradually decreased in 2007.

COUNTRY REPORT FOR THAILAND

INTRODUCTION

Thailand fisheries production comes from capture fisheries (75.89%) and aquaculture (24.11%). The capture fisheries can be divided into two categories based on resources; demersal and pelagic fisheries. Fisheries production obtained from the Gulf of Thailand and the Andaman Sea in 2008 were about 104,205 MT and 66,710 MT respectively (Department of Fisheries, 2010). The marine fish in Thai waters include 1,347 species belonging to 141 families. They consist of 618 species of fishes of economic value, 350 species of aquarium fish and 379 species of trash fish (Sukhavisidth, 1996). The small pelagic fishes, particularly scads and mackerels, are the most common commercial stocks in Thailand.

The fish migration pattern of fishes in the Gulf of Thailand and the Andaman Sea is available only for *R. brachysoma*. The intensive tagging experiments were carried out by the Marine Fisheries Division, Department of Fisheries of Thailand during 1960 – 1965 in the Gulf of Thailand and during 1981-1984 in the Andaman Sea and only recaptured 4,191 fishes from 26,864 fishes released and 191 fishes from 6,912 fishes respectively. If we considered the result of the tagging activity in Thailand, there is something that we should know such as the fishes in the eastern part of the Gulf of Thailand is a shared stock with Cambodia's fish stock, fishes in the southern part of the Gulf of Thailand is a shared stock with Malaysia's fish stock, and fishes in the northern part of Andaman Sea is a shared stock with Myanmar's fish stock.

Therefore, in 2007, The Department of Fisheries of Thailand has collaborated with SEAFDEC/MFRDMD to conduct a study program on tagging program for economically important pelagic species in the South China Sea and Andaman Sea which donated fund by Japanese Trust Fund II. All process of study and technical view has led and supported by SEAFDEC/MFRDMD, Malaysia. The objectives of this program were to (1) determine the migration pattern of *R. brachysoma, R. kanagurta, D. maruadsi* and *D. macrosoma* in Thai waters, (2) gather local knowledge of the target species, (3) collect information on the fish aggregating devices (FADs) in Thailand, and (4) collect information about the sardine resources in Thailand.

MATERIALS AND METHODS

Tagging activities were carried out in at four sites which were Ranong and Satun province in the Andaman Sea, as well as Songkhla and Trat province in The Gulf of Thailand. The target species of the study are Short mackerel (*R. brachysoma*), Indian mackerel (*R. kanagurta*), Japanese scad (*D. maraudsi*) and Shortfin scad (*D. macrosoma*). Species identification was based on the Field Guide to Important Commercial Marine Fishes of the South China Sea (Mansor *et. al.,* 1998).

Two types of fishing gear were used for tagging operations; a light luring purse seine and bamboo stake trap. Target fishes from the Bamboo stake trap and purse seine were collected using a scoop net and transferred to a square cage. Selected live target fishes were transferred into stocking tank using plastic basin filled with seawater for the tagging operation. This tagging operation used the same materials and procedures as described in Standard Operating Procedures (Abu Talib *et al*., 2013). After getting sufficient number of the target species, the tagging activity was conducted 3 nm away from the fishing site. The releasing procedure depends on the condition of the tagged fishes. Healthy tagged fishes were kept in the holding tank until 100 tails before being released. This is to allow the fish move in school and to reduce mortality due to predation. The unhealthy fishes were immediately released after being tagged to reduce further stressed.

The amount of recovery of tagged fishes depended on public awareness of the tagging program. When some people found tagged fish, they would inform the nearest Department of Fisheries office. After that the staff of DOF would inform the project staff to make contact with the finder and to collect tagged fish with relevant information. The information gathered was recorded into a recovery data sheet. Data and information about tagging operation and recovery was recorded in the internet database that was created by SEAFDEC/TD.

RESULTS AND DISCUSSION

The total number of tagged fish in Ranong Province was 4,038 tails which comprised of 756 *D. macrosoma*, 2,389 *D. maruadsi*, 756 *R. kanagurta* and 124 *R. brachysoma*. In Satun Province, total number of tagged fish was 1,648 which consisted of one *D. macrosoma*, 1,035 *R. kanagurta* and 612 *R. brachysoma*. In Songkla Province, the total number of tagged fish was 3,593 which consisted of 33 *D. maruadsi*, 2,673 *R. kanagurta* and 887 *R. brachysoma*. The total number of tagged fish in Trat Province was 1,868 which comprised of 812 *D. maruadsi*, 135 *R. kanagurta* and 921 *R. brachysoma*. The project utilized 5 types of media for publicizing the project and the fisherman radio communication was the best way to publicise the tagging program followed by posters which were distributed to fishing ports along the coastline of Thailand.

All the tagged fish were found within the EEZ. In the Gulf of Thailand, there is no recaptured of tagged fish in Songkla Province. In Trat Province, only four (0.44%) *R. brachysoma* was recaptured with the longest days at liberty of 96 days during the southwest monsoon. In the Andaman Sea, only one of *R. kanagurta* with recapture rate 0.13% was recaptured after five days during northeast monsoon. In Ranong Province, the numbers of tagged fish were recaptured included 61 (9.95%) *D. macrosoma,* 58 (7.00%) *D. maruadsi,* 7 (1.14%) *R. kanagurta* and two (1.61%) *R. brachysoma* were recaptured during the Northeast monsoon. There was no recaptured of tagged fish during the Southwest monsoon except for *D. maruadsi* where 0.06% or 1 fish was recaptured with 113 days in the sea. The longest recovery days were 59 days, 113 days, 20 days and 34 days for *D. macrosoma, D. maruadsi, R. kanagurta* and *R. brachysoma* respectively.

The comparison between tagged fish direction of travel and sea surface currents showed that tagged fishes swam against sea surface current. This was identified from recovery data of *D. maruadsi* which was released at Ranong Province in April 2011 and recaptured in June 2011 was from South to the North while the direction of sea surface current from a study by Monton & SEAWATCH (1999) was north to south. The direction of travel from recovery data of two *R. brachysoma* at Trat province which were released in April 2011 and recaptured in June and July 2011 was west-east and west-northeast along the coast line whilst the direction of sea surface current in the study of Chinorost *et al*., (2001) was southeast to northwest. The result showed that the two recovered tagged fishes moved against sea surface current. The fish filter the food out of the water as planktons and other kinds of food flow with the currents.

The migration pattern of *R. brachysoma* at Trat Province is the same as the result of study conducted in 1960-1965. The Indian mackerel migrate to coastline of Chanthaburi province and might be the same as the stock at Western Gulf of Thailand. This fishes moved south to Chang Island at Trat Province then they move to the coastline and return to upper Gulf of Thailand. However all fishermen that catches small pelagic fishes in the area of Eastern Gulf of Thailand said that the stock of *R. brachysoma* is not same stock as of Western Gulf of Thailand, but it is the same with the stock of Cambodia. This can resulted in confusions regarding *R. brachysoma* not considered the same stock with other since the study in 1960.

Gonad and stomach content study of target fishes were conducted from 2010 to 2011 at 3 sites, Ranong, Songkhla and Trat province. The data indicated that the spawning season and spawning area for *D. maruadsi* in the Andaman Sea was in April around Latitude 9° 00' to 9° 32' and Longitude 97° 28' to 97° 59' that was 22.11 – 51.18 nm from shore with water depth 40 – 88 m.

The project utilized 5 types of media for publicizing the project which include posters, letters, radio, personal communication and fishermen radio communication. The information from finder of recovered tagged fish showed that fisherman radio communication was the best way to publicise the tagging program. The second best method was using posters which were distributed to fishing ports along the coastline of Thailand.

The result of local knowledge from fishermen showed that the peak catching season for small pelagic were divided into two periods in the Gulf of Thailand i.e. March to May and September to November; and from March to May in the Andaman Sea. The fishermen agreed that the stock size of target species were lightly changed since the past 10 years. The best action to be taken by government to increase small pelagic fish stocks are ban on anchovy purse seine with light fisheries, increase in area of new artificial reef, a ban on illegal fishing gears and increase protected area.

COUNTRY REPORT FOR VIETNAM

INTRODUCTION

In Vietnam, scads and mackerel are also important small pelagic fishes, which contribute a large part to the total catches. The results from resources surveys during 2003-2005 showed that scads, (*D. maruadsi* and *D. macrosoma*) and Indian mackerel (*R. kanagurta*) contributed about 31% and 15% respectively of the total small pelagic resources. Pelagic fisheries are widely dispersed along the coast; purse seine fleet mainly catches these resources, especially round scads and mackerel. The Vietnamese fishery is presently facing problems, such as over-exploitation of the resources in the coastal waters, and lack of system for the resources management. These need to be tackled for the rationales of medium-term and long-term developments.

In order to maximize the rational utilization of the small pelagic fish resources in the Southeast Asia region, SEAFDEC conducted a research program called "Information Collection for Sustainable Pelagic Fisheries in the South China Sea" from 2003 to 2006. "Tagging program for Economical Important Pelagic Species in the South China Sea and Andaman Sea" was initiated under Japanese Trust Fund II and was implemented during 2007-2012. This country report presents the summary activities of the "Tagging program for Economical Important Pelagic Species in the South China Sea and Andaman Sea" project in Vietnam.

MATERIALS AND METHODS

The Vietnam waters are divided into four large ecological areas i.e. Gulf of Tonkin, Central, Southeast and Southwest waters. Initially, four tagging sites were selected namely Nghe An, Nha Trang, Ben Tre and Kien Giang (Abu Talib *et. al*., 2013). However, due to limitation of budget, only Nghe An and Khanh Hoa selected for tagging activities. Three target species were selected which were Indian mackerel (*R. kanagurta*), Japanese scad (*D. maruadsi*), and Shortfin scad (*D. macrosoma*).

Medium-sized light purse-seine fishing boat was used for the purpose of tagging operation of small pelagic fishes at sea. A dark colour round tank with diameter of about 3 meter, which place on desk, was used to maintain the alive fish for tagging. The tank was supplied with flow through sea waters and maintained water levels of about 60 cm depth with the covered net to prevent fish from jumping out of the tank. Scoop net was used when catching the live fish from the holding tank. Fish was held in the purse seine net for 0.5 - 1.0 hour before transferring to the rounded bamboo tanks using scoop net to reduce the damage. Fish was kept in tank with the density of 30 ind.m^{-3}.

Four persons involved in conducting a tagging operation. First person scooped the live fish and identified its species, second person hold the fish and did the fork length measurement; third person did tagging work; the last person recorded data/information into a tagging data sheet (tag number, measure of fish, condition of tagged fish at the release, etc.).

Information from this tagging program was collected using two dedicated forms. All data collected during the tagging operation were kept in 'Tagging Data Sheet'. Data / information obtained on the recovery of the tagged fishes were gathered in 'Recovery Data Sheet'. Rewards in terms of cash money with amount of 81,000 VND (~ 5 USD) was paid to the individual who found and returned tagged fish to the project official. Therefore, publicity in the forms of poster distribution and news dissemination through mass media (radio, television and newspaper) on the conduct of this tagging project was conducted to create awareness among the general public.

RESULTS AND DISCUSSION

A total of 10,809 individuals of fish were tagged for whole tagging activities in Vietnam, including 1,292 individuals of *D. macrosoma*; 9,025 individuals of *D. maruadsi*; and 942 individual of *R. kanagurta*. The length range of the tagged fish for *D. macrosoma*, *D. maruadsi* and *R. kanagurta* were from 7.0 cm to 23.0 cm, 8.0 cm to 27.0 cm 8.0 cm to 25.0 cm respectively.

The result shows that 120 recoveries of tagged fish *D. maruadsi* using lift-net fishing boats during the Southwest Monsoon with the longest day at liberty were 9 days. It is equivalent to 10.4% of the recovery rate. However, there was no record of recovery of other species. The size of the tag used in the tagging activity might be too large for the fish to carry without stress. Their movements would effected by the tag. So, the pattern of movements was not reflecting the true migration of the fishes.

The publicity of the tagging program in Vietnam was done in various manner using posters, mass media coverage (radio and news), internet and personal communication. The posters were designed in A4 size in local Vietnamese language. During 2008 to 2010, 3,500 posters were distributed to locals at jetties and adjacent coastal provinces. News about the tagging program was broadcast daily at the end of the 'fishing ground forecast news' by the Voice of Vietnam Radio at 5.30 A.M. Though the publicity was well-done, they might not cover whole the fishing fleets. There might be many fishermen who did not well informed about the tagging program. So, when they found the tagged fishes, they did not report or just discarded. This led to under reporting situation, which effected to the estimation of fishing mortality.

During the program, additional information on local knowledge was also collected. The fishermen agree that small pelagic resources are declining and will extinct if catch and fishing effort is not controlled. They also very agree that close season during spawning will increase fish resources.

OVERVIEW PAPER ON FISHERIES IN MALAYSIA

INTRODUCTION

Malaysia is a confederation composed of the Peninsular Malaysia and the states of Sabah and Sarawak with 330,000 km^2 of land area and a coastline of 4,492 km. As in many Asian countries, fisheries in Malaysia are an important industry in terms of trade exchanged, food security and employment provider. The marine fishing sector directly employed almost 129,622 people of which 72% are local and 28% are foreign crews (DoFM, 2012). This made about 1% of the national labour force working on-board the 49,756 licensed fishing vessels in the country.

In terms of food security, fish provides 21% of total protein supply in Malaysia, with the per capita fish consumption estimated at 52.2 kg per person which is the highest in South East Asia. The rate of demand for fish as a protein source in Malaysia continues to increase, with total annual consumption growing to 56 kg per person in 2010. Presently, the Self Sufficiency Level (SSL) for fish stood at 91%.

CURRENT STATUS OF FISHERY RESOURCES

The marine capture fisheries in Malaysia take place in three distinct areas that have different environmental conditions, namely, the eastern zone of the Straits of Malacca bordering the west coast of Peninsular Malaysia; the western and eastern corridors of the South China Sea bordering the east coast of Peninsular Malaysia and the west coast of Sabah and Sarawak; and the western zone of Sulu - Sulawesi Seas which bordering the east coast of Sabah. The total national catch in 2010 was came from the Straits of Malacca i.e. about 806,726 MT (52%) followed by the South China Sea i.e. about 575,503 MT (40%) and the Sulu – Sulawesi Seas (6%). Small and large demersal species in the Straits of Malacca show overall stable or increasing trend but the trend is stable or slight decline in the South China Sea. Although, large pelagic in the Straits of Malacca is decreasing but small pelagic increasing. Contribution of pelagic species including anchovy and sardine in the South China Sea were declined.

Scads contribution to the total catch were double than mackerels in the South China Sea. While, mackerels contributed to the total landings were five times more than scads in the Straits of Malacca. Scads caught in the South China Sea and landed in Malaysia constitute 89% by purse seine and 11% by trawl, drift/gill net, lift net and hooks & lines. Scads from the Straits of Malacca exploited mainly by purse seine. Mackerels are caught by various types of gear in the South China Sea particularly purse seines (45%), drift/gill nets (31%) and trawls (18%). Mackerels in the Straits of Malacca are caught by purse seines (43%), drift/gill nets (37%) and trawls (20%) in 2008. The fishing grounds of purse seiners and trawlers are more offshore than the drift/gill netters. This requires analysis of landings data by species since distribution of species might be different from each other. Study shows that the Indian mackerel (*R. kanagurta*) made up about 25% of the total catch of purse seines in the South China Sea of Malaysia, while Short mackerel (*R. brachysoma*) only contributes to 2% (Raja Bidin & Ku Kassim, 2007). In the Straits of Malacca, purse seines using FAD and light purse seine catch more Indian mackerel. Short mackerels are caught mainly by the Thai purse seines. However, trawler using high opening trawl nets mainly catch the Short mackerels.

FISHERY HABITATS IN MALAYSIA

At the end of 2004, Malaysia's mangrove forests covered a total area of about 564,971 hectares (ha), with 97,882 ha in Peninsular Malaysia, 340,689 ha in Sabah and 126,400 ha in Sarawak. Of this total, 436,714 ha have been gazetted as forest reserves, while the remaining 128,257 ha are gazetted as state land. Malaysian mangroves are of global biodiversity significance – they harbour 41 mangrove species, or two-thirds of the world's total. Some rare species that have very restricted distribution such as *Sonneratia griffithii, Bruguiera hainessi, Aegiceras floridum, Osbornia octodonta, Algaiacucullata, Heritiera forms* and *Heritiera globosa* are at risk of localised extinction as there are no significant efforts to conserve them. In some parts of the world, conservationists are working with local residents to develop sustainably managed mangroves forests that provide income and natural resources. Matang Mangrove Forest located in Perak state in Peninsular Malaysia is one of the best examples of a sustainably managed mangrove forest.

Seagrasses are complex in morphological structure and possess multiple ecological functions. They are associated with shallow inter-tidal habitats, mangrove areas, coral reefs, semi-enclosed lagoons and shoals; and have the ability to tolerate a wide range of salinity. Seagrasses are distributed along the coasts of Malaysia in patches or meadows. The 14 seagrass species recorded are: *Enhalusa coroides, Halophila beccarii, H. decipiens, H. ovalis, H. minor, H. spinulosa, H. pinifolia, H. uninervis, Cymodocea rotundata, C. serrulata, Thalassia hemprichii, Syringodium isoetifolium, Ruppia maritime* and *Thalassodendron ciliatum* (MOSTI, 2009).

Seaweeds are macroscopic marine-benthic algae that can be divided into four large groups namely divisions Cyanophyta, Chlorophyta, Ochrophyta or Phaeophyta and Rhodophyta. The tally of Malaysian marine algae is 358 taxa, which comprised of six (6) Cyanophyta, 93 Chlorophyta, 85 Phaeophyta and 174 Rhodophyta. There is minimal occurrence of coral reefs along the mainland coast of Peninsular Malaysia, but coral reefs occur around all the offshore islands. Overall some 346 species of scleractinian coral have been identified in Malaysian waters. With a high concentration of biodiversity and islands supporting 1,687 square kilometres of reefs, Malaysia depends on the economic activity provided by fisheries.

Marine protected areas (MPAs) including marine parks, have been designated in many places worldwide, which can help protect and restore threatened species, but MPAs are limited in size and therefore, limited to the marine life that inhabits those areas. Marine Parks are protected areas of sea zoned one or two nautical miles from the shore at lowest low tide. These marine parks are not necessarily established just for fisheries conservation; many also target the conservation of biodiversity, such as sea turtles or other vulnerable species. Depending on their location, the total of 53 marine parks in Malaysia was fall under different jurisdiction; 42 marine parks in Peninsular Malaysia, 3 marine parks in Sarawak and 5 marine parks in Sabah.

Population of many species are decreasing at an unsustainable rate, and the number of species listed as endangered from marine life families such as whales, dolphins, dugongs, salmon, seabirds, sea turtles and sharks to name a few, are on the rise. The threats to marine species are difficult to perceive because marine animals are not as visible as animals on land.

FISHERIES MANAGEMENT AND POLICY

The Department of Fisheries (DOF) is the main agency responsible for management and development of the fisheries industry besides the Fisheries Development Authority (LKIM). Both agencies are under the administration of the Ministry of Agriculture and Agro-based Industries (MOA). Fisheries management in Malaysia is governed by the Fisheries Act 1985 and its subsidiary regulations. However, most fisheries enforcement in Malaysia is now undertaken by the Malaysian Maritime Enforcement Agency (MMEA), and this is especially so beyond three nautical miles from the shoreline.

Generally, there are four major fisheries in Malaysia defined according to the fishing technique namely; fish trawl, shrimp trawl, fish purse seine and anchovy purse seine fishery. Management structure for specific fishery in Malaysia is not well formed. Therefore, the present management measures are more general in nature although some are rather for specific. Among the main measures are; fishing zones, closed fishing areas, fishing effort controls, control of fishing units, controls in port and at sea, registration of fishermen, conservation of marine habitat, and the community-based fisheries management. All fishing vessels are required to be registered and all the fishing appliances are required to be licensed before conducting fishing in Malaysia Fisheries Waters.

Strategy and policy on fishery is formulated and implemented almost entirely top down. Consultation to the stakeholders was normally done toward the end of the formulation and right before the implementation. Recently, the consultation processes are more thorough starting from the formulation process. This results a better acceptance by the stakeholders of new policy.

RISK ASSESSMENT FOR JAPANESE SCAD (*Decapterus maruadsi*) IN THE SOUTH CHINA SEA OFF THE EAST COAST OF PENINSULAR MALAYSIA

INTRODUCTION

Scads (*Decapterus* spp.) or Selayang are among the most important small pelagic fishes in Malaysia which contributed to more than 9% to the total small pelagic production in 2010. In the South China Sea waters of the country, production of scads are much higher and reached 36% of the total small pelagic. The objective of this case study is to present 'assessments' of Japanese scad (*D. maruadsi*) fishery in the east coast of Peninsular Malaysia. Although this paper is based solely on information in Malaysia, it's demonstrated the initial steps for the development of regional fisheries management plan (RFMP). These assessments represent a 'benchmarking' of the fishery, and are considered an important *starting point* from which regional fisheries management plans can then be developed.

OVERVIEW OF JAPANESE SCAD

The Japanese Scad, *D. masuadsi* (Temminck & Schlegel) is a pelagic fishes, dwells in large schools in coastal waters to depth of 20 m. The Japanese scad belong to plankton feeder as well as preyer of fishes. The maximum size of Japanese scad is 35 cm but common sizes are around 25 cm. Growth and population parameters of Japanese scad in the study area have been estimated from the five-year SEAFDEC regional project showed that stock in the east coast of Peninsular Malaysia has faster growth, larger maximum size and reaching maturity stage at a smaller size for the female. Spawning season for Japanese Scad is between January to August for the whole South China Sea of Malaysia.

'Tagging Program for Economically Important Pelagic Species in the South China Sea and Andaman Sea' under the Japanese Trust Fund II Program for four small pelagic species, including Japanese Scad, have been undertaken by the Marine Fishery Resources Development and Management Department of SEAFDEC (SEAFDEC/MFRDMD) since 2007 and continued until end of 2011. In the South China Sea, a total of 32,344 fishes (including 14,579 *D. maruadsi*) were tagged and released. Unfortunately, the recovery of the tagged fishes from 2008 until 2011 was very poor, with only a total of 351fishes including 108 *D. maruadsi*.

There are three main gears catching small pelagic fishes in the study area showing continues increased in number since 2000 except for the trawl gear. Scads caught in the South China Sea and landed in Malaysia constitute 89% by purse seine and 11% by trawl, drift/gill net, lift net and hooks & lines. It showed that the purse seine fishery is the sole main fishing gear exploiting scads in the east coast of Peninsular Malaysia.

METHODOLOGY

The assessments presented in this case study were made based on a literature review, therefore it represent a 'rapid appraisal' of the fishery. This study has used a benchmarking standard developed by the Marine Stewardship Council (MSC). The risk assessment of the fishery is based on an assessment of performance against three main issues, or 'Principles'; stock status

(Principle 1), ecosystem impacts (Principle 2) and fisheries management (Principle 3). The performance can be viewed as weak (scored as 0 and red), intermediate (scored as 1 and amber), or good (scored as 2 and green). The use of a wide range of indicators, and a simple colour-coded scoring system, allows for easy identification of both the strengths and the weaknesses in the status, impacts and management of these fisheries.

Due to a desire to ensure that developing country fisheries (where data may often be lacking) can also engage with the MSC certification process, a Risk-Based Framework (RBF) has been developed by the MSC and can be used to evaluate and score some outcome performance indicators when data-deficiency is encountered. The RBF includes two methods for assessing the risk to each of the ecological components from activities associated with the fishery under assessment. The first is a system based on expert judgment (Scale Intensity Consequence Analysis - SICA), which is a qualitative analysis which aims to identify which activities lead to a significant impact on any species, habitat or ecosystem. The second is a semi-quantitative analysis to assess potential risk (Productivity Susceptibility Analysis - PSA). A Productivity Susceptibility Analysis (PSA) was undertaken utilizing the risk-based approach to fisheries assessment developed by the MSC. The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities. The PSA is then used in order to determine the overall risk to the stock.

The seven productivity attributes are specific to the species and determined according to species growth and maturity characteristics, trophic level and fecundity. The scores will be consistent across a single stock, regardless of which countries or gears are targeting the fishery. Based on current evidence, for the purpose of the PSA, the Japanese Scad present in the South China Sea is considered to be a single stock.

Low productivity species are potentially easier to over exploit so fisheries for these stocks are higher risk. However, in order to finally determine the level of risk, productivity scores must be combined with information about the susceptibility to capture. The susceptibility analysis considers attributes that are specific to the gear that is targeting the fishery and assessed according to the overlap of the fishing area compared with the species range, selectivity of the gear and the likelihood of post capture survival.

FISHERY ASSESSMENT

The main 'unit of assessment' for the scad fishery in the South China Sea area of Malaysia is defined as purse seine fishery. Purse seiners with 1 inch (25mm) mesh size targeting small pelagic with Japanese scad as one of the target species and other species retained are categorize as by-catch. The risk assessment was conducted based on the three principles i.e. stock status, ecosystem impacts for purse seine fishery and fishery management framework. While, the assessment of PSA only conducted for target species and retained species.

The fishery assessment of Principle 1 consist stock status/outcome, harvest strategy/stock management and productivity-susceptibility for Japanese Scad in the South China Sea. All indicators for Principle 1 for risk assessment were scored as weak except for indicator stock assessment that scored as intermediate. Japanese scad scores low risk on six productivity attributes and high for trophic level. Japanese scad also is highly susceptible to being caught by the purse seine. Due to the fishing method, it has a low selectivity in that most fish encircled will be captured. From a stock status perspective purse seine is considered to be high risk to Japanese scad in the study area as shown more than 90% of the landings came from purse seine.

The ecosystem impact for the purse seine fishery (Principle 2) were involved the assessment for retained species, ETP species, habitat and ecosystem. All indicators in Principle 2 for purse seine fishery were scored same amount of good, intermediate and weak. All habitat indicators i.e. habitat status (2.4.1), habitat management (2.4.2) and habitat information (2.4.3) also ecosystem management (2.5.2) for the ecosystem indicator have scored good. The PSA has also been undertaken for other species that are likely to be captured in conjunction with the small pelagic fishery, including Indian mackerel and tuna species. The main retained species are known comprising about 28 pelagic species (of which 8 are main that contributed >3% of purse-seine total catch). Overall therefore it is expected that the Japanese scad purse seine fishery hindering recovery of main retained species.

The assessment of performance for Principle 3 indicators are relating to both the general governance and policy framework, and also to fishery specific management. The assessment shows that only indicator 3.1.2 scored as good. The indicators 3.2.1, 3.2.2 and 3.2.4 scored as weak while the rest scored as intermediate.

SUMMARY

After the PSA and risk assessment were conducted for the Japanese Scad fishery in the east coast of Peninsular Malaysia, it showed that the target species and major retained species had high risk to the purse seine fishery. From 28 indicators in three principles risk assessment, only five were scored as good while 12 indicators were scored as weak. In terms of stock, some information including estimated population parameters is given but this is now some years old and more significantly has not informed a harvest strategy. The recording of landings is comprehensive and as no discarding occurs is assumed to effectively relate to total catch. However more extensive investigation of by-catch and ETP interactions is needed. Zonal management in Malaysia is relatively advanced as is the well-established network of marine parks. However there remain shortcomings in the implementation of management measures.

ASSESSMENT OF THE INDIAN MACKEREL (*Rastrelliger kanagurta*) FISHERIES IN THE ANDAMAN SEA OF INDONESIA, MALAYSIA, MYANMAR AND THAILAND

INTRODUCTION

The objective of this report is to present 'assessments' of Indian mackerel (*Rastrelliger kanagurta*) fisheries in the Andaman Sea covering Malaysia, Indonesia, Thailand and Myanmar. The impact to Indian mackerel by the 3 different fishing gears will be highlighted.

The risk assessment presented in this case study were made based on the literature review, therefore it represent a 'rapid appraisal' of the fishery. This study used a benchmarking standard developed by Marine Stewardship Council (MSC). This methodology analyses the fisheries against three 'Principles'; stock status (Principle 1), ecosystem impacts (Principle 2) and fisheries management (Principle 3). It should be emphasized that this is not a normal MSC assessment, but the MSC framework is used as a comprehensive assessment method for assessing key strength and weakness in the fisheries under review. Under each of these three Principles, the fisheries are 'scored' based on number of specific indicators used to assess performance. The performance can be viewed as weak (scored as 0 and red), intermediate (scored as 1 and amber), or good (scored as 2 and green).

A Risk-Based Framework (RBF) has been developed by the MSC for assessing data-poor fisheries. The RBF includes two methods for assessing the risk, i.e. Scale Intensity Consequence Analysis (SICA) and Productivity Susceptibility Analysis (PSA), but the PSA forms a more useful and insightful tool for use during this assessment.

The PSA approach examines attributes of each species that contribute to or reflect its productivity or susceptibility, in order to provide a relative measure of the risk to the scoring element from fishing activities. The PSA is then used in order to determine the overall risk to the stock. The seven productivity attributes are specific to the species and determined according to species growth and maturity characteristics, trophic level and fecundity. The susceptibility analysis considers attributes that are specific to the gear that is targeting the fishery and assessed according to the overlap of the fishing area compared with the species range, selectivity of the gear and likelihood of post capture survival.

SYNTHESIS OF THE INDIAN MACKEREL FISHERIES IN INDONESIA, MALAYSIA, MYANMAR AND THAILAND.

The Indian mackerel, *R. kanagurta* (Cuvier) is a neritic pelagic shoaling scombroid fish widely distributed in the Indo-West Pacific region. Longevity is believed to be at least 4 years. Indian mackerel is a migratory species, however only limited information is available on its migration pattern. Details of species migration provide important information for stock identification and shared stock of pelagic fishes. However, the information on migration of Indian mackerel in this region remains fragmentary and inadequate for the purpose of managing the fishery. Tagging experiments on four small pelagic species, including Indian mackerel have been undertaken by SEAFDEC/MFRDMD since 2007 until end of 2010. In the Andaman Sea, tagging operation were conducted in Indonesia, Malaysia, Myanmar and Thailand, with a total of 6,635 Indian mackerel tagged and released. Unfortunately, the recovery of tagged fish was low i.e. 38 tails (0.45%).

The main fleets and gears catching Indian mackerel in Indonesia, Malaysia, Myanmar and Thailand were purse seine fisheries that targeted small pelagic, including Indian mackerel. While, other gears such as bottom otter trawls and gill nets were taking this species as a retained by-catch. In Thailand and Indonesia, catches of Indian mackerel are low (compared to total national landings), and that the socio - economic importance of Indian mackerel fisheries may be small in terms of total employment and income generation. Small pelagic such as Indian mackerel are generally low cost to consumers and have high micro-nutrient content as well as providing an important source of animal protein. They thus serve an important socio-economic role in term of food security.

PRODUCTIVITY SUSCEPTIBILITY ANALYSIS

PSA was utilizing the risk-based approach to fisheries assessment developed by the MSC for the gear types targeting Indian mackerel. Indian mackerel is highly susceptible to being caught by purse seine and trawl fleets operating in Indonesia, Malaysia, Myanmar and Thailand. Vessels deploying these gears are likely to overlap more than 30% of the natural distribution of Indian mackerel, as well as having a high overlap with the habitat and depth range inhabited by this species. From a stock status perspective, the overall impact of both purse seine and trawl fisheries are considered to be high risk, while gillnet fisheries is considered low risk to Indian mackerel. The PSA was also undertaken for the main retained species in each of the gear types targeting Indian mackerel. The PSA analysis indicates that purse seine vessels present a high risk to the majority of small and large pelagic species with the exception of three species assessed as medium risk.

Indian mackerel is landed as a by-catch by bottom otter trawlers operating in Indonesia, Malaysia and Myanmar. On account of excellent productivity the shrimp and Indo-Pacific mackerel are considered at medium risk. All other main retained species are at high risk from trawling due to high trophic status and high overlap with species range, as well as habitat and depth distribution. The overall performance is therefore considered weak.

FISHERY ASSESSMENT

Principles 1 provides assessment for stock status / outcome and harvest strategy / stock management for Indian mackerel. The result from the assessment showed that there is a lack of knowledge on many aspects relating to the stock status of Indian mackerel, accurate assessments of stock biomass are not available, no reference points have been defined and no harvest strategy or harvest control rules and tools in place to manage the fishery in Indonesia and Myanmar. In Malaysia, information is primarily based on ad-hoc research on pelagic resources rather than on regular assessment and no reference points or harvest control rules. In Thailand, there is no regular assessment of spawning stock biomass (SSB) on which to base stock management.

The assessments for each indicator under the Principle 2 (ecosystem impact) were made for purse seine, trawl and gill net fishery across Indonesia, Malaysia, Myanmar and Thailand. The current mesh size for purse seine and trawl gear (and some gill net) is 1 inch (25 mm) in Indonesia and Thailand which result in high catch rates of juveniles and is likely to lead to overfishing. In Malaysia, regulations have been developed to reduce fisheries impacts on species and habitats, but these are yet to be fully applied or enforced.

The Principle 3 indicator are relating to both the general governance and policy framework and also fishery specific management (noting that specific management rules are covered under P1 and P2). As there is no regional management of Indian mackerel at present time, even though stocks are shared, the assessments have been completed on a national basis rather than assessing policy and management at a regional level. Although the legislative framework for fisheries management is in place, but fisheries-specific policies e.g. for small pelagic are lacking.

CONCLUSION

Both purse seine and trawl fisheries are considered to be highly risk to Indian mackerel in term of stock status in Indonesia, Malaysia, Myanmar and Thailand. The stock status of other retained species that landed together with Indian Mackerel was poor, especially in trawl and purse seine fisheries. Indian mackerel is highly susceptible to being caught by the purse seine and trawl fleets operating in Indonesia, Malaysia, Thailand and Myanmar.

REFERENCES

Abu Talib A., Konishi Y., Raja Bidin R.H. & Mohammad Faisal M.S. (2013). Standard Operating Procedure for Tagging of Small Pelagic Species. SEAFDEC/MFRDMD/SP/20. 20pp.

Abu Talib A., Noorul Azliana J. & Wahidah M.A. (2013). Standard operating procedure for tissue sample collection and preservation. SEAFDEC/MFRDMD/SP/21.

Anon. (2009) Annual Fisheries Report. Department of Fisheries Malaysia, Ministry of Agriculture and Agro-Industry.

Chinorost B., Varatip V. & Raweewan N. (2001). The characteristic of the sea surface residual flow and the circulation in the Gulf of Thailand from the long term collected data of the SEAWATCH Thailand program. Proceedings of the 39th Kasetsart University Annual Conference, Kasetsart, 5 – 7 February 2001. Kasetsart University. pp. 315 – 329.

Department of Fisheries. (2010). Fisheries statistics of Thailand 2008. No. 12/2010. Information Technical Center, Department of Fisheries, Ministry of Agriculture and Cooperatives. 91 pp.

DoFM. (2012). Fisheries Annual Statistics 2010. Department of Fisheries Malaysia.

GenBank database National Center for Biotechnology Information, USA: NCBI Homepage http://www.ncbi.nlm.nih.gov

Gulland J.A. & Holt S.J. (1959). Estimation of growth parameter for data at unequel time intervals. J. Cons. CIEM 25 (1): 47 – 49.

Hadil and Richard. (1991). Distribution and biological status of the pelagic resources off Sarawak Malaysia. Fisheries Bulletin No. 68. Department of Fisheries, Ministry of Agriculture Malaysia.

Hariati T., Nugroho D. and Girsang E.S. (2000). Development of purse seiner fleet in Malacca Straits. Jour. Pen. Perik. Ind. 6(2): 43 – 51.

Mansor M.I., Kohmo H., Ida H., Nakamura H.T., Aznan Z. & Abdullah S. (1998). Field guide to important commercial marine fishes of the South China Sea. SEAFDEC/MFRDMD/SP/2.

Monton A. & SEAWATCH Thailand. (1999). The surface current of Andaman Sea around Phuket Island and Rave Island. Kasetsart J. (Nat. Sci.) 33: 407 – 411.

MOSTI. (2009). National coastal resources and marine environment profile of Malaysia. 116 pp.

Raja Bidin R.H. & Ku Kassim K.Y. (2007). Information collection for sustainable pelagic fisheries in the South China Sea. Volume 1: National country report. SEAFDEC/MFRDMD/RM/22. 358pp.

Rohizan M. & Ismail E. (2011). Genetic structure and haplotype diversity of *Trachyphelus gigas* population along the west coast of Peninsular Malaysia – inferred through mtDNA AT rich region sequence analysis. Journal Biotechnology 10(3): 298 – 302.

SEAFDEC. (2012). The Southeast Asian state of fisheries and aquaculture 2010. Southeast Asian Fisheries Development Center, Bangkok, Thailand.

Sherman K. (2008). The large marine ecosystem approach to marine resource assessment and management. In: Bianchi G. And Skjoldal H.R. (*eds.*). The ecosystem approach to fisheries. CABI Publishing and FAO, Rome. pp. 47 – 75.

Skjoldal H.R. (2004). Fish stocks and fisheries in relation to climate variability and exploitation. Natural resource system challenge: ocean and aquatic ecosystem. In: Wolanski E. (ed.) Encyclopedia of life supporting system (EOLSS), developed under the auspices of the UNESCO. EOLSS Publishers, Oxford, UK.

Skjoldal H.R. & Misund O.A. (2008). Ecosystem approach to management: definitions, principles and experiences from implementation in the North Sea. In: Bianchi G. And Skjoldal H.R. (eds). The ecosystem approach to fisheries. CABI Publishing and FAO, Rome. pp. 209 – 227.

Skjoldal H.R., Dalpadado P. & Dommasnes A. (2004). Food webs and trophic interactions. In: Skjoldal H.R. (ed.) The Norwegian Sea ecosystem. Tapir Academic Press, Bergen. pp. 447 – 506.

Sukhavisidth D. (1996). Checklist of marine fishes of Thailand. Technical paper no. 2/1996. Marine Resources Surveys Section, Bangkok Marine Fishes Development Center, Marine Fishes Division, Department of Fisheries.

Tanaka S. (1967). Estimation of coefficient of Mojako by tagging experiment on drifting seaweeds – I: Method and an example. Bull. Jpn. Soc. Sci. Fish., 33(12): 1108 – 1115.

UNDP. (2007a). Reversing environmental degradation trends in the South China Sea and Gulf of Thailand. Report of the eight meeting of the regional working group on fisheries. UNEP/GEF/SCS/RWG-F.8/3.

UNDP. (2007b). Reversing environmental degradation trends in the South China Sea and Gulf of Thailand. Report of the ninth meeting of the regional working group on fisheries. UNEP/GEF/SCS/RWG-F.9/3.

Wudianto, Suwarso and Hariati T. (2007). Fishery and biological information of small pelagic fishes in the South China Sea of Indonesia. SEAFDEC/MFRDMD/RM/22 March 2007: 70 – 110.

Zohrah H.S. (2003). Population genetic structure of Indian Mackerel *Rastrelliger kanagurta* (Perciformes: Scombridae) in the coastal waters of Brunei. In: Phillips B., Megrey B.A. and Zhou Y. (Eds.) Proceedings of the third world fisheries congress: feeding the world with fish in the next millennium – the balance between production and environment. American Fisheries Society, Symposium 38, Bethesda, Maryland. pp. 631 – 636.

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