Report of the Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand

Bangkok, Thailand

22-23 September 2016

Southeast Asian Fisheries Development Center

The Secretariat

Supported by the Government of Sweden

SEC/SP/172 **July 2017**

PREPARATION AND DISTRIBUTION OF THIS DOCUMENT

Report of the Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand, Bangkok, Thailand, 22-23 September 2016, was prepared by the Secretariat of Southeast Asian Fisheries Development Center (SEAFDEC). The document is distributed to participants of the meeting, SEAFDEC Member Countries, SEAFDEC Departments and concerned institutions.

BIBLIGRAPHIC CITATION

SEAFDEC. 2017. Report of the Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand, Bangkok, Thailand, 22-23 September 2016, Southeast Asian Fisheries Development Center. 69 pp.

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Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand

22-23 September 2016, Bangkok, Thailand

I. OPENING OF THE MEETING

1. The Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand was convened by the SEAFDEC Secretariat in Bangkok, Thailand on 22-23 September 2016. Supported by the SEAFDEC-Sweden Project, the Experts Group Meeting was attended by representatives and fisheries experts from the countries bordering the Gulf of Thailand, namely: Cambodia, Malaysia, Thailand and Viet Nam, and Resource Persons from the Department of Fisheries and Kasetsart University in Bangkok, Thailand, as well as from Rambhai Barni Rajabhat University, Chanthaburi Province, Thailand. Also in attendance were senior officials and staff from the SEAFDEC Secretariat, Marine Fishery Resources Development and Management Department (MFRDMD), and Training Department (TD); Members of the Regional Fisheries Policy Network for Malaysia, Thailand, and Viet Nam; and observers from the Upper Gulf of Thailand Marine Fisheries Research and Development Center, Faculty of Science of Kasetsart University, Department of Fisheries of Thailand. The List of Participants appears as **Annex 1.**

2. The Senior Advisor to SEAFDEC, *Dr. Magnus Torell* welcomed the participants to the Meeting, and briefed the objectives and expected outputs which include a set of information to understand the stock conditions and status of anchovy, Indo-Pacific mackerel and blue swimming crab (AIB) species in the Gulf of Thailand (GoT); as well as to obtain appropriate methodologies for better understanding of the stock of AIB species. He recalled that the Meeting is being convened to address the concerns raised during the GoT Sub-region Meeting in 2015. He then emphasized that the recommendations of the Meeting would be used as inputs for the development of the future work plans for the sustainable management these economically-important species in the GoT and would be included as inputs for discussion during the next Meeting of the GoT Sub-region.

II. ADOPTION OF THE AGENDA AND INTRODUCTION ARRANGEMENTS

3. The Background as well as the Agenda and Arrangements of the Meeting were presented by *Dr. Worawit Wanchana* from the SEAFDEC Secretariat. He informed the Meeting that based on the discussions during the previous meetings on the GoT Sub-region to assess the status of fisheries in GoT, it was agreed that three priority economically-important species would be given focus in future research activities in the GoT, namely: anchovy, Indo-Pacific mackerel and blue swimming crab. He explained that the Experts Group Meeting would therefore serve as an avenue for better understanding of the fisheries and the migratory pattern of the AIB species to facilitate the development of joint management plans for these species in the countries surrounding GoT as well as for the development of future plan of actions on such species. He added that SEAFDEC, on its part, would continue to coordinate with the GoT countries, especially in facilitating the conduct of human resources development activities to enhance the technical expertise of the countries with respect to the management of the AIB species. He also cited that view of its geographical location, GoT Sub-region includes Cambodia, Malaysia, Thailand, and Viet Nam, and that the participation of Malaysia in the GoT meetings would complete the overall fisheries picture in the sub-region. He then introduced the Provisional Agenda and Arrangements of the Meeting.

4. The Meeting adopted the Agenda as shown in **Annex 2**.

III. GULF OF THAILAND COUNTRIES' PRESENTATIONS

3.1 Cambodia

5. In his presentation (**Annex 3**), the representative from Cambodia *Mr. Suy Serywath* cited that there are difficulties in compiling fish catch landings in Cambodian fisheries, especially for the AIB species. Although some information had been collected by the Fisheries Administration (FiA) of Cambodia, such information are believed to be inconsistent and are only estimates in view of the absence of standards and methods of collecting such data. It is therefore very difficult to obtain relevant fisheries information on the AIB species from the landing sites and ports in the country's coastal provinces, especially that catch data are grouped and not classified according to species. Nevertheless, he expressed the hope that once the country's data collection system is improved through enhanced capacity building not only in the aspect of data collection but also in species classification, it would be able to come up with the stock status of the AIB species in its waters in the future. He also informed that Meeting that under the Fisheries Law and proclamations of the Ministry of Agriculture, Forestry and Fisheries of Cambodia, fishing gears using luring light and paired trawls are prohibited while otter-board trawls are not allowed to operate in waters less than 20 m deep, and catching mackerels is banned from 15 January to 31 March of each year. As part of the policy management on marine fisheries, the country's fisheries had been divided into small, medium and large scales while fishing boats are classified as boats with no engine and boats with engine.

6. During the discussion, the representative from Cambodia explained the difficulties encountered in implementing the country's management policy due to the absence of information about the resources in these waters and that it would not be possible to draw a fixed line to define the depth of the waters making it difficult for the country to control the use of fishing gears although Cambodian fishing boats which are small could not also go very far to catch mackerel. However, small-scale fishers are still allowed to fish even during the closed season but not the medium or large-scale.

3.2 Malaysia

7. The representative from Malaysia, *Mr. Adul Wahab Abdullah* specified that the status of AIB species in his presentation covers only the East Coast of Peninsular Malaysia (**Annex 4**). For the anchovy, the dominant species caught in Malaysia are *Stolephorus commersonii*, *S. Indicus, Encrasicholina heteroloba* and *Dussumieria elopsoides.* Currently, there is an ongoing study aimed at determining the present stock status of anchovy resource in the State of Kelantan, which is an important anchovy fishing ground of East Coast of Peninsular Malaysia (ECPM). Anchovy fishing season in ECPM starts in May and last until October of each year, and are caught by purse seines (for day operation and night operation). For the Indo-Pacific mackerel, the main gears used are gill nets/drift nets and purse seines and their catch is landed in the States of Kelantan, Terengganu, Pahang, and East Johor. During 2009-2015, the highest quantities of mackerel were recorded in Zone A in Kelantan and Pahang, and Zone B in Terengganu and East Johor. Blue swimming crab fisheries in Malaysia are more common in the West Coast of Peninsular Malaysia than in ECPM, where trawls, drift nets and crab traps are used to capture the crabs. Except for crab traps, the blue swimming crabs are non-target species. He cited however that the status of the stocks of blue swimming crabs is unknown in all the concerned fishing areas.

3.3 Thailand

8. In the presentation of *Ms. Pakjuta Khemakorn*, the representative from Thailand, she cited that the most common anchovy species in the country are *Encrasicholina heteroloba, E. punctifer*, *E. devisi* and *Stolephorus* spp. (*e.g. S. indicus*), and that the Indo-Pacific mackerel (*Rastrelliger brachysoma*) and blue swimming crab (*Portunus pelagicus*) are also common (**Annex 5**). Anchovies are mainly caught by anchovy falling net with and without luring light, and daytime anchovy purse seine net. Reports have indicated a decreasing trend of anchovy catch from its peak at 139,326 metric tons in 2004 to 97,102 metric tons in 2012.

9. *Ms. Pakjuta* added that the fishing grounds for anchovies are the Northern, Eastern, Central and Southern parts of GoT, with eggs and larvae that are mostly distributed in high density in Eastern and Central parts. The existing management measures include issuance of fishing licenses based on Total Allowable Catch (TAC), defined fishing zones and gear restriction in term of mesh size regulation. For catching the Indo-Pacific mackerel, four main fishing gears are used, namely: purse seine, encircling gillnet, paired trawl, and gillnet. Catch trends from these gears seemed to have increased in the mid 2000s but catch of the mackerel from small-scale fisheries had been declining from 2003 to 2012. The fishing grounds for this mackerel are in the Central and Southern parts of GoT, while the spawning grounds are reported to be located in Northern and Central parts, after which the fish migrate to the Southern part. Meanwhile, two main fishing gears are used to catch the blue swimming crab, *i.e.* crab gillnet and collapsible crab trap, using small fishing boats (10-20 GT). The existing management measures include issuance of fishing licenses; defined fishing zones, *i.e.* restricted coastal areas; gear restriction, *i.e.* mesh size of crab trap > 2.5 centimeters; enforcement of prohibited fishing season for gravid crabs during October-December.

10. She informed the Meeting that specifically for the Indo-Pacific mackerel, the Department of Fisheries of Thailand has been developing management plans that could be adapted based on the changing situations of the country's fisheries. During the enforcement of closed season and closed area, commercial fishing vessels are not allowed to fish but artisanal fishing gears are allowed. At the start, the fishers resisted such regulation, but now fishers understand that catching the fish spawners will leave them without any young fish at all.

3.4 Viet Nam

11. In the presentation of the representative from Viet Nam *Dr. Nguyen Khac Bat*, it was clarified that the transboundary waters between Viet Nam (Kien Giang Province) and Cambodia (Kampot Province) is in the eastern part of the Gulf of Thailand. While Kampot has a coastline of 95 km, that of Kien Giang is 200 km. The most important landing sites and fishing grounds in Kien Giang Province are Phu Quoc, Nam Du and Tho Chu islands. The major fish species in the transboundary area are anchovies, Indo-Pacific mackerel, and blue swimming crab (**Annex 6**). Anchovy is a very important resource in Viet Nam with an estimated biomass of 140,000 metric tons in 2013, and is mainly concentrated in Tho Chu Island. Two main fishing gears are used to catch anchovies, *i.e.* traditional purse seine and pelagic paired trawl (introduced from China). Anchovy catch in Viet Nam is used to produce fish sauce, dried anchovies, fish milk, etc. Blue swimming crab is another economically-important species in Kien Giang Province. The fishing gears to catch blue swimming crab are traps and gillnet where the main fishing grounds are in Phu Quoc and Kien Luong District. From research results, it has been estimated that the biomass of the blue swimming crab was 7,130 metric tons in 2013, the total catch of blue swimming crab was reported at 7,854 metric tons, therefore, the resource had been overfished. Indo-Pacific mackerel is mainly distributed in the northeastern areas of the GoT. However, there had been only few biological and fisheries data on the mackerel in Viet Nam, thus, there is a need for the improvement of the data collection system for the AIB species to be able to compile biological, environmental and fisheries information on AIB species. Nevertheless, this would also need continuous human resource development in order that the expertise of the GoT countries would be enhanced, especially in the areas of species identification, otolith analysis, DNA analysis, etc.

12. During the discussion, it was clarified that anchovies were caught from the lower part of GoT from Phu Quoc to the border of Cambodian waters. *Dr. Bat* added that collection of data on anchovy made use of a model which converts estimated total catch based on analysis from technical study. Specifically, acoustic survey had been used to determine the biomass. Results of the analysis showed that the stock of anchovy in Viet Nam could be over-fished or fully fished. The Meeting added that the use of pelagic paired trawl to catch anchovy might make it difficult to manage the anchovy resources.

IV. RELEVANT INFORMATION ON AIB SPECIES IN THE GULF OF THAILAND

4.1 Preliminary Data for AIB Species in the Gulf of Thailand

13. The representative from SEAFDEC/TD, *Mr. Supapong Pattarapongpan* presented some information on AIB species in GoT based on results of research studies and surveys (**Annex 7**), specifically in FAO Fisheries Area 71 (Western Central Pacific). This area encompasses the maritime areas of Cambodia, Indonesia, Malaysia, Philippines, Singapore, Viet Nam, and Australia, also includes the Gulf of Thailand. Anchovies in the area belong to the Family Engraulidae and two Genera, *i.e. Encrasicholina* and *Stolephorus,* where 10 species were found in the GoT. The main species are *E. heteroloba* (Ruppell, 1837) and *S. indic*us (van Hasselt, 1823). Records have shown that the peak highest catch was recorded in 2004 (326,012 metric tons (MT)) and the peak lowest catch was in 2013 (192,423 MT). As for the Indo-Pacific mackerel also known as short mackerel, the main species is *Rastrelliger brachysoma* while two similar species are also found in the area, *i.e. R. kanagurta* and *R. faughni*. The peak highest catch of mackerel in the area using purse seine and falling net was in 1996 at 328,955 MT while the lowest catch had 3 peaks, in 1999, 2005 and 2010 at 289,285 MT, 283,984 MT and 259,354.56 MT, respectively that never reached 300,000 MT as recorded in 1996. As for the blue swimming crab, he cited that this is caught by traps and gillnet. Catch of blue swimming crab showed declining trend from 1999 until 2007, but started to increase from 2008 until 2014 when the catch appeared stable. Therefore, there is a need to observe such trend carefully to make sure that the stock of blue swimming crab in the GOT is sustainable.

14. In the discussion, it was suggested that results of the many research studies conducted on the *Stolephorus heteroloba* (short head anchovy) before its genus name was changed to *Encrasicholina heteroloba,* should be reviewed in order to obtain better understanding on the biology and fisheries of the species. In addition, there is a need to standardize the measurement of the length of fish whether to use standard length (SL) or fork length (FL) or total length (TL) in order to harmonize the reference points which is useful in developing the transboundary approach for the conservation and management of the species.

4.2 Study on Indo-Pacific Mackerel Resource in Relation to Sea Surface Environment in the Gulf of Thailand

15. The Resource Person from Kasetsart University, *Dr. Methee Kaewnern* presented the status of Indo-Pacific mackerel in the GoT in relation to sea surface environment (**Annex 8**). He cited that based on results of many studies, the Indo-Pacific mackerel stock in GoT had reduced by 10-20% during the past two years from 2014 to 2015, in spite of the enforcement of seasonal closure measures. Therefore, he conducted a study on the changing population of the Indo-Pacific mackerel using satellite data and taking into consideration changes in the chlorophyll-a on the water surface, plankton, water quality, distribution of fish larvae, biological and ecological data for adult fish, and economic data. Results indicated that changes of the phytoplankton affected the distribution of fish larvae as it had some impacts on the optimum condition of water current in GoT, more particularly on the temperature. However, a suitable area for fish larvae could be carried out in further research, the results of which could be used to update the closed areas which might be shifted based on the gonad development of female mackerel. He added that while conducting a study on the mackerel, an activity on the migration and life cycle of anchovies was also carried out considering that marketing of these two species is somewhat related. Meanwhile, results of the economic study showed that catching juvenile mackerel can lose the overall market value of the fish by about 10 times more than the price of small fish.

16. During the discussion, the Meeting was informed by the representative from the Department of Fisheries (DoF) of Thailand that based on the spawning data collected by DoF, gonad development of the mackerel still occurs at the same period. In the middle part of GoT, spawning season peaks between February and May every year with slight shifts. Data on presence of larvae could be used to revise the closed season and closed area as necessary, to protect the spawners and the nursery

grounds. However, there is much concern now on the use of fishing gear that target the big-size mackerel.

4.3 Regional Study on Indo-Pacific Mackerel (Rastrelliger brachysoma) in the Gulf of Thailand

17. The representative from MFRDMD, *Mr. Mohammad Faisal Md. Salleh* presented the status of Indo-Pacific mackerel in the GoT (**Annex 9**) based on results of several research projects on pelagic species including *Rastrelliger* spp. And *Decapterus* spp. Conducted by MFRDMD from 2003 to 2010. In Cambodia, catch data during 2003-2004 indicated that there are two high catch peaks in Sihanoukville Province, *i.e.* first peak in January and February; and second peak in July, September, and October. The mackerel catch composition was 86% of the total pelagic catch in 2003 and 2004. In Kampot Province, there is only one high catch peak in May, June, July and September and the mackerel catch composition was 40% of the total pelagic catch in 2003 and 63% in 2004. In Thailand, fishing ground for *R. brachysoma* is along the west coast and upper part of the GoT. Results of tagging experiments carried out by DoF in 1960-1965 indicated that the fish along the eastern and western coasts of the GoT did not intermix, and that the migration route appeared to be southward along the western coast of the GoT, which was considered to be partially related to its spawning behavior. In Malaysia, the average catch composition of short mackerel with respect to total catch in 2005 in Tok Bali and Kuantan were 3.0% and 1.0%, respectively. In Viet Nam, *R. brachysoma* contributed 4.4 % in the catch composition of purse seine fishing at Ben Tre in 2003. Meanwhile, in Binh Thuan, 50.0% of the length at first maturity of female *R. brachysoma* was 22.10 cm and 20.53 cm for male.

18. Moreover, *Mr. Faisal* also provided a brief report on the results of the Tagging Program for Economically Important Small Pelagic Species in the South China Sea and Andaman Sea, where a total of 5,220 *Rastrelliger brachysoma* were tagged in 2008-2011. Results showed that 12 tails of the mackerel were recaptured representing 0.23% and the average fork length at recapture was 169 mm. The longest time at liberty was 96 days recorded in Trat Province, Thailand, and the longest distance travelled was 85 km recorded in Sihanoukville Province, Cambodia. He then summarized the results as follows: most tagged fishes were recaptured within the vicinity of released location, *i.e.* within the country's EEZs; and tagged fishes do not migrate too far from released site. However, he noted that the information obtained from the Tagging Program were insufficient to determine the migration pattern and stock structure due to the low recovery rate of the tagged fishes. He therefore suggested that other methods could be used to confirm the population structure and identity of the stocks that may be shared by the GoT countries, which is through genetic studies which MFRDMD had already initiated.

4.4 AIB Species Management in the Gulf of Thailand

19. The Senior Advisor to the Department of Fisheries of Thailand on Marine Fisheries, *Mr. Pirochana Saikliang* reported on the abundance and distribution of AIB species in the GoT based on results of marine resource surveys conducted in the Thai waters by DOF Research Vessels operated 4 trips/year (**Annex 10**). On the life cycle and migratory route of Indo-Pacific mackerel *R. brachysoma*, there are two stocks one of which is in Western GoT and other one in Eastern GopT. Fish larvae of Scombridae, Engraulidae and other species are abundant during and after the closed season. He also summarized the various fisheries management tools have been adopted in Thailand. For example, in the case of anchovies, the management measures include prohibiting the use of anchovy purse seine with luring lights and limiting the number of fishing vessels and licenses for specific fishing gears, and zoning. For Indo-Pacific mackerel, prohibiting the use of some commercial gears during the closed season and protecting the nursing ground through enforcement of closed season of the Inner GoT from 1 June to 31 July of every year for 3 years since 2014. For blue swimming crab, prohibiting their capture in October to December of each year, prohibiting the catch of berried female, prohibiting the use of crab traps with mesh size less than 2.5 cm, and prohibiting some fishing gears to operate within 3 km from the shore. Moreover, the installation of VMS on vessels,

use of logbook system, and PIPO (port-in port-out fishing vessels control center) are enforced to control the fishing vessels.

20. In response to the query on why the management area for Indo-Pacific mackerel does not include the area from Prachuab Khiri Khan, Pranburi and Hua Hin, which is also important area for Indo-Pacific mackerel recruitment, *Mr. Pirochana* cited that such area has not been proposed as protected area but the concerned Fisheries Research Centers still continue to collect the necessary data and in the future such area could be proposed as part of the management area. For blue swimming crab, it is necessary to protect the recruitment in the inshore areas. For anchovies, since fingerlings are caught in many areas of Prachuab Khiri Khan Province, there is a need to develop management tools because fingerling harvest is still allowed in this area. *Mr. Pirochan*a also explained that the DoF had considered the size of first maturity and design of mesh size of fishing gear as basis for the development of the most appropriate management tools, however, the fishers did not agree to adopt such measure so the DoF adopted on the use of VMS to monitor the catch.

21. Regarding the basis for identifying the management area for the Indo-Pacific mackerel, *Mr. Pirochana* explained that trawl surveys and larval surveys had been carried out in the Thai waters, and results from studies on landing sites and fishing grounds were confirmed through the larval surveys. From all the results, DoF came up with the closed season and area specifications, which were then discussed with all stakeholders to determine the demarcations of the management areas.

4.5 Population Structure and Genetic Mixed-stock Analysis of Short Mackerel, *Rastrelliger brachysoma*, Fishery Catches in the Upper Gulf of Thailand

22. The Resource Person from Kasetsart University in Bangkok, Thailand, *Ms. Sirithorn Kongsang* reported on the results of the identification of population of short mackerel *Rastrelliger brachysoma* from four spawning grounds (Samut Songkhram, Prachuap Khiri Khan, Surat Thani, and Trat) during 2014-2016 through DNA information, *i.e.* using microsatellite analysis (**Annex 11**). The results showed that short mackerels in the upper GoT belong to four populations according to their spawning grounds and Samut Songkhram population (SKM) is the major contributor to the total catch of short mackerel in the upper GOT. Trat (TRT) and Surat Thani (SNI) populations are the second and third large contributors and also provide gene flow to the Samut Songkhram population. Prachuap Khiri Khan's population (PKN) is the smallest contributor and has low gene flow to other spawning areas. Meanwhile, based on the results of the mixed-stock analysis (MSA), results showed that SKM, TRT and SNI had the high impact to the fishery catch in the upper GoT, while PKN had the lowest one. More than 80% of the Indo – Pacific Mackerel caught in the upper GoT, inhabit the area almost all year round. The near shore of Prachuap Khiri Khan is the spawning ground for its local population while the offshore area is the migratory route for SKM and SNI. These information could be used for assist the sustainable fishery management in the upper GoT.

23. During the discussion, it was suggested that samples from Cambodia and Southern Viet Nam should also be classified and clarified, as these areas could be migratory routes of the eastern group of Indo-Pacific mackerel stocks.

4.6 Stock Discrimination of Indo-Pacific Mackerel by Otolith Shape Analysis Techniques

24. The Resource Person from the Department of Fisheries of Thailand, *Ms. Sansanee Srichangam* reported on the results of a study aimed at determining the Indo-Pacific mackerel stock using otolith shape analysis (**Annex 12**). As defined, otolith also known as "earstone" is a hard, calcium carbonate structure located directly behind the brain of bony fishes, and is specifically located at the inner ear, and part of balance organ in the fish's skull. She described the methodology used in the study such as collecting morphological parameters, obtaining otolith measurements, analyzing otolith shape and using a program to detect the descriptors that describe the otolith contour, and for the data analysis. The results showed that otolith analysis could be used to classify stocks more efficiently than using morphological parameters.

4.7 Age and Growth Determination of Indo-Pacific Mackerel Using Otolith Microstructure Technique

25. In another presentation of *Ms. Sansanee Srichangam*, she reported on the results of age and growth determination of Indo-Pacific mackerel using otolith microstructure technique (**Annex 13**). One stock from the GoT and another stock from the Andaman Sea were used in the study which aimed to investigate the morphological and otolith shape that would clarify the biological parameters of both stocks based on the assumption that fish in the different environmental will have different growth pattern leading to different shapes of otoliths. Using t-test and multivariate analysis of variance (MANOVA), the results showed that the sequence genetic identifier (GI) of the Andaman Sea stock was significantly higher than that of the GoT stock. She cited that otolith can be used to determine the age of fish more correctly than using their biological parameters, and that otolith analysis could also be used to identify the mature from immature groups more efficiently than morphological analysis.

26. During the discussion, it was clarified that the parameter of Von Bertalanffy Growth Function (VBGF) was used to describe the growth rate in relation to the otolith size while exponential model was used to convert total length to age of fish in the length-based model. VBGF is used to express the mean length that fish from a given stock would reach assuming that the fish continue to grow for an infinitely long period of time. *Ms. Sansanee* added that this method could be used to differentiate the stocks of GoT from those in the Andaman Sea. The Meeting therefore suggested that this method could be used to distinguish not only the Indo-pacific mackerel stocks but also the anchovy stocks in the transboundary areas of Thailand and Cambodia, and Cambodia and Viet Nam, considering that anchovies are similar to Indo-Pacific mackerel. Moreover, results of the study could also be used to determine the baseline or reference point taking into consideration the changing environment of an area such as changes in the nutrients due to climate change.

4.8 Stock Identification of Short Mackerel in the Gulf of Thailand: An Otolith Microchemistry Approach

27. The Resource Person from the Faculty of Agricultural Technology, Rambhai Barni Rajabhat University in Chanthaburi, Thailand, *Mr. Sontaya Koolkalya* presented the results of the study which aimed to understand the stock structures of *Rastrelliger brachysoma* in the GoT using otolith microchemistry as a classification method (**Annex 14**). He cited that although management regimes for the short mackerel, *R. brachysoma* already exist, such as yield control and size limitations base on the single stock for the whole GoT, which somehow not suitable because its catch continues to decline over time. Therefore, there is a need to clearly understand the biological parameters, *i.e.* biological characteristics and population dynamics of each stock of *R. brachysoma* for effective regulations and management regimes. Using samples from small-scale fisheries to ensure that these fish come from an area's population. The study use otolith microchemistry as it could determine the correction factor of the stock's environment. The otolith was analyzed by extracting the micro-elements components such as lithium (Li), magnesium (Mg), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), strontium (Sr), barium (Ba), and uranium (U), and were normalized to calcium (Ca). For the analysis, MANOVA and Principal Component Analysis (PCA) were used to display the micro-chemical data of the sectioned otolith materials to detect stock differentiations among the sampling sites and examine the relative importance of each variable, *i.e.* microchemistry elements compared to Ca concentration. Linear Discriminant Function Analysis (LDFA) was used to classify individual fish with respect to their collection areas using micro-chemical values at the edge of the otolith sections and the whole otolith. The results showed that there are four (4) stocks of *R. brachysoma* in the Gulf of Thailand, *i.e*. Eastern, Upper, Central and Lower stocks. Members in each stock comprised individual fish from different origins of the larvae but grouped together, at least by 41% (male) and 67% (female) in their life span.

4.9 Resource Mapping of Marine Fisheries Resources

28. The representative from SEAFDEC/TD, *Ms. Siriporn Pangsorn* described the importance of resource mapping to understand the location and distribution of the resources for making decisions on management of the resources (**Annex 15**), and presented some examples of resource maps based on information from scientific works, research studies, resource surveys, and questionnaire resources surveys, *i.e.* Mackerel and Anchovy in Sihanoukville, Cambodia; Anchovy including its Eggs and Larvae in Gulf of Thailand, Thailand; Life Cycle of Short Mackerel in GoT, Thailand; Blue Swimming Crab Fishing Ground in Chumphon Province, Thailand; Engrauridae Species (17 species) in Waters of Viet Nam. The future plan is to come up with the geographical distribution, *e.g.* habitats, fish eggs, larvae, fishing grounds, for AIB resources in GoT, which is useful for risk assessment and development of relevant management plans on the AIB species.

V. PLENARY SESSION

5.1 Summary of Major/Priority Issues

29. The representative from SEAFDEC Secretariat, *Dr. Worawit Wanchana* reiterated that the Experts Group Meeting is expected to establish the stock status and distribution of AIB species in the Gulf of Thailand; compile set of information that could assist in harmonizing indicators and methodologies; and to prioritize the issues to be included in the Work Plan for 2016 and 2017. He added that from the presentations and discussions during the Meeting, in general, the stocks of anchovy and Indo-Pacific mackerel in the GoT had exhibited decreasing trend due to overfishing while that of blue swimming crab is stable and increasing as results from the successful restocking programs that must have contributed to the stabilization of its population. Specifically, the status of the stocks of AIB species of each country in GoT is shown in **Table 1**.

Table 1. Stock status of AIB species in GoT countries

Species	**Stock Status Trend**		
	Decreasing	Stable	Increasing
Anchovy	Viet Nam	Thailand	Malaysia (slightly)
Indo-Pacific Mackerel		Malaysia (sustainable harvest level), Thailand	
Blue Swimming Crab	Thailand and Viet Nam	Malaysia	

30. In the ensuing discussion, the Meeting suggested that a review of the technical papers available in the countries should be carried out to confirm the status of AIB species in respective countries. Moreover, since indications on stock status could only be reported as “increasing trend” or “decreasing trend” but not on the causes of the occurrence of such trends, focus should be given to specific areas for effective management of the AIB species. Considering that it might still be too early to conclude that overfishing occurs in certain waters of the GoT without any scientific evidence, and if overfishing really does occur, it is important that concerned countries should come up with the necessary management plans to overcome stock depletion.

31. The Meeting also suggested that Cambodia should exert more efforts to collect and compile relevant information on AIB species in the GoT, and continue enhancing its capacity in developing and/or adapting the methodologies for data collection. The SOP for Data Collection of AIB Species in the Gulf of Thailand (**Annex 16**) which had been developed during the 2015 Gulf of Thailand Sub-regional Meeting, could be adapted in the process of collecting the necessary data. The representative from Cambodia also explained that in the case of anchovy for example, although fishers from Sihanoukville had been catching anchovies in Cambodian waters, their catch is landed in neighboring countries and not in Cambodia because mid-water trawl is prohibited in Cambodian waters, making it difficult to monitor the catch landings and establish the status of the anchovy stock.

32. The representative from Malaysia revealed that the trend of anchovy stock in Malaysia is still not overfished as it has been increasing during the past five (5) years. He explained that since anchovy species does likely not migrate far from their breeding and foraging grounds, it is important that management plans should concentrate on such areas, which could be different for the highly migratory species such as Indo-Pacific mackerel. He also informed the Meeting that aside from anchovy catches in the Perhentian Island in Kelantan and Terengganu border, very few landings of anchovy have been reported in other parts of East Coast Peninsular Malaysia. He also mentioned that based on acoustic surveys conducted by the Department of Fisheries Malaysia in 2013, 2014, and 2015, small pelagic species in the east coast of Peninsular Malaysian waters are still under-exploited and sustainable which includes the Indo-Pacific mackerel. For the blue swimming crab, the stock is still sustainable in the East Coast of Peninsular Malaysia based on the country's catch record during the past seven years.

33. In the case of Thailand, the trends of the stocks of AIB species generally appear stable. Specifically, there is no evidence that anchovy stock is overfished based on the calculation of MSY in 2015. In fact, there has been an increasing trend for the anchovy stock in the Thai waters of the GoT as a result of the several management plans that have been introduced to regulate the anchovy fishery of the country. Meanwhile, based on some studies, the source of the Indo-Pacific mackerel stock in Thailand must have come from several parts in the GoT. In addition, there is insufficient data to confirm that the catch trend of mackerel is decreasing. On the blue swimming crab, several scientific publications suggested that the catch trend in the waters of Thailand in the GoT is decreasing due to overfishing. However, the blue swimming crab being overfished in some area in the GoT may not affect whole GoT area, a situation that needs to be verified.

34. The Meeting noted that Viet Nam fishers are likely exploiting the shared stocks of anchovy in the transboundary waters of Viet Nam and Cambodia although there is no scientific evidence to prove such presumption. For the Indo-Pacific mackerel, although reports indicate that several kinds of gears are used to capture the fish, there are no data to justify such reports. On blue swimming crab, the stock is likely stable and increasing although data in 2015 suggested that the population of blue swimming crab had started to decline in spite of the crab bank projects which could be possibly because of environmental changes. However, concerns were raised on the continued indiscriminate catching of juvenile and adult crabs in the country's waters as this could result in heavy fishing pressure of the crab resources.

5.2 Information for Better Understanding of Sock Status and Migratory Pattern of AIB Species in the GoT

35. Based on the geographical distribution of Indo-Pacific mackerel in GoT, it could be concluded that it is one of the transboundary species, but need scientific evidence to confirm on geographical migration route pattern of the resources. While management measures are in place for local mackerel stock, there is none for the transboundary stocks as much information is still needed to confirm. Therefore, it is necessary to develop a model or approach to determine the transboundary stocks of the GoT countries then develop the necessary joint management plans for the conservation of the resources.

Distribution of anchovy in GoT

36. It is likely that Viet Nam and Cambodia are utilizing the same stock of anchovy. Considering the short coastline of Cambodia and the statistical data from Viet Nam indicating sustainable production trend of the species. However, there is no scientific evidence to confirm whether the stock is same or not. Checking the data from Viet Nam and comparing this with those from Thailand could help in understanding the distribution of anchovies in the GoT. Moreover, more research work is needed to confirm that Thailand and Malaysia are using the same stock of anchovies, especially through genetic analysis. The Meeting also noted that the distribution of juvenile Indo-Pacific mackerel is schooling with the short head anchovy, which could have led to the relatively high catch composition from anchovy purse seine and anchovy falling net.

Distribution of Indo-Pacific mackerel in GoT

37. Considering the gene flow pattern of the Indo-Pacific mackerel in the waters of Thailand, there is the possibility that the same stock of mackerel is utilized by some countries in the GoT (**Fig. 1** and **Fig. 2**). This is based on results genetic studies to determine the baseline populations, which suggested that there are possibly four (4) different populations in the GoT, namely from those from i) Trat, ii) Samut Songkhram, iii) Prachuap Khiri Khan, and iv) Surat Thani, and that the stocks between Trat and Samut Songkhram, Surat Thani and Samut Songkhram do migrate although little movement had been observed for the stocks between Trat and Prachuap Khiri Khan, and Surat Thani and Prachuap Khiri Khan.

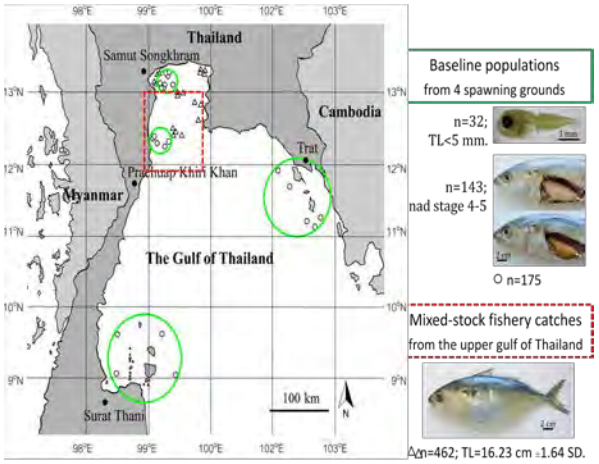

Fig. 1. Baseline populations of Indo-Pacific mackerel in 4 fishing grounds in the Gulf of Thailand

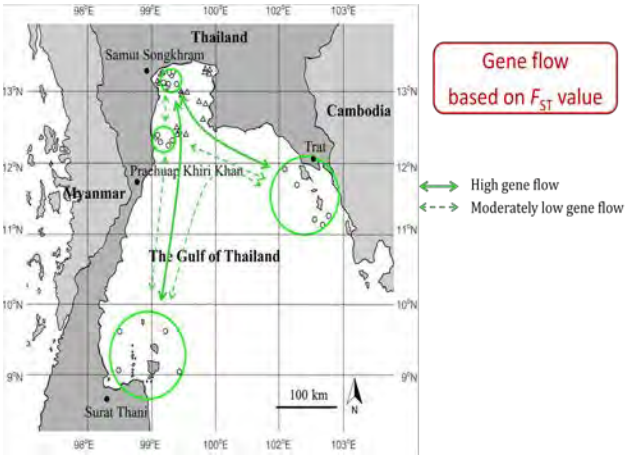

Fig. 2. Gene flow of Indo-Pacific mackerel in s in the Gulf of Thailand

Distribution of the blue swimming crab in GoT

38. As there is no sufficient data at the sub-regional scale on the distribution of the blue swimming crab in the GoT, there is a need for the GoT countries to cooperate in order to improve data collection on this species.

VI. RECOMMENDATIONS

39. Since the SOP for Data Collection of AIB Species in the GoT is already in place, the Meeting suggested that Cambodia should adapt such SOP to be able to collect and compile the necessary data. In this regard, the representative from Cambodia requested for assistance to be able to carry out such task. Meanwhile, existing methodologies for collecting data (catch and efforts, biomass, MSY and other relevant information for fisheries management) are in place in Thailand and to some extent in Viet Nam and Malaysia but not in Cambodia. Therefore, data collection on AIB species in the GoT should be improved using the existing SOP, which means that there is the need to find and train the enumerators for the data collection and analysis, and convene meetings to discuss and validate the data compiled based on the SOP. Nevertheless, since information from Thailand on AIB species are relatively comprehensive, these could be used as starting point to explore data/information required from other GoT countries, especially for Cambodia.

40. Furthermore, tagging program should be carried out at the same time to confirm that there are clearly 4 (sub) populations of the Indo-Pacific mackerel in the GoT. In fact, aside from tagging, other approaches could also be adopted, *e.g.* otolith analysis, larvae information, before any conclusion could also be made. Moreover, tagging could also be conducted for the blue swimming crab to check the possible sharing of stocks among the GoT countries.

41. In order to determine recruitments, mixed-stock analysis (MSA) should be conducted as this would determine the contributions from other stocks (**Fig. 4**). This could also confirm the presence of unique stocks and determine the number of stocks in the GoT. Moreover, morphological and otolith

analysis can be used for stock identification (otolith has higher correction factor as compared to morphological analysis). However, since the surrounding environment in each state of the life cycle may be different from place to another, therefore such approaches should be used only to confirm the result of stock identification after genetic analysis (baseline and MSA).

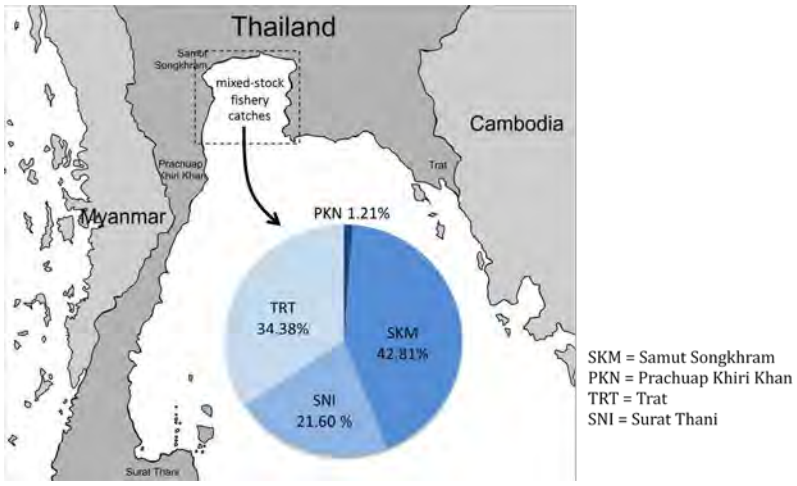

Fig. 4. Results of mixed-stock analysis in the Gulf of Thailand

VII. CONCLUSION AND WAY FORWARD

42. In conclusion, in order to confirm the stock structure and migratory pattern of AIB species in the GoT, several methodologies and approaches could be together applied, *e.g.* genetic analysis, otolith analysis, tagging, study of larval distribution, and use of remote sensing data. Nonetheless, more data is still required to understand the stock structure of the AIB species, especially for Indo-Pacific mackerel, *e.g.* environmental data, nutrients, micro-chemical parameters, etc. Such data would be useful to explain the occurrence of weight difference from the length-weight relationship between the stocks from the Andaman Sea and GoT. Therefore, the future plans of activity and methodologies for better understanding of the stock structures of AIB species in GoT should be undertaken as summarized in **Table 2**.

Table 2. Future plans and methodologies for better understanding of the stock structure of AIB species in GoT

Activities	Outputs	Outcomes
Short-term plans of activity		
1. Conduct MSA using genetic study (1-year to complete)		
Step 1: Identify major fishing ground information in national waters by concerned countries in GoT	• Inputs for designing the genetic study on AIB species in GOT	• Fishing ground mapping for AIB species in GoT
Step 2: Conduct baseline population studies	• Determine the number of stocks in GoT	• National and joint management plans for AIB species in GoT
Step 3: Conduct MSA	• Determine the amount of contribution from other stocks in particular area of study	• National and joint management plans for AIB species in GoT
2. Improve data collection on AIB species using the existing SOP		
Step 1: Name the enumerators for each landing site and study area	• Enumerators designated for landing sites in study areas	• Harmonized regional data in GoT countries

Step 2: Train the designated enumerators	• Enhanced knowledge on biological and environmental data	• Improved capacity of enumerators from GoT countries who could serve as trainers for the Southeast Asian region
Step 3: Data collection and analysis	• Updated information and data on biological and environmental aspects	• National and sub-regional management plans for AIB species in GoT
Step 4: Convene meeting to discuss and validate data compiled	• Validated data for understanding the stocks of AIB species in GoT	• National and sub-regional management plans for AIB species in GoT
Medium/long-term plan		
1. Monitoring change in catch and landing		
• Periodic catch and landing surveys (depending on the country)	• Updated information on stock status/condition	• Effectiveness of the management plans

43. In order to understand the stock structure and migratory nature of AIB species in GoT, it is necessary that short-term activities on MSA using genetic studies should be carried out in one-year period to improve data and information on the species as shown in **Table 2**. In addition, medium-term activity should be carried out to follow-up on the short-term activities in order to monitor the changes in catch and landing which could be used for developing the appropriate management measures.

44. The Report of the Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand would be used as working documents during the Sixth Meeting of the Gulf of Thailand Sub-region in December 2016. This is necessary in order that the Sixth Meeting would be able to confirm the priority AIB species in GoT and for the continuation of the SEAFDEC-Sweden Project in the future.

VIII. CLOSING OF THE MEETING

45. In his brief Closing Remarks, the Senior Advisor of SEAFDEC, *Dr. Magnus Torell* thanked the participants for their active participation in the discussion, and especially the Resource Persons for providing very useful data and information on the status and trend of AIB species in the Gulf of Thailand. He then requested the representative from Malaysia to continue its active participation in the sub-regional initiatives in the Gulf of Thailand considering that Malaysia is one of the countries bordering the GoT, citing also that such activities would lead to the development of joint management plans for AIB species among the concerned countries in the GoT. After informing the participants that the Report of the Meeting would be circulated for comments and confirmation as soon as possible as this would be used during the 6th Gulf of Thailand Sub-regional Meeting, he declared the Experts Meeting closed.

Annex 1

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Annex 2

AGENDA

Expert Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand

22-23 September 2016, Century Park Hotel, Bangkok, Thailand

1. Introduction and Opening the meeting
2. Countries presentation
   - 2.1. Viet Nam
   - 2.2. Cambodia
   - 2.3. Thailand
   - 2.4. Malaysia
3. Plenary Discussion
4. Relevant Information
   - 4.1. Preliminary Data for AIB Species in the Gulf of Thailand
   - 4.2. Regional Study on Stock Structure of Indo-Pacific Mackerel in Southeast Asia: Case Study in the Gulf of Thailand
   - 4.3. Population Structure of Short Mackerel, *Rastrelliger brachysoma*, Caught in Upper Gulf of Thailand
   - 4.4. Stock Identification of Short Mackerel in the Gulf of Thailand: an Otolith Microchemistry Approach
   - 4.5. Stock Discrimination of Indo-Pacific Mackerel by Otolith Shape Analysis Techniques
   - 4.6. Age and Growth Determination of Indo-Pacific Mackerel Using Otolith Microstructure Technique
   - 4.7. Indo – Pacific Mackerel Resources in the Gulf of Thailand
   - 4.8. One Year Research on Indo-Pacific Mackerel in the Gulf of Thailand
   - 4.9. Blue Swimming Crab Project in the Gulf of Thailand
   - 4.10 Resource Mapping of Marine Fisheries Resources
5. Set of Recommendation required for better understanding of the stock status of AIB - species in the Gulf of Thailand
6. Conclusion and way forward

CAMBODIA

Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab(AIB) Species in the Gulf of Thailand
22-23 September 2016
Century Park Hotel, Bangkok, Thailand

Brief of Marine Fisheries Resources In Cambodia

The Fisheries Administration (FiA), Cambodia
September 2016
Prepared by: Suy Serymath

Contents

- General information
- Main landing sites
- Estimate production of AIB-species
- Fishing gears for AIB-species
- Fishing boats
- Challenging issues
- Conclusion/recommendation

General information

- There are 435 km coast line covered 4 provinces (Koh Kong, Preah Sihanouk and Kep)
- Exclusive economic zone (EEZ) covered 55,600Km2
- Consist of 4-province (Koh Kong, Preah Sihanouk, Kampot and Kep province)
- Exclusive economic zone (EEZ) covered 55,600 Km2
- Fisheries contribute to protein intake about 80%
- Fisheries consumption is 52.4kg/person/year and
- Fisheries contributed to 8-12 GDP

Main landing sites in each province

- **Koh Kong**: 3landing sites (Koh Sdanch, Thmasar and Dong Tung)
- Preah sihaouk: 3 landing sites (Steunghav, Tomnum rolok and Prey nup)
- Kampot: 4 landing sites (Kdat/Trapaing Ropov, Troey Koh, Spean Khiev/Kbal Romeas and Prek Chak/Lok,
- Kep: 3 landing sites (OKrasa, Prey Thom/Phum Thmey and Angkol)

Estimate production of AIB-species

Year	Koh Kong province			Preah Sihanouk province			Kampot province		
	A (T)	I (T)	B (T)	A (T)	I (T)	B (T)	A (T)	I (T)	B (T)
2010	0	650	2266	9645	1600	1056	21	166	828
2011	545	642	1961	4418	988	1261	185	44	425
2012	595	1585	1770		1650	1810	80	101	510
2013	460	1742	1880	8856	1650	1810	85	112	685
2014	500	2295	8100	4100		2100	150	650	1500
2015	486	1076	1760	4085	1265	1270	185	820	592

Source: FiA(2010-2015)
Note: A-Anchovy, I-Indo-pacific Mackerel and B-Blue swimming crab

Fishing gears for AIB-species

Year	Koh Kong province				Preah Sihanouk province				Kampot		
	OAnchovy encircling seine (set)	Mackerel Gillnet (m)	Crab gill net (m)	Crab trap (N)	Anchovy encircling seine (set)	Mackerel Gillnet (m)	Crab gill net (m)	Crab trap (N)	Anchovy encircling seine (set)	Mackerel gillnet (m)	Crab gill net (m)	Crab trap (N)
2010	1 500,000	450,000	419,800	1	188,000	895,000	61,760	0	96,000	18,000	89,000	
2011	8 205,400	625,500	160,200	0	182,000	450,000	105,760	0	27,000	88,000	75,000	
2012	8 205,400	625,500	228,400	0	282,000	450,000	105,760	0	27,000	88,000		
2013	2 206,000	626,500	166,800	0	182,000	450,000	105,760	0	27,500	88,000	75,000	
2014	2 206,000	75,000	51,800	0	182,000	450,000	105,760	0	95,000	56,000	75,000	
2015	1 206,000	76,000	52,800	0	182,000	450,000	105,760	0	96,000	71,000	78,000	

Source: FiA (2010-2015)

Fishing boats

Name province	hp<16	hp=16-45	hp=46-90	hp>90	Total
Koh Kong	1,647	1,471	69	148	8,885
Preah Sihanouk	1,095	1,860	5	285	2,745
Kampot	456	176	2	8	687
Kep	198	20			218
Total	**3,831**	**3,527**	**76**	**441**	**8,966**

Source: FIA (2015)

Challenging issues

- The data on fish production, fishing gears and fishing boats (etc.) are not consistent,
- Most of data are estimated/quest estimate (there are no standard/method was used to collect those related data),
- Lack of interested to collect the data; and
- Knowledge of fisheries officer both their capacity and skills of collect data are limited.

Conclusion/recommendation

- The capturer fisheries production was estimated in total production rather then by species composition,
- There are very limited/haven't been conducted scientific research/study on marine resources (eg. AIB),
- There are limited human resource and finance on research action,
- There are lack/limited interested in scientific work; and
- There are need time and strongly effort/encourage to conduct research/study on marine resource(target species) at the future.

Thanks

Annex 4

MALAYSIA

Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab(AIB) Species in the Gulf of Thailand

22-23 September 2016, Century Park Hotel, Bangkok, Thailand

Country presentation

The Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) species of the East Coast of Peninsular Malaysia

Abdul Wahab Abdullah, Abd Haris Hilmi Ahmad Arshod

Fisheries Research Institute (Kg Acheh), Department of Fisheries Malaysia

22 September 2016

Status of anchovy in the ECPM

Map source: FAO.org

- Currently a study is on-going for the duration of 2 years (2016-2017) to determine the present status of anchovy resource stock.
- The study is concentrated at the state of Kelantan, the most northern part of the East Coast of Peninsular Malaysia (South China Sea).
- Among the reasons in choosing the sites was due to the importance and contribution of anchovy to many aspects such as economical and well being of the people.

Anchovy industry

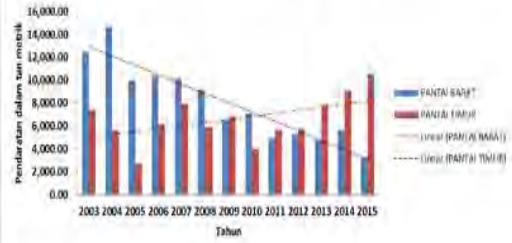
- Anchovy is an important industry and mainly contributed to the SMEs product and development.
- Malaysia exported anchovy related product which worth RM21.7 million in 2014 (DOFM, Fisheries Statistics, 2015).
- Other than export products, among the product for local consumption were dried anchovy, crispy anchovy, anchovy sauce, concentrated anchovy sauce and many more.

Anchovies species in Malaysia and its distribution

No.	Species name	Common name	Local name	Distribution
1	*Encrasicholina heteroloba*	Shorthead anchovy	Bunga air kepala pendek	WCPM, ECPM, Sabah, Sruk
2	*Encrasicholina punctifer*	Buccaneer anchovy	Bunga air tembaga	WCPM, ECPM, Sabah, Sruk
3	*Stolephorus andharaensis*	Andhra anchovy	Bilis andra	WCPM, ECPM, Sabah, Sruk
4	*Stolephorus baganensis*	Bagan anchovy	Bilis bagan	ECPM, West Sabah, Sruk
5	*Stolephorus chinensis*	China anchovy	Bilis Cina	ECPM
6	*Stolephorus commersonii*	Commerson's anchovy	Bilis tembaga	WCPM, ECPM, Sabah, Sruk
7	*Stolephorus dubiosus*	Thai anchovy	Bilis siam	ECPM
8	*Stolephorus indicus*	Indian anchovy	Bilis bunga air	WCPM, ECPM, Sabah, Sruk
9	*Stolephorus insularis*	Hardenberg's anchovy	Bilis pusu	WCPM, ECPM
10	*Stolephorus tri*	Spined anchovy	Bilis teri	ECPM
11	*Stolephorus waitei*	Spotty-face anchovy	Bilis muka tanda	WCPM, ECPM, Sabah, Sruk

WCPM- West Coast P.Malaysia, ECPM-East Coast P.Malaysia, Sruk - Sarawak
(FAO Species Identification Guide for Fishery Purposes, Volume 3)

Landing trends of anchovy in ECPM & WCPM from 2003 to 2015



Anchovy fishing vessels

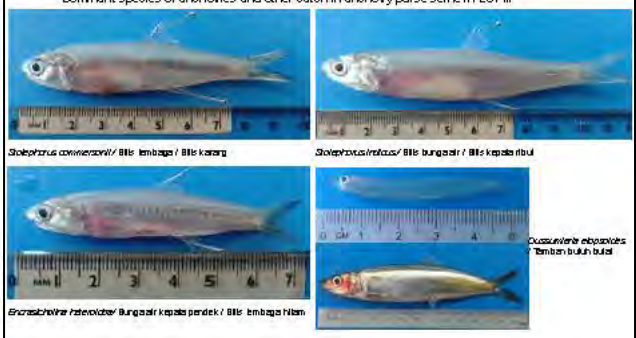
Anchovy purse seine (day operation) (ECPM – Tumpat district)

Anchovy purse seine (night operation) (ECPM – Tumpat district)

Anchovy purse seine (WCPM – Pangkor island)

Anchovy purse seine (WCPM – Langkawi island)

Dominant species of anchovies and other catch in anchovy purse seine in ECPM



Stolephorus commersonii / Bilis lembaga / Bilis karang

Stolephorus indicus / Bilis bungasir / Bilis kepala tebal

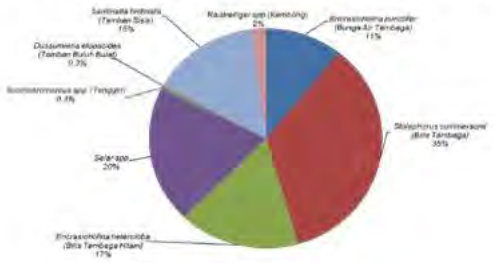
Encrasicholina heteroloba / Bungasir kepala pendek / Bilis lembaga hitam

Dussumieria elopsoides / Tamban buluh buloi

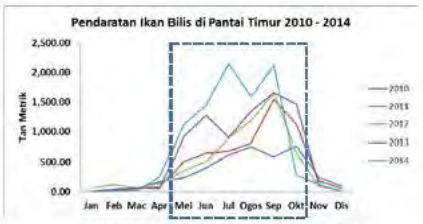
Fishing area for the vessels in state of Kelantan

- Fishing area in the state of Kelantan – Artificial reefs and near Perhentian Islands
- Operational time - night
- Season - April/May to November
- 1 trip/day

Species composition (Light purse seine of ECPM in June 2016)



Monthly landing of anchovy in the ECPM from 2010 to 2014

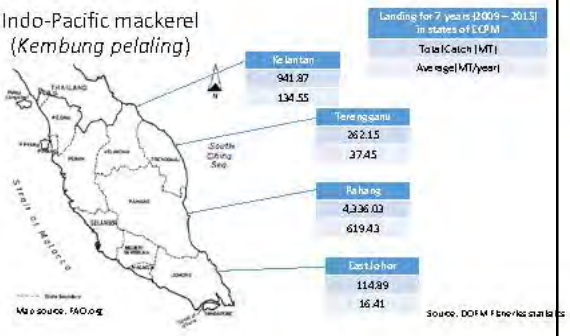


The anchovy fishing season started in May till October.

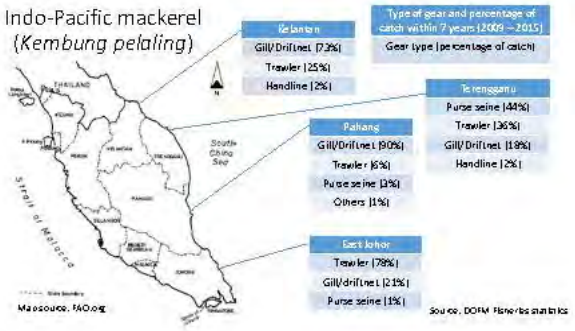
Indo-pacific mackerel at ECPM

- Latest studies were conducted by SEAFDEC/MFRDMD
- The species distribution are more concentrated to the coastal area
- Main gears – gillnets/driftnets and purse seiners

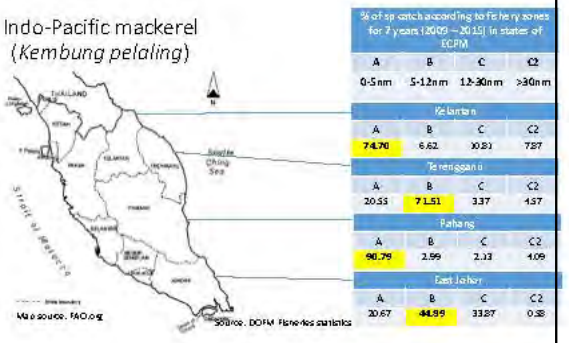
Indo-Pacific mackerel (*Kembung pelaling*)



Indo-Pacific mackerel (*Kembung pelaling*)



Indo-Pacific mackerel (*Kembung pelaling*)

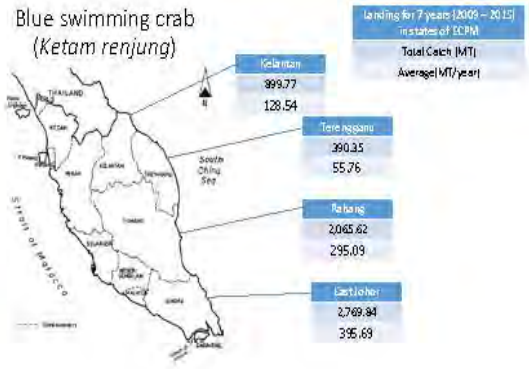


Blue swimming crab (*ketam renjung*)

- The blue swimming crab fisheries in Malaysia are located in eight areas along the WCPM and in one along the ECPM. The most common gears are trawls, drift nets and crab traps. Except for the crab traps, the blue swimming crab are actually retained non-target species. The status of the blue swimming crab stocks is unknown in all the areas.

Source: WWF-US report (2009)

Blue swimming crab (*Ketam renjung*)



Thank you

Annex 5

THAILAND

Fishery Information of AIB Species in the Gulf of Thailand

Ms. Pakjuta Khemakorn
Mr. Piyachoke Sinanun
Ms. Sansanee Srichan-ngarm
Department of Fisheries, Thailand

22-23 September 2016, Bangkok,Thailand

AIB Species in Thai Waters

- A: Anchovy
  - *Encrasicholina heteroloba*, *E. punctifer*, *E. devisi* and *Stolephorus* spp. (eg. *S. indicus*)

- I: Indo-Pacific mackerel
  - *Rastrelliger brachysoma*

- B: Blue swimming crab
  - *Portunus pelagicus*

Overall Information

- Catch and landing
  - Quantity and value
- Main fishing gears
  - Fishing vessels: size and numbers
- Biological information
- Existing management measures
- Researches and studies
- Projects and management plans

Thailand

- Total land area: 513,115 km²
- Including 77 provinces
- Coastal area: consist of 24 provinces (both the Gulf of Thailand and Andaman Sea)
- Coastline: 2,614 km
- EEZ: 420,280 km²
  - Gulf of Thailand: 304,000 km² (85 m max. in depth)
  - Andaman Sea: 116,280 km² (1,200 m max. in depth)

Anchovy

- 2 main fishing gears
  - Anchovy falling net with light luring (AFNs and AFN)

<14 m

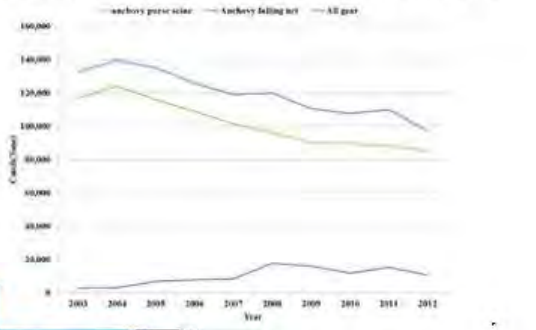
>14 m

Anchovy

- Anchovy purse seine (APS)
  - Operating in day time

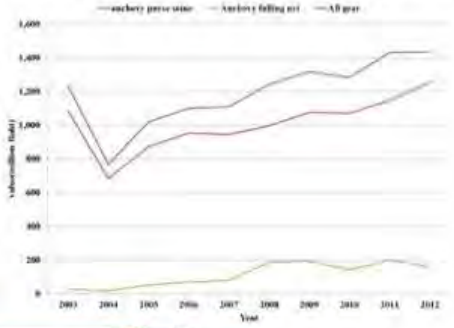
Anchovy

Total Catch of Anchovy in the Gulf of Thailand 2003-2012



Anchovy

Total Value of Anchovy in the Gulf of Thailand 2003-2012



Anchovy

year	Catch (Tons) Anchovy purse seine	Anchovy falling net	All gear	Value (million Baht) Anchovy purse seine	Anchovy falling net	All gear
2003	116606	2872	132,550	1083.95	26.7	1,232
2004	124173	2990	139,326	683.13	16.45	766
2005	115799	6919	135,140	873.33	52.18	1,019
2006	109023	7809	125,919	951.29	68.14	1,099
2007	101268	8459	118,886	944.3	78.88	1,109
2008	96119	17881	119,964	995.45	185.18	1,242
2009	90191	16197	110,410	1075.58	193.16	1,317
2010	89717	11896	107,565	1069.49	141.81	1,282
2011	88272	15318	110,014	1148.1	199.23	1,431
2012	85053	10723	97,192	1255.44	158.28	1,435

Anchovy: Number of Fishing Vessels

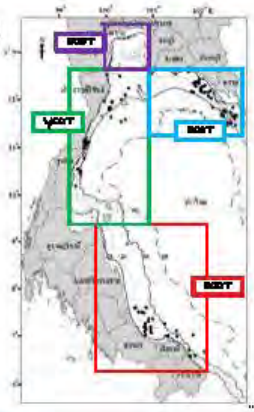
GOT

Fishing gear	10-20 GT	20-60 GT	60-150 GT	> 150 GT	Total
Anchovy purse seine	25	53	98	22	**198**
Anchovy falling net with light luring	78	325	77	1	**481**
Anchovy lift net	2	12			**14**

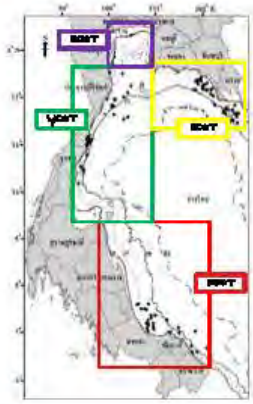
(based on no. of fishing licenses as of 31 Aug 16)

Anchovy: Fishing Grounds

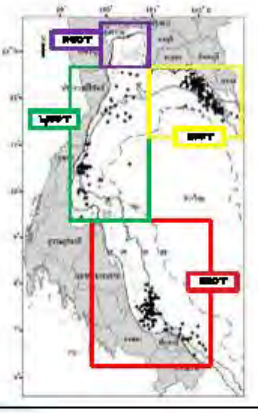
- **SGOT:** the southern part of the Gulf (4 provinces: Narathiwat, Pattani, Songkhla and Nakhon Si Thammarat
- **MGOT:** the middle part of Gulf (3 provinces: Surat Thani, Chumphon, and Prachuap Khiri Khan)
- **NGOT:** the northern part of Gulf (5 provinces: Petchaburi, Samut Songkhram, Samut Sakhon, Samut Prakan and Chonburi)
- **EGOT:** the eastern part of Gulf (3 provinces: Rayong, Trat and Chanthaburi)

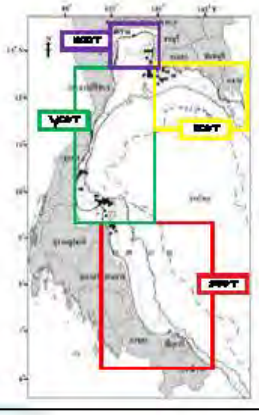


Fishing Grounds of Anchovy Falling Net With Light Luring (LOA <14 m) in the Gulf of Thailand



Fishing Grounds of Anchovy Falling Net With Light Luring (LOA >14 m) in the Gulf of Thailand



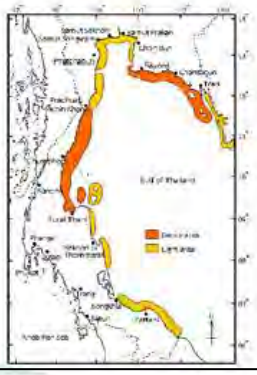


Species Composition of Anchovy Obtained by Fishing Gears

Species Group	Fishing Gear		
	AFNs	AFN	APS
Pelagic fish	95.82	95.75	95.72
Anchovy	83.92	83.22	87.63
E. devisi	11.15	9.66	1.96
E. heteroloba	34.47	30.44	74.59
E. punctifer	30.83	37.68	0.59
***Stolephorus* spp.**	2.42	1.35	0.75
small anchovy	5.25	4.09	9.74
Others pelagic fish	11.90	12.53	8.09
Others	4.18	4.25	4.28

Some Biological Information of Anchovy in the Gulf of Thailand

Distribution of anchovy eggs and larvae in the Gulf of Thailand



Some Biological Information of Anchovy in the Gulf of Thailand

Area/Sub area	Species	Spawning season	Spawning ground
The southern part of the Gulf	*E. heteroloba*, *E. punctifer*, *E. devisi* and *Stolephorus* spp.	Feb-Apr and Jul-Sep	off Nakhon Sri Thammarat to Songkhla, 20-30 m
The middle part of the Gulf	*E. heteroloba*, *E. punctifer*, *E. devisi* and *Stolephorus* spp.	Feb-Apr and Jul-Aug	off Prachuap Khiri Khan, off Chumporn and off Surat Thani, 10-30 m
The northern part of Gulf	*E.heteroloba*, *E. punctifer*, *E. devisi* and *Stolephorus* spp.	not confirmed	Off Chonburi, 10-20 m
The eastern part of Gulf	*E. heteroloba*	Oct-May	Ko Chang, Ko Kut off Trat, off Chanthaburi and off Rayong, 10-20 m

Anchovy

- Existing management measures
  - Fishing licenses (based on TAC)
  - Fishing zone
  - Gear restriction

Researches & Studies (GOT)

- **Anchovy**
  - Abundance and Distribution of Anchovy Eggs and Larvae in Southern Gulf of Thailand (2001)
  - Stock Assessment of Anchovies (*Encrasicholina devisi* (Whitley, 1940), *E. punctifer* Fowler, 1938 and *E. heteroloba* (Ruppell, 1837)) along the Andaman Sea Coast of Thailand (2008)
  - Anchovy Fisheries in the Gulf of Thailand (2008)

Indo-Pacific Mackerel

- 4 Main fishing gears
  - Purse seine

Indo-Pacific Mackerel

- Pair trawl

Indo-Pacific Mackerel

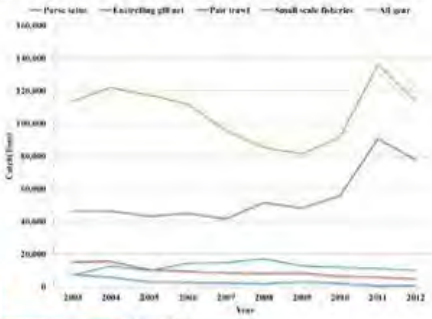
- Indo-Pacific mackerel encircling gill net

Indo-Pacific Mackerel

- Indo-Pacific mackerel gill net

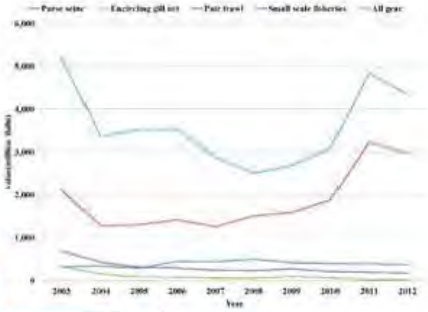
Indo-Pacific Mackerel

Total Catch of Indo-Pacific Mackerel in the Gulf of Thailand 2003-2012



Indo-Pacific Mackerel

Total Value of Indo-Pacific Mackerel in the Gulf of Thailand 2003-2012



Indo-Pacific Mackerel

catch(ton)

year	Purse seine	Encircling gill net	Pair trawl	Small scale fisheries (e.g. gill net)	All gear
2003	46,569	7879	15190	7,096	118,659
2004	46482	5788	15568	12,587	122,070
2005	48266	8086	10892	9,889	117,218
2006	45085	2609	9819	14,889	111,865
2007	41698	2177	8846	14,786	95,668
2008	51482	1921	8141	17,080	85,260
2009	48227	2996	8450	12,817	81,555
2010	55661	2111	6252	11,926	91,470
2011	90728	594	5659	11,149	186,005
2012	77869	788	4781	10,010	118,659

Value(million Baht)

year	Purse seine	Encircling gill net	Pair trawl	Small scale fisheries (e.g. gill net)	All gear
2003	2181.57	867.75	695.28	824.8	5,202
2004	1281.21	158.88	429.48	847.82	8,868
2005	1801.89	91.85	812.7	297.56	8,527
2006	1421.88	82.87	294.28	452.72	8,582
2007	1258.52	65.71	251.98	446.82	2,888
2008	1510.79	56.48	289.14	501.72	2,504
2009	1591.8	98.86	278.82	422.91	2,691
2010	1888.18	71.42	211.52	404.49	8,095
2011	8288.64	21.17	201.7	897.87	4,847
2012	2978.98	80.15	180.99	882.94	4,848

Indo-Pacific Mackerel: Number of Fishing Vessels

GOT

Fishing gear	10-20 GT	20-60 GT	60-150 GT	> 150 GT	Total
Purse seine (all types)	26	140	535	39	**740**
Pair trawl	1	230	709	6	**945**
Pelagic gill net (including Indo-Pacific mackerel gill net)	182	316	91	3	**592**

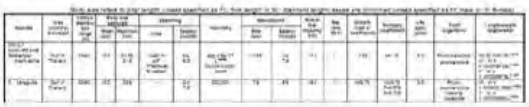
(based on no. of fishing licenses as of 31 Aug 16)

Indo-Pacific Mackerel: Fishing Grounds

Some Biological Information of Indo-Pacific Mackerel in the Gulf of Thailand

- Distribution: along the coastal areas, less than 50 m in depth
- Spawning season: all year round (high peak during Jan-Mar and Jun-Aug)
- Spawning grounds: the middle of the Gulf of Thailand (off Prachuap Kiri Khan, Chumphon and Surat Thani Provinces)
- Life cycle:
  - Gravid fish move from the inner Gulf to spawn in the middle Gulf
  - Fertilized eggs float in the areas of 20-30 m in depth
  - Juveniles move to the inner Gulf

Indo-Pacific Mackerel: Key Biological Features



Indo-Pacific Mackerel

- Existing management measures
  - Closed season
  - Closed area

During 15 Feb-15 May to conserve gravid fish and juveniles in this area

  - Fishing licenses
  - Fishing zone
  - Gear restriction

Researches & Studies (GOT)

Indo-Pacific Mackerel

- Reproductive Biology of Short Mackerel *Rastrelliger brachysoma* (Bleeker, 1851) and Indian Mackerel *R. kanagurta* (Cuvier, 1816) in Thai Waters (2003-2005)
- Maturation of Indo-Pacific Mackerel (*Rastrelliger brachysoma* (Bleeker, 1851)) along the Coast of Trat Province (2008)
- Assessment of Fisheries Status by Using Sustainable Fisheries Indicators Case study: Indo-Pacific mackerel, *Rastrelliger brachysoma* (Bleeker, 1851) in the Gulf of Thailand (1968-2009)
- Some Biologies of Indo-Pacific Mackerel (Rastrelliger brachysoma (Bleeker, 1851)) and Indian Mackerel (*R. kanagurta* (Cuvier, 1816)) in Trat Province, 2009 (2009)
- The Stock Discrimination of Indo-Pacific Mackerel by Otolith Shape Analysis Technique (2010-2011)
- Age and Growth Determination of Indo-Pacific Mackerel Using Otolith Microstructure Technique (2010-2011)

Blue Swimming Crab

- 2 main fishing gears
  - Crab trap

Blue Swimming Crab

- Crab gill net

Long tail boat: Rayong

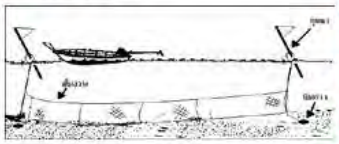
Inboard-engine boat: Phetchaburi

Long tail boat: Pattani

Inboard-engine boat: Surat Thani

Blue Swimming Crab

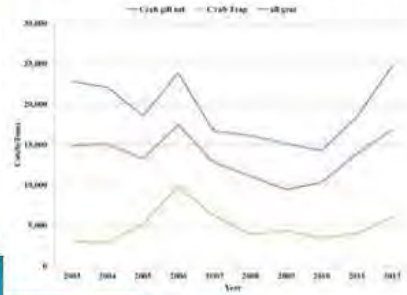
- Crab gill net



- Made of monofilament
- 12-30 meshes in depth
- Stretched mesh size between 7.50-13.75 cm

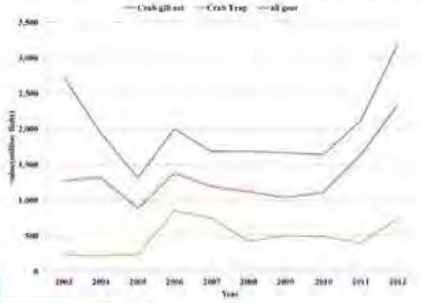
Blue Swimming Crab

Total Catch of Blue Swimming Crab in the Gulf of Thailand 2003-2012



Blue Swimming Crab

Total Value of Blue Swimming Crab in the Gulf of Thailand 2003-2012



Blue Swimming Crab

	Catch (Tons)			Value (million Baht)		
year	Crab gill net	Crab Trap	all gear	Crab gill net	Crab Trap	all gear
2003	14,879	3,075	22,825	1,272.67	229.16	2,732.03
2004	15,097	2,886	22,113	1,326.98	226.80	1,947.08
2005	13,240	5,237	18,567	885.92	234.58	1,313.62
2006	17,466	9,780	23,850	1,381.24	856.84	2,006.54
2007	12,779	6,176	16,638	1,198.74	756.33	1,685.04
2008	11,148	3,908	16,156	1,121.92	427.29	1,690.65
2009	9,479	4,363	15,132	1,042.22	505.49	1,669.18
2010	10,334	3,478	14,262	1,113.44	490.17	1,642.81
2011	13,866	4,007	18,411	1,633.43	403.54	2,120.36
2012	16,848	6,124	24,741	2,335.68	747.26	3,185.66

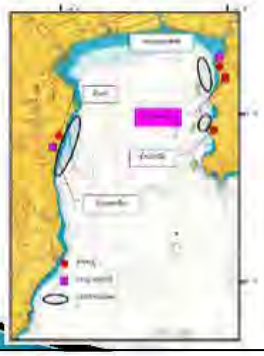
Blue Swimming Crab: Number of Fishing Vessels

GOT

Fishing gear	10–20 GT	20–60 GT	60–150 GT	> 150 GT	Total
Crab trap	197	170	1		**368**
Bottom gill net (including crab gill net)	116	100	1		**217**

(based on no. of fishing licenses as of 31 Aug 16)

Blue Swimming Crab: Fishing Grounds



Blue Swimming Crab

- Existing management measures
  - Fishing licenses
  - Fishing zone, i.e. restricted coastal area
  - Gear restriction, i.e. mesh size of crab trap > 2.5"
  - Prohibited fishing season for gravid crabs during October–December
- Action plan for sustainable management of blue swimming crab resources in Thailand
- FIP Project (with WWF in Surat Thani Province)

Researches & Studies (GOT)

- **Blue Swimming Crab**
  - Crab Gill Net Fishery (2004–2005)
  - Fishermen 's Attitude on Management of Blue Swimming Crab Resource (2004)
  - Fishermen's Attitude on Blue Swimming Crab Resource Management in the Eastern Gulf of Thailand (2004)
  - Biology and Stock Assessment of Blue Swimming Crab *Portunus pelagicus* (Linnaeus, 1758) in the Upper Gulf of Thailand (2003–2004)
  - Crab Bottom Gill Net and Collapsible Crap Trap Fisheries in the Inner Gulf of Thailand (2003–2005)
  - Spawning Season, Fecundity and Sex Ratio of Blue Swimming Crab in Thai Waters (2003–2005)
  - Crab Gill Net Fishery along the Eastern Gulf of Thailand (2003–2005)
  - An Assessment of Financial Loss and Gain from Berried Blue Swimming Crab Culture in Crab Bank, Phetchaburi Province (2006)
  - Suitability of Gravid Female Blue Swimming Crab for Hatching in the Crab Bank (2008)

Projects & Management Plans

- Projects for food security
- Projects of marine resource enhancement and management
- The Master Plan on Marine Fisheries Management of Thailand (2009–2013, 2014–2018)
- Marine Fisheries Management Plan of Thailand (2015–2019)
- Stock assessment
  - Ongoing MSY Analysis (including AIB Species, result expected by Feb 17)

Thank you

Annex 6

Viet Nam

Stock status Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) species in the Southwest waters of Vietnam

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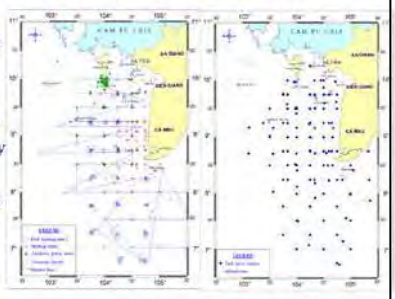
Mr. Tran Van Cuong
Research Institute for Marine Fisheries
224 Lelai, Haiphong, Vietnam
Email: nkbat2005@gmail.com

OVARALL INFORMATION

- The transboundery waters between the provinces of Kien Giang (Viet Nam) and Kampot (Combodia) are lacated in the eastern portion of the Gulf of Thailand.
- The coastlines of the two provinces totals 295 km, including 95 km in Kampot province and 200 km in Kien Giang province.
- In Kien Giang province, Phu Quoc, Nam Du and Tho Chu islands are important landing side and main fishing grounds
- According to RIMF, total biomass of marine resources in southwestern waters was estimated at 1.07 mill. tons (2006) and 584 thousand tons (2015).
- Depending on fishing gears and areas, fishing time of resource groups can be varied from area to area.
- Main marine resources in transboundary area: Anchovy, Indo Pacific mackerel; Blue swimming crab

Research programs in the Southwest waters of Vietname

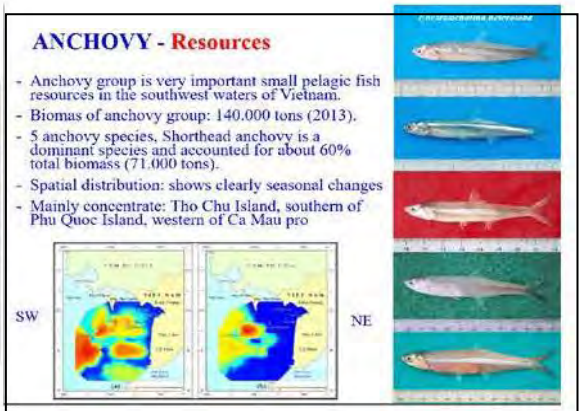
- **Year 2000 - 2006**
  - 7 Fish bottom trawls
  - 4 Shrimp trawls
  - 4 Acoustic survey
  - 4 Purse seine survey
  - 10 Fish larvae survey
- **Year 2011 - 2015**
  - 2 Fish bottom trawls
  - 1 Shrimp trawls
  - 2 Acoustic survey
  - 4 Fish larvae survey



MARINE RESOURCES SURVEY FISH - LARVAE SURVEY

ANCHOVY - Resources

- Anchovy group is very important small pelagic fish resources in the southwest waters of Vietnam.
- Biomas of anchovy group: 140.000 tons (2013).
- 5 anchovy species, Shorthead anchovy is a dominant species and accounted for about 60% total biomass (71.000 tons).
- Spatial distribution: shows clearly seasonal changes
- Mainly concentrate: Tho Chu Island, southern of Phu Quoc Island, western of Ca Mau pro

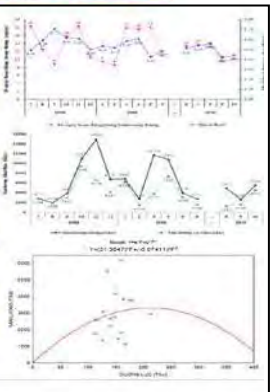


ANCHOVY - Fishery

- Khai thác cá cơm tập trung chủ yếu ở tỉnh Kiên Giang.
- 2 loại nghề khai thác chính: lưới vây cá cơm truyền thống; kéo đôi nổi (lưới kéo cao tốc) du nhập từ Trung Quốc
- Sản phẩm chế biến cá cơm: nước mắm, cơm sấy khô, cơm tẩm, bột cá chế biến thức ăn gia súc…

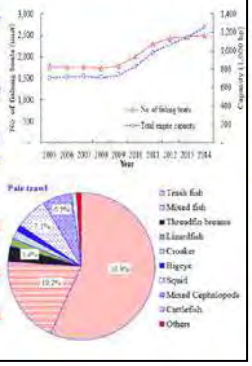
ANCHOVY - Fishery - Anchovy Purse Seine

- Year 2011: 230 units in Kien Giang Province
- Fishing activity: 2-3 days/trip; 8-9 days/months; BAC = 0,54; Mean CPUE: 1,7 tons/day.
- Fishing season: Apr., Aug., Nov.
- Total catch: 40,000 tons (Y2010), 41,800 tons (Y2013).
- Shorthead anchovy: 29,500 tons
- MSY: 40,000 tons ≈ 3.32 tons/month
- Maximum fishing effort: 210 units.
- The total fishing effort need to be reduced



ANCHOVY - Fishery - Pelagic Pair trawls

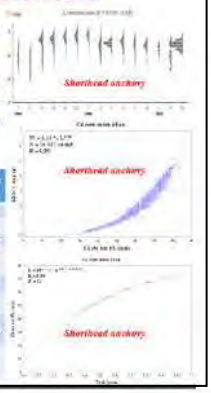
- Year 2014: 2,507 units (Bottom Pair trawl and Pelagic Pair trawl).
- Không thống kê số tàu giã đôi nổi
- Fishing activity: 2-4 hauls/day; 7-10 days/trip; 20-24 active days/month;
- Mean CPUE (>150 HP): 1.7 tons/day (quarter II); 1.3 tons/day (quarter III, IV).
- Fishing season: all year
- Cá tạp chiếm 56,9% trong tổng sản lượng.
- Cá cơm chiếm 58% trong sản lượng cá tạp (cá cơm môm nhọn - 32,5%)
- Chưa xác định được sản lượng của nghề lưới đôi nổi.



ANCHOVY - Fishery - Anchovy Purse Seine

Some biological characteristics of 5 anchovy species in the southwest waters:

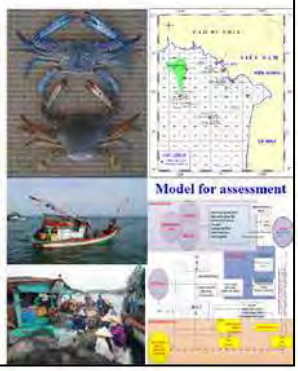
Length frequyency, mean length, length-weight relationship, sex ratio, length at fisrt maturity, spawning season, absolute fecundity…



English name	Shorthead anchovy	Buccaneer anchovy	Devis' anchovy	Commerson's anchovy
Size range (mm)	16-85	39-85	48-86	45-94
Mean length (mm)	62.3	63.8	69.0	79.7
W=a.L^b	1.10^{-6} ; $L^{3.4}$	4.10^{-6} ; $L^{3.18}$	3.10^{-6} ; $L^{3.30}$	4.10^{-6} ; $L^{3.22}$
L_∞; k; t_0	86; 1.82 -0.028	89; 1.93 -0.037	90; 2.09 -0.021	99; 2.14 -0.007
Sex ratio	1.20:1.00	1.20:1.00	0.95:1.00	0.95:1.00
L_{50} (mm)	63.0	69.0	64	74
Fecundity (oocytes)	1.670-14.946	3.587+15.357	1.917-7.697	1.230+5.662
Spawnming season	May-June Nov-Jan	May Sep-Dec	Jan-Apr Oct-Dec	May-July Sep-Dec

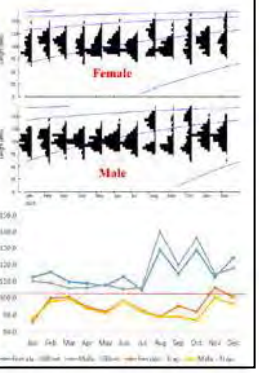
BLUE SWIMMING CRAB - Resources

- BSC fisheries is important to the coastal fishing communities in Southwest waters of Vietnam, especially in Kien Giang Province
- Fishing gear: trap and gillneter
- Stock assessment of BSC in Kien Giang waters started studying from 2013 using the landing data.
- Stock biomass of BSC was estimated at 7.13 thousand tons corresponding to 1.54 x 106 individuals, with 3 thousand tonnes of mature crabs and 4.1 thousand tonnes of immature crabs.



BLUE SWIMMING CRAB - Resources

- Carapace width (CW) ranged 59 - 167mm
- L-W rel.: W = 0.037776.CW $^{3.1633}$ (F)
  W = 0.035038.CW $^{3.3706}$ (M)
- Spawning: Feb. - Apr. and Aug. - Nov.
- Size at first maturity CW_{50}: 99.28 mm
- VB function: CW=175.88*(1-exp$^{-0.99}$ *t)
- Sex ratio: 1.45:1.0

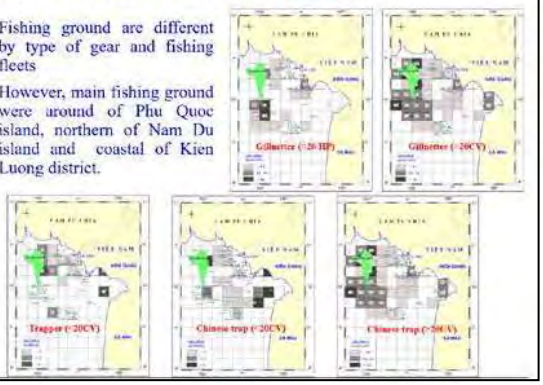


BLUE SWIMMING CRAB - Fishery

- **Year 2013:** Totally 1,728 fishing unit, 381 trappers and 1337 gillnetters
- **Mean activity day:**
  Gillnetter: 11.3-23.6 days/month
  Trapper: 12.5-23.1 days/month
- **Catch per unit effort** (CPUE)
  Gillnetter: 0.4 kg/km net
  Trapper: 4.9 kg/100 traps
  6.1 - 7.4 kg/100 traps
- **Mean BAC:**
  Gillnetter: 0.45-0.78
  Trapper: 0.36-0.85

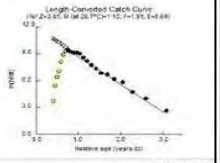
BLUE SWIMMING CRAB - Fishery

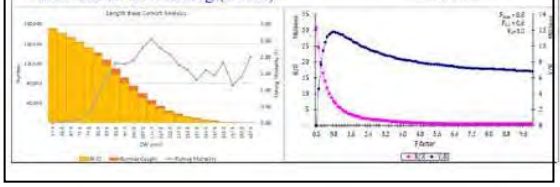
- Fishing ground are different by type of gear and fishing fleets
- However, main fishing ground were around of Phu Quoc island, northern of Nam Du island and coastal of Kien Luong district.



BLUE SWIMMING CRAB - Fishery

- In 2013, total catch of BSC was about 7,854 tons.
- Gillnetters accounted for about 53.4% (4,196 tons)
- Trappers accounted about 46.6% (3,658 tons).
- BSC stock: Overfishing (E>0.5)

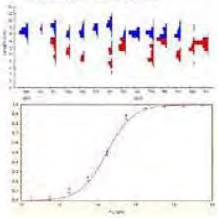




INDO PACIFIC MACKEREL

- Ở biển Việt Nam, cá ba thú phân bố tập trung ở vùng biển TNB nơi giáp với Campuchia và Thái Lan.
- Cá ba thú khai thác ở vùng biển TNB có chủ yếu sử dụng ăn tươi
- Cá ba thú ít được nghiên cứu: FL 4-21cm; L_{∞} = 22.6cm; K = 1.8 year^{-1}; E = 0,63
- Trữ lượng nguồn lợi nhóm cá bạc mà (gồm cả cá ba thú) ở vùng biển TNB khoảng 264 nghìn tấn ở mùa SW và 169 nghìn tấn ở mùa NE.
- Thiếu thông tin về: sinh sản, sinh trưởng, dinh dưỡng, di cư, lượng bổ sung, sản lượng khai thác ….

Cá ba thú
Rastrelliger branchysoma



Thanks for your attention!

Annex 7

PRELIMINARY DATA FOR AIB SPECIES IN THE GULF OF THAILAND

Preliminary Data for AIB – Species in the Gulf of Thailand Sub – Region

Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific Mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand

22 – 23 September 2016, Bangkok, Thailand

Area 71

-Area 71 (Western Central Pacific)

-Including maritime area of Cambodia, Indonesia, Malaysia, Philippines, Singapore, Vietnam and North and Northeast Australia

-The Gulf of Thailand sub-region was included into this area

Gulf of Thailand Sub – Region

- regarding to the Sub – Regional Meeting on the Gulf of Thailand in 2009, GoT've divided into 4 areas namely

(1) Sub – area 71 a: Marine fishing area of Thailand (Gulf of Thailand);

(2) Sub – area 71 b: Marine fishing area of Cambodia;

(3) Sub – area 71 c: Marine fishing area of Vietnam (Southwest Vietnam) and

(4) Sub – area 71 d: Marine fishing area of Malaysia (East Coast of Peninsular Malaysia).

3 Selected Commercial Species

- Anchovy (Engraulidae)
- Short Mackerel (*Rastrelliger brachysoma*) and
- Blue Swimming Crab (*Portunus pelagicus*)

Anchovy

- Small pelagic schooling fish in Family Engraulidae
- Commonly in coastal area
- Focus in 2 genera, *Encrasicholina* and *Stolephorus*

Anchovy (Cont.)

- 2 genera, 10 spp. have found in GoT (Supongpan et. al., 2000)
- Regarding to recent revision, during 2001 – 2013, 2 genera and 8 spp. were found

Species	Gulf of Thailand		
	Thailand	Malaysia	Sarawak
Encrasicholina devisi		1	
E. punctifer	1		
E. heteroloba	1		
Stolephorus andhraensis		1	
S. banganensis		1	1
S. dubiosus	1		
S. indicus	1	1	
S. waitei	1		

Table 1: The distribution of *Encrasicholina* spp. and *Stolephorus* spp. in SEA region

Anchovy (Cont.)

- *Encrasicholina heteroloba* (Rüppell, 1837)
- Body nearly cylindrical
- Maxilla tip longer than deep
- Scale moderate, 39 – 43 in lateral line series
- Color, pale cream (when scale loss),
- Dull silver – grey band on flank
- With distinct blue upper edge (when alive)

Anchovy (Cont.)

E. heteroloba

Anchovy (Cont.)

- *Stolephorus indicus* (van Hasselt, 1823)
- Body slender, round in cross section
- Posterior tip of maxilla pointed, extending beyond anterior border of preopercle
- Caudal fin large and folked
- Cycloid scale present, 40 in longitudinal rows
- Color, translucent, yellowish dorsally
- Board silver stripe present midlaterally
- Head silvery

Anchovy (Cont.)

S. indicus

Anchovy (Cont.)

Parameter	*Encrasicholina heteroloba*	*Stolephorus indicus*
Size (cm Standard Length: SL)	About 7.5 cm.	About 12 cm.
L_{∞} (cm SL)	9.7 (Range 7.9 – 12.3 cm)	16.4 (14.5 – 19 cm)
L_{max} (cm SL)	5.45 (Range 5.8 – 5.8 cm)	About 12 cm.
K (year)	2.4 (Range 0.80 – 4.09 /year)	1.0 (0.71 – 1.42/year)
Distribution	From southern Japan to northern Australia, Indo – Pacific (including Samua and Fiji) to Eastern Africa	From Hongkong to northern and eastern Australia, Samoa and Tahiti to Madacuscar
Diet	Zooplankton	Zooplankton

Anchovy (Cont.)

- Anchovy have caught by several gears
- Supongpan *et al.*, (2000) have reported the gear that target on anchovy in gulf of Thailand as these followings
  - Anchovy Purse Seine without light, daytime fishing (APS)
  - Anchovy Purse Seine with Light luring (APSL)
  - Lift Net with Light luring (LNL)
  - Falling Net with Light luring (FNL)
  - Pair Trawl (PT)
  - Push Net (PN)
  - Bamboo Stake Trap (BST) and
  - Beach Seine (BS)

Anchovy (Cont.)

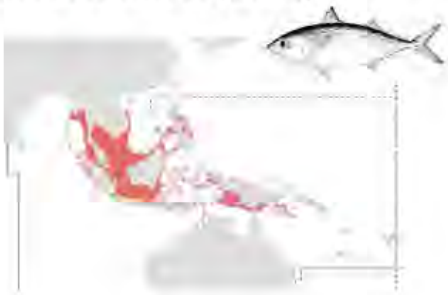
Anchovy (Summary)

- Regarding to SEAFDEC statistical data base (1995 – 2014)
- The catch trend showing the highest catch in 2004 (326,012 MT)
- But trend show the reducing trend since 2005 and lowest catch shown in 2013 (192,423 MT)
- Even though catch data seems to be increasing in 2014 but this trend still needed to be observed carefully

Short Mackerel

- *Rastrelliger brachysoma* (Bleeker, 1851)
- Pelagic – neritic fish
- Deep body (3.7 – 4.3 times FL)
- Head equal to or less than body depth
- Very long gill rakers present when mouth opened
- 5 dorsal and anal finlets present
- Body silvery with dark green and dark spot in dorsal margin,
- pectoral and pelvic fin dusky, other fins yellowish

Short Mackerel (Cont.)



Short Mackerel (Cont.)

Parameter	*Rastrelliger brachysoma*
Size (cm. Folk Length: FL)	20 cm. (Range between 15 – 20 cm.)
L_{∞} (cm. FL)	25 cm. (Range between 21.2 – 34.5 cm.)
$L_{50\%}$ (cm. FL)	17 cm. (Range between 15 – 18 cm.)
K (year)	1.6 (Range between 0.6 – 4.14)
Longevity	At least 2 years
Distribution	From the coast line of Myanmar to the Pacific Island and central Vietnam to northern Australia
Diet	Microzooplankton with a high phytoplankton component

Short Mackerel (Cont.)

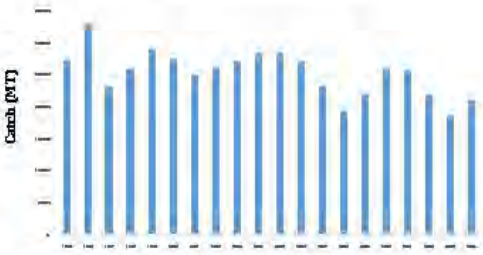
- The similar 2 species occurred in the same area
- They will sold under the name *Rastrelliger* spp. in some area

Rastrelliger brachysoma

Rastrelliger kanagurta

Rastrelliger faughni

Short Mackerel (Cont.)



(SEAFDEC data base, 1995 – 2014)

Short Mackerel (Summary)

- Regarding to SEAFDEC data base (1995 – 2014)
- Catch trend show the highest peak in 1996 (328,955 MT) and getting declined
- Even we have at least 3 peaks (1999, 2005 and 2010) but the catch never reach to 300,000 MT as in 1996, and each peak were getting lower (289,285 MT, 283,984 MT and 259,354.56 MT, respectively)
- This data can be assumed, **roughly**, that they have reached and over MSY level since 2010 – 2011, but needed to be observed carefully due to the increasing catch in 2014

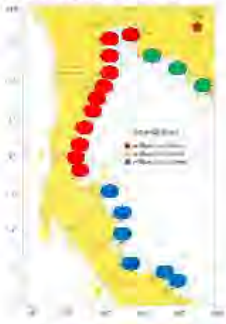
Anchovy and Short Mackerel

Family		Larvae Composition (%)		
		South GoT	East GoT	Central GoT
Non – economic Larvae		27.53	56.24	32.03
Economic Larvae	Engraulidae	2.24	10.44	12.31
	Clupeidae	53.78	3.99	21.41
	Scombridae	4.56	5.73	11.58
	Nemipteridae	4.29	4.09	8.02
	Carangidae	2.32	11.89	5.92
	Other	5.28	7.62	8.73

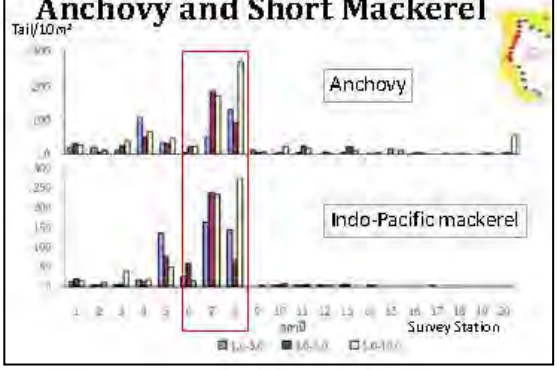
Indo – Pacific Mackerel and Important Economic Species, SEAFDEC, 2010)

Anchovy and Short Mackerel

- The study of "Abundance and Distribution of Economic Fish Larvae in 10 Nautical Miles Inshore Area in the Gulf of Thailand"
- By Thai DoF
- 3 stations in Eastern GoT, 11 stations in Central GoT and 6 stations in Southern GoT in 2010
- Result show that this following table



Anchovy and Short Mackerel



Anchovy and Short Mackerel

- Result from Central Gulf of Thailand show that the distribution and density of Juvenile Short Mackerel and Anchovy both related together
- Both using same nursing ground for feed due to the need of same food item (Phytoplankton and Microzooplankton)
- The result from the research survey project from Faculty of Fishery, Kasetsart University, Thailand show that the Juvenile mackerel also get caught together with anchovies
- Prove that they've migrated together in the related schooling
- Now we've data from central GoT but we need more data from this sub-region for whole picture of GoT sub-region

Blue Swimming Crab

- *Portunus pelagicus* (Linnaeus, 1758)
- Tropical marine crab
- Rough to granulose carapace present
- 9 teeth on left and right anterolateral margin
- Chelae (arms) elongate
- Large 2 segments of last pair paddle – like
- Color
  - Male: Blue marking with small white spots and bands
  - Female: Dull green with small white spots and bands

Blue Swimming Crab (Cont.)

Blue Swimming Crab (Cont.)

Parameter	*Portunus pelagicus*
Size (cm. Carapace Wide. CW)	14 – 20 cm.
L_∞ (cm. CW)	15.3 cm. (Range between 12.59 – 20.00)
L_{50} (cm. CW)	7.16 cm. (Range between 7.00 – 9.00)
K (year)	1.5 (Range between 0.10 – 3.00)
Distribution	Indo and Western Pacific Ocean and Coastal line of Indian Ocean , East Africa and Mediterranean Sea
Diet	Wide range Carnivorous, feed mainly on Zoobenthos and detritus, Canibalism present in Megalopa and Juvenile crab

Blue Swimming Crab (Cont.)

- Blue Swimming Crab can be caught by using
  - Collapsible Crab Trap,
  - Cylindrical Wire Traps,
  - Other crab traps,
  - Pots,
  - Crab Gillnet and
  - etc. for main catch
- And by bottom trawl for bycatch
- Regarding to the demand in both domestic and international
- Both freezing and proceeded crab with high income
- Blue Swimming Crab now have got the high fishing pressure

Blue Swimming Crab (Cont.)

Blue Swimming Crab (Summary)

- Regarding to SEAFDEC data base (1995 – 2014)
- Catch trend show the declining, since 1999 until 2007
- In 2008 catch trend seems to be increasing and stable till 2014
- But regarding to this data, we can see the suddenly peak and reducing of catch in 2006 and 2011 which cause might be observed
- The catch data collection needed to be observed carefully

References

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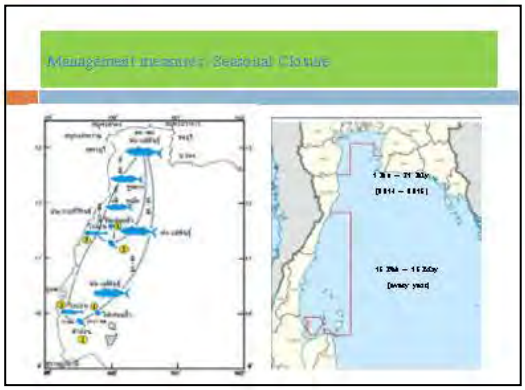
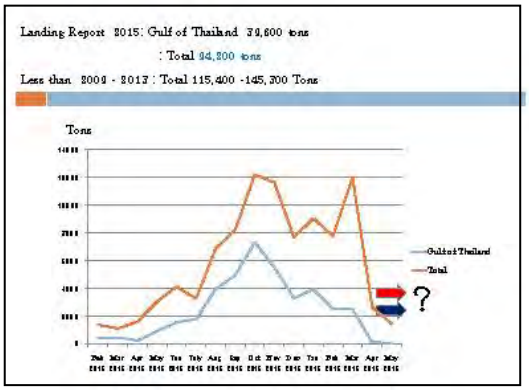
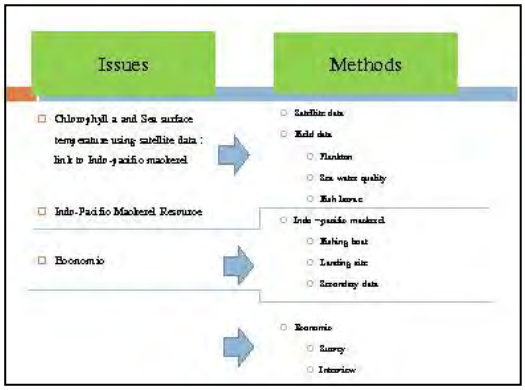
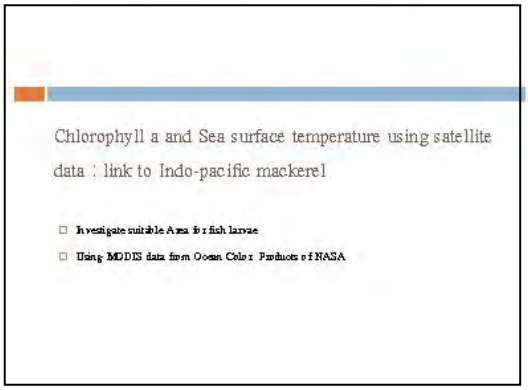
- Supongpan *et al.*, 2000, Technical Report on the Anchovy Fisheries in the Gulf of Thailand, Food and Agricultural Organization of the United Nations, Rome, 105 p.
- *Rastrelliger brachysoma*: http://www.fao.org/fishery/species/2477/en
- *Portunus pelagicus* http://www.fao.org/fishery/species/2629/en
- http://www.fao.org/fishery/area/Area71/en
- http://www.fishbase.org/summary/Encrasicholina-heteroloba.html
- http://www.sealifebase.org/summary/Portunus-pelagicus.html
- http://www.fishbase.org/summary/Rastrelliger-brachysoma.html
- http://www.fishbase.org/summary/Stolephorus-indicus.html
- http://www.marinespecies.org/aphia.php?p=taxdetails&id=212280
- http://www.marinespecies.org/aphia.php?p=taxdetails&id=219980

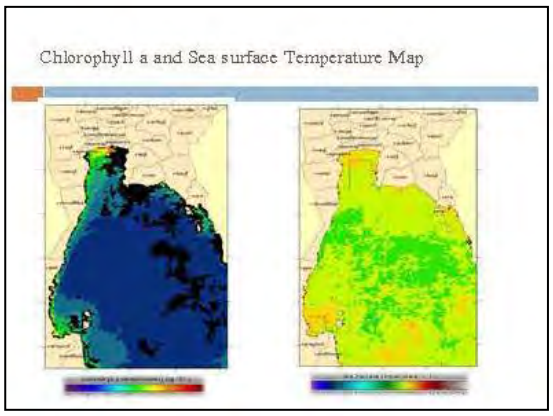
STUDY ON INDO – PACIFIC MACKEREL RESOURCE IN RELATION TO SEA SURFACE ENVIRONMENT IN THE GULF OF THAILAND

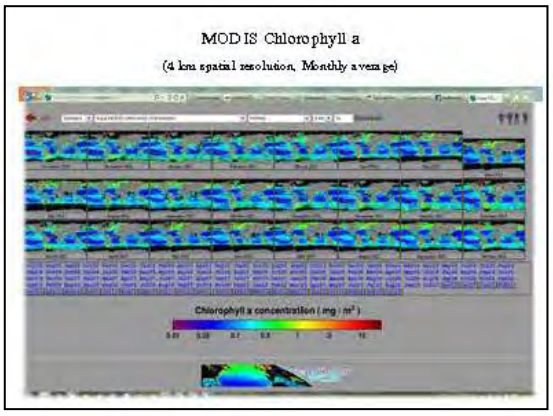


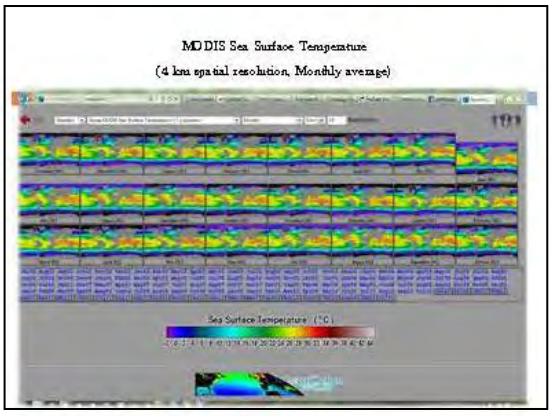




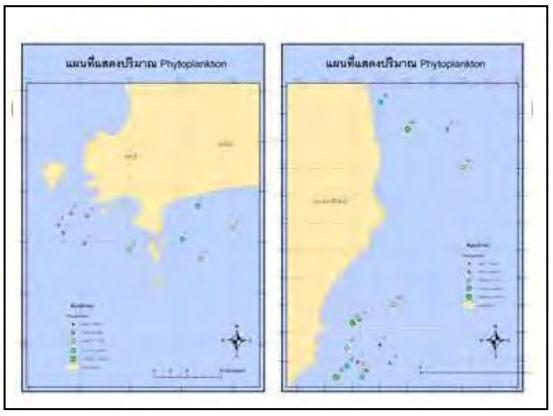


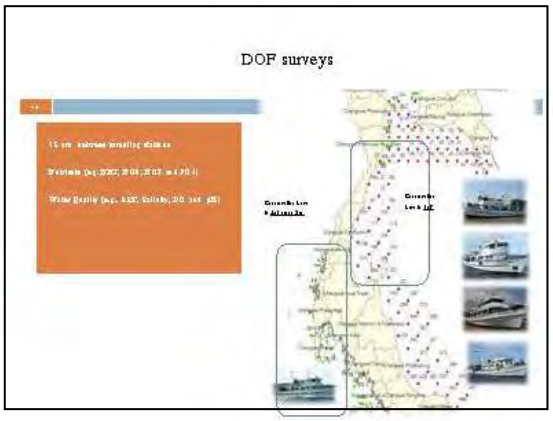

Chlorophyll a and Sea surface Temperature Map

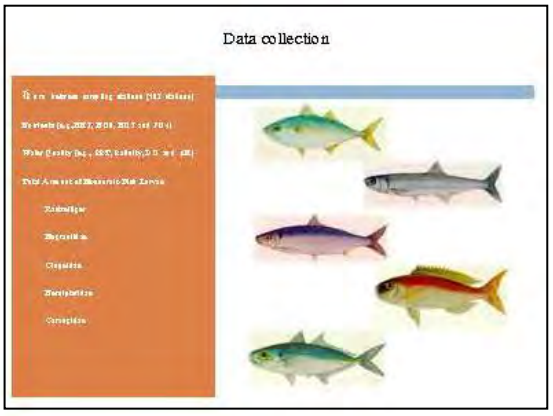

MODIS Chlorophyll a
(4 km spatial resolution, Monthly average)
Chlorophyll a concentration (mg / m³)

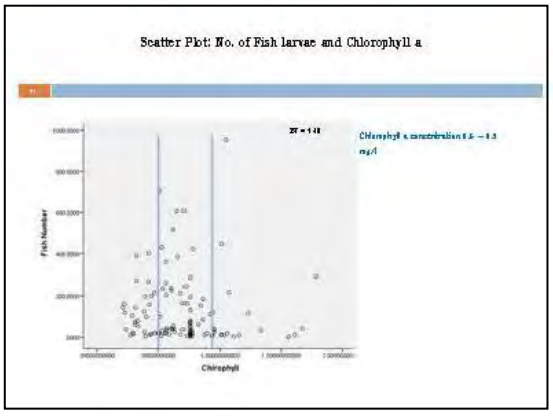

MODIS Sea Surface Temperature
(4 km spatial resolution, Monthly average)
Sea Surface Temperature (°C)

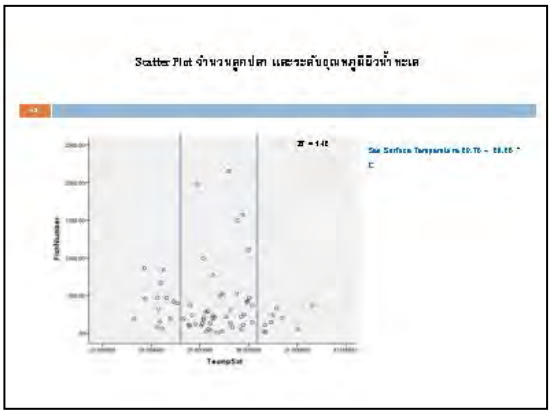

Suitable area for fish larvae
Field Survey (Data)
Statistical Analysis (Scatter Plot)
Spatial Analysis (Classification and Overlay)

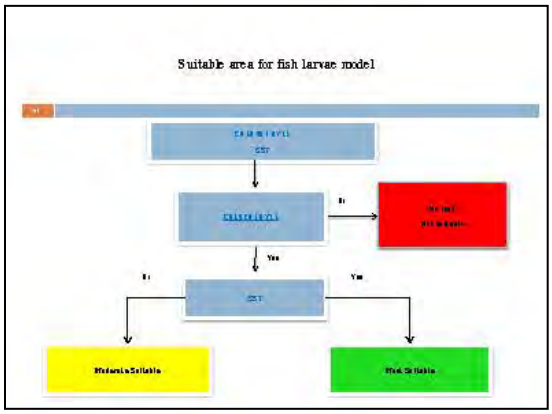

แผนที่แสดงปริมาณ Phytoplankton
แผนที่แสดงปริมาณ Phytoplankton

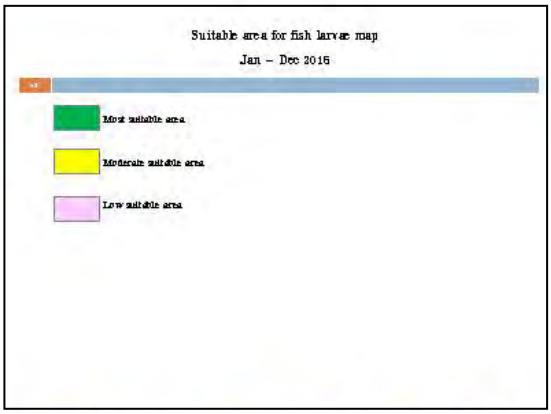

DOF surveys

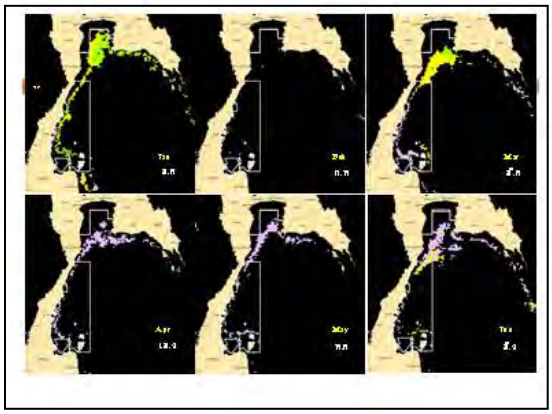

Data collection

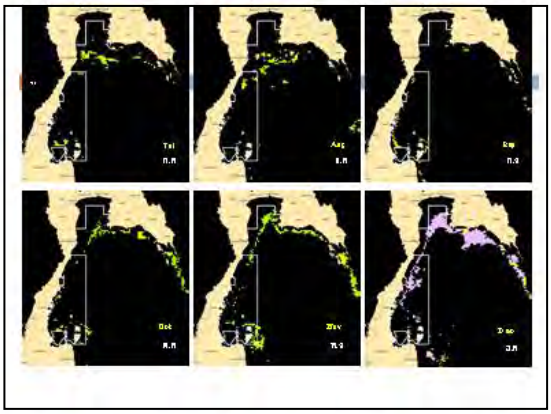

Scatter Plot: No. of Fish larvae and Chlorophyll a
Fish Number
Chlorophyll

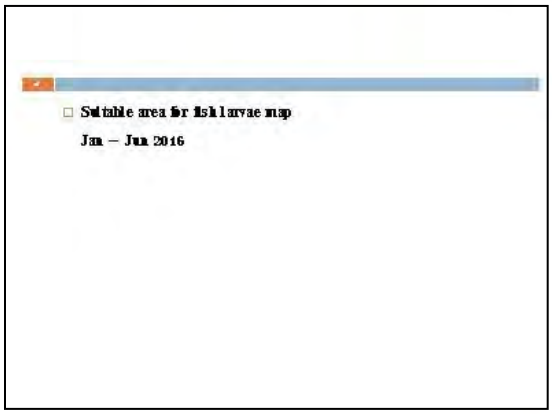

Scatter Plot จำนวนลูกปลา และระดับอุณหภูมิผิวน้ำทะเล

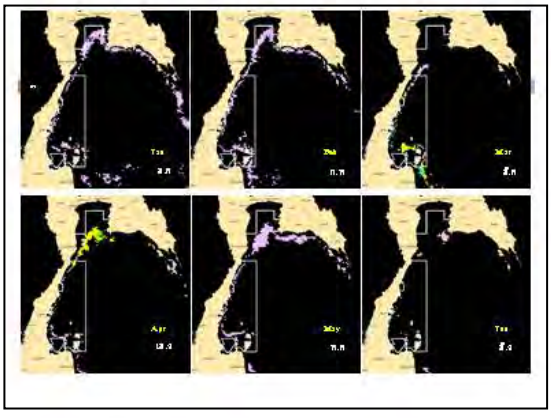

Suitable area for fish larvae model

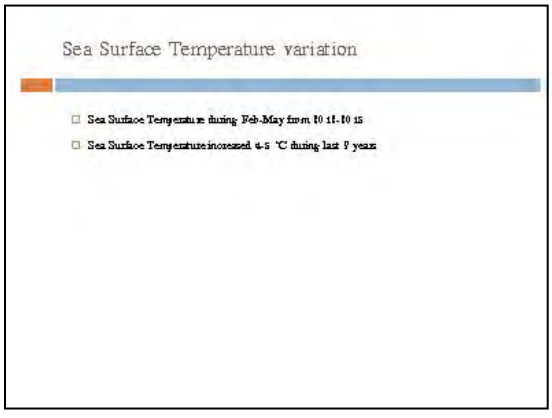

Suitable area for fish larvae map
Jan – Dec 2016
Most suitable area
Moderate suitable area
Low suitable area

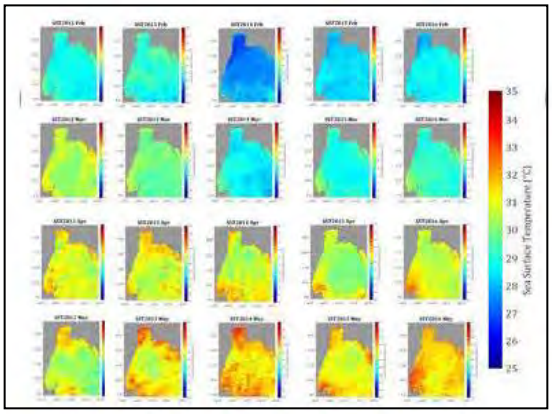




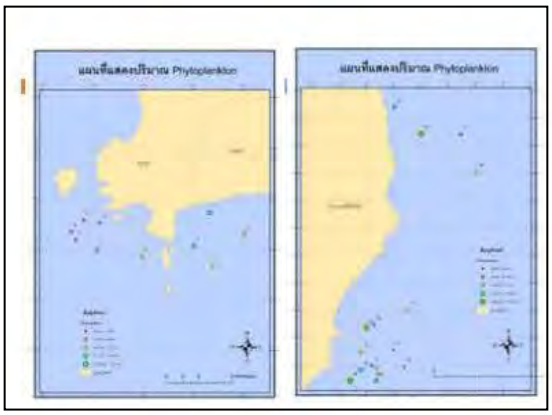

Suitable area for fish larvae map
Jan – Jun 2016

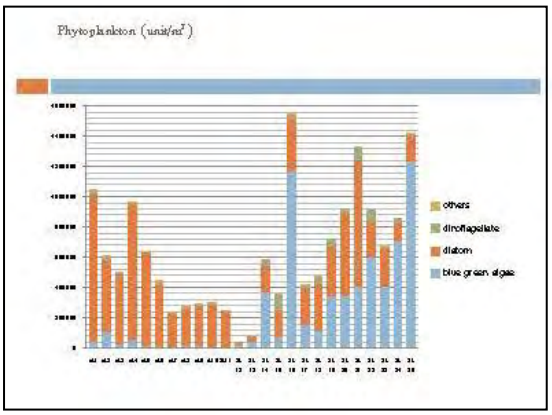



Sea Surface Temperature variation
Sea Surface Temperature during Feb-May from 10 11-10 15
Sea Surface Temperature increased 4-5 °C during last 9 years



Plankton

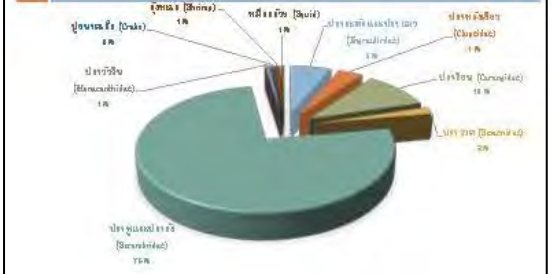




Stomach contents

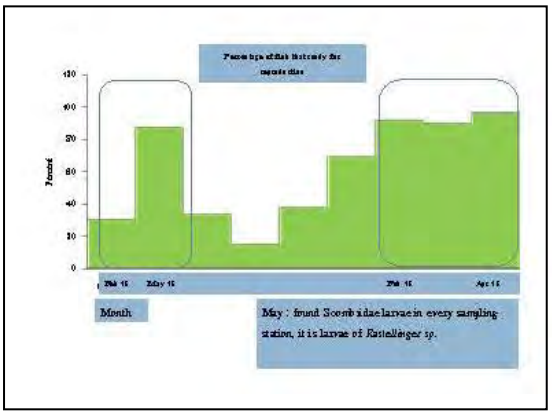
- In general : phytoplankton and zooplankton
- Diatom, Cheyopds and Shrimp larvae

Catch composition ; sampling

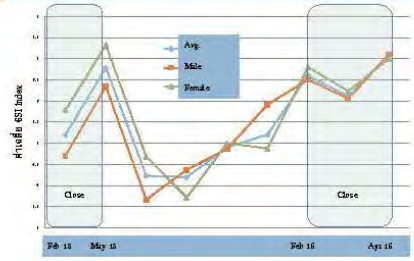


Development of gonad

- Before area closure
  - Not develop
- Before area closure end
  - High not develop
- After area closure end
  - High proportion of male and female still develop
- Although area closure still cover the peak but shift of peak is found
  - need more research



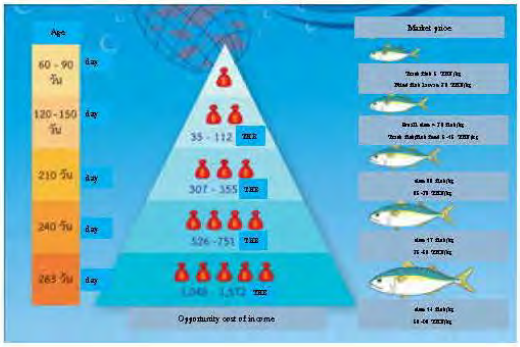
GSI index



Economics

- Indo-pacific mackerel larvae from Anchovy fishing
  - Anchovy fishing : May-October : same area with fish larvae habitat
- Indo-pacific mackerel in market
  - Fresh + Cold storage
  - Gulf of Thailand + Andaman sea
- Main fishing gear
  - purse seine

Indo-pacific mackerel larvae from Anchovy fishing



Recommendations for Conservation + Allocation

- Larvae should be concerned
- Need more and detailed study on stock
  - DNA
- Integrate with environment and runoff data
- Fishing gears that catch Indo-pacific mackerel
  - Commercial fisheries
  - Small-scale fisheries
- More study on by catch from Anchovy fishing and Indo-pacific mackerel fishing
- Try to find a balance for suitable management
  - EBFM – Ecosystem Based Fishery Management
  - Resource allocation

Annex 9

REGIONAL STUDY ON INDO – PACIFIC MACKERAL (*Rastrelliger brachysoma*) IN THE GULF OF THAILAND

Regional study on Indo-Pacific mackerel (*Rastralliger brachysoma*) in Gulf of Thailand

Presented By
Mohammad Faisal bin Md Saleh
SEAFDEC/MFRDMD

Expert Group Meeting on Stock Status and Geographical Distribution of Pelagic Indo-Pacific Mackerel and Blue Swimming Crab (ABC) Species in the Gulf of Thailand, 22-23 September 2016, Bangkok, Thailand

Introduction

- Since 2003 until 2012, SEAFDEC/MFRDMD has conducted several research projects involving pelagic fishes such as *Rastrelliger* spp. and *Decapterus* spp in this region.
- The research projects were:
  - Information collection for sustainable pelagic fisheries in South China Sea, 2003-2005
  - Tagging program for economically important small pelagic species in the SCS and AS, 2007-2012
  - Genetic survey for population structure of Indian mackerel (*R. kanagurta*) and Japanese Scad (*D. maruadsi*) in the SCS and AS 2010-2012.
- However, as requirement of this meeting, only *R. brachysoma* in Gulf of Thailand will be presented.

A) Project: Information collection for sustainable pelagic fisheries in South China Sea, 2003-2005

Main objective of Project:

- To determine the growth and mortality parameters of the selected small pelagic fish species in the South China Sea
- To obtain the reproduction information of the selected small pelagic fish species in the South China Sea.

ASEAN-SEAFDEC through MFRDMD had conducted regular monitoring activities of small pelagic fisheries in South China Sea. In this activities, the biological data on pelagic fisheries that primarily caught by the local commercial purse seiner in each country in South China Sea were collected.

CAMBODIA

i) Catch data (2003 and 2004)

a) Sihanouk ville

- There were two high catches times for Indo-pacific mackerel in Sihanouk ville.
- The 1st peak period: January and February,
  The 2nd peak period: July, September, and October.
- The total catch composition was 86% in both year 2003 and 2004.

b) Kampot

- There was only one high catches times which was in May, June, July and September.
- The total catch composition was 40% in 2003 and 63% in 2004.

ii) Length frequency data

- The mean size of R.b in:
  Sihanouk ville: 177.72 to 175.62 mm
  Kampot: 180.96 to 181.46 mm.

iii) Spawning period

- Sihanouk ville, there were two peaks of the GSI mean value.
  Male: May and November
  Female: March and October.
- In Kampot, the mean value of GSI for male and female shows fluctuate trend with three similar prominent peaks in February, April, and December.

iv) Length at first maturity

- The number of Rb specimen sampled at Kampot (year 2003) for gonad study are 112 individuals for males and 98 individual females.
- By referring to the analysis (Udupa's formula 1986), 50% of the length at first maturity for female Rb was 19.8 cm while for male was 20.0 cm.

THAILAND

i) Length frequency analysis

- Based on the previous study in GoT (year 2003-2005), the Total Mortality (Z) value for *R. brachysoma* that was obtained by using catch curve analysis is 32.83 which is bigger than previous studies.
- One of the reason could be because *R. brachysoma* caught by FADs generally had bigger sizes due to their fishing grounds, which were mostly in the central part of GoT.

ii) Length at the first maturity

- By using length at the first catch (Lc), the length at the first maturity of R. brachysoma was 15.20 cm.

iii) Sex ratio

- Sex ratios between male and female were obtained by examining the fish samples from all sampling sites during study period (year 2003 – 2005).
- For *R. brachysoma*, the average sex ratio between female and male was 1:1.08.

iv) Spawning season determination from Gonado Somatic Index (GSI)

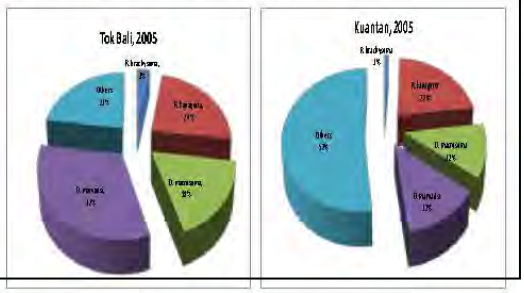
- The highest peak for spawning period was recorded in April and July.

v) Estimation the spawning ground

- The fishing ground for *R. brachysoma* was along the west coast and upper part of the Gulf of Thailand (GoT).
- According to intensive tagging experiment of *R. brachysoma* during 1960-1965, the result showed that the fish which were along eastern and western coast of the GoT did not inter mix for a big number.
- The migration route, southward along the western coast of the GoT, was considered to partially relate to spawning behaviour.

PENINSULAR MALAYSIA

- During this project (year 2005), the average catch composition for short mackerel in Tok Bali and Kuantan were 3% and 1% respectively.



VIETNAM

- Indo-pacific mackerel, *R. brachysoma* contribute 4.4 % in catch composition of purse seine at Ben Tre, Vietnam in 2003.
- Meanwhile, in Binhthuan, 50% of the length at the first maturity for female *R. brachysoma* was 22.10 cm while for male was 20.53 cm.

B) Project: Tagging program for economically important small pelagic species in the SCS and AS, 2007-2012.

- **Main objective of Project:** To ascertain the migration route and existence of sub populations of small pelagic fish in the study areas.
- The project involves on-site training for tagging in each participating SEAFDEC member country and tagging was implemented in the South China Sea and Andaman Sea.
- Tagging poster printed in national language was distributed throughout the countries involved to promote awareness on the project and to inform public on the reward given upon returning of recaptured tagged fish to the authority.
- Information and data includes date, time and tagging site, releasing position, tag number, fork length and species of the tagged fish were recorded in the 'Tagging Data Sheet' and uploaded to the Small Pelagic Tagging Database which was developed by SEAFDEC/TD

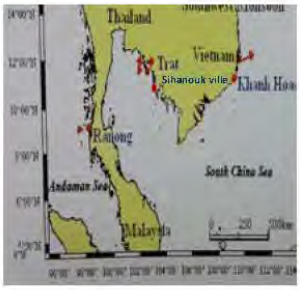
- Tagging sites: 13 in South China Sea & 6 in Andaman Sea

Outcomes

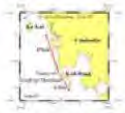
Rastrelliger brachysoma (Indo Pacific Mackerel)

	SCS
No. of tagged fish	5220 tails
No. of recaptured	12 tails
Recovery rate	0.23 %
Average fork length	169 mm
Longest time at liberty	96 days (Trat, Thailand)
Longest distanve travelled	85 km (Sihanouk Ville, Cambodia)

Migration pattern



i) Trat



ii) Sihanouk Ville

Conclusions

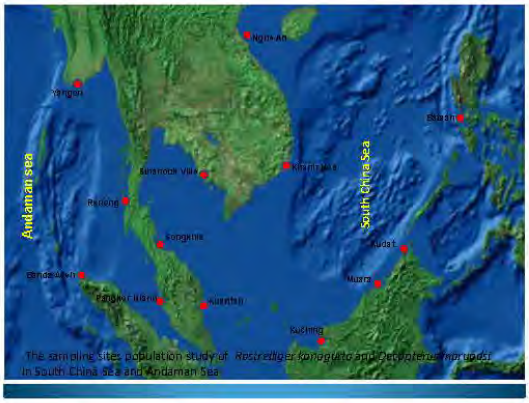
- Most tagged fishes were recaptured within the vicinity of released location.
  - Within the EEZs
- Tagged fishes does not migrate too far from released site
- Information obtained are insufficient due to;
  - Unclear migration pattern
  - Low recovery rate of tagged fishes
- Other possible methods 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.

Genetic Study

C) Project: Genetic survey for population structure of Indian mackerel (*R. kanagurta*) and Japanese Scad (*D. maruadsi*) in the SCS and AS, 2011-2012.

Main objective : To Ascertain the existence of sub-populations or one panmictic population within the species of Indian mackerel (*Rastrelliger kanagurta*) and Japanese scad (*Decapterus maruadsi*).

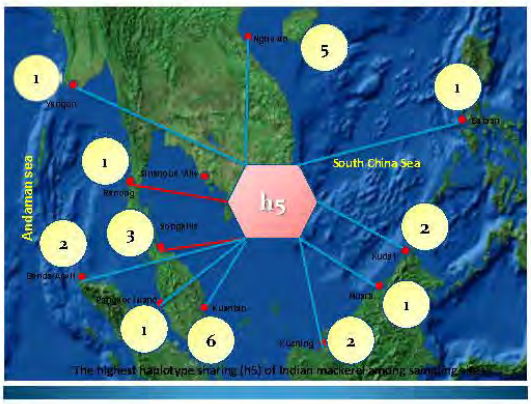
- Tissue sample of 35 individual from each *R. kanagurta* and *D. maruadsi* were collected from 10 sites in SCS and 4 sites in AS.
- Molecular marker used was mtDNA cytochrome b (910 basepairs)
- Primer used were RBCyF and RBCyR.



The sampling sites population study of *Rastrelliger kanagurta* and *Decapterus maruadsi* in South China Sea and Andaman Sea

Outcomes

- Out of 777 samples collected, 434 **individuals are *R. kanagurta*** and 343 individuals are *D. maruadsi.*
- From 434 individuals of Indian mackerel, **323 haplotypes were produced** and 115 haplotypes were produced from 343 individuals of Japanese scad.
- **14 haplotypes shared** by more than one sites for *R. kanagurta* and 15 haplotypes for *D. maruadsi.*
- **Among of 14 shared haplotype in *R. kanagurta*, h5 was shared by the most number of sites (25 samples).** Meanwhile, in *D. maruadsi*, h1 was shared by most number of sites (109 samples)

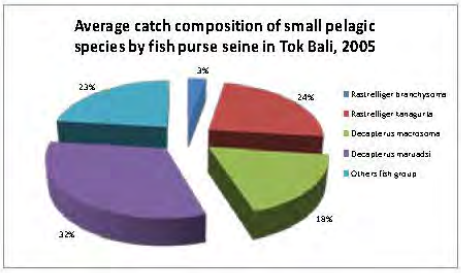


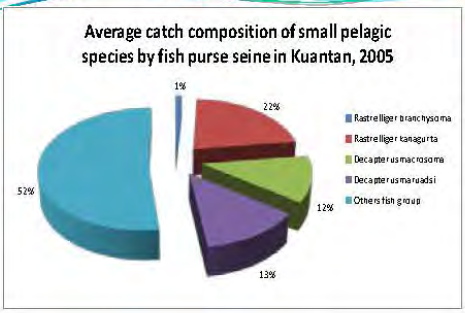
The highest haplotype sharing (H5) of Indian mackerel among sampling sites

Conclusions

- This study provided the genetic structure of ***Rastrelliger kanagurta*** and *Decapterus maruadsi*.
- It shows that **Indian mackerel in the South China Sea** and Andaman Sea and Japanese scad in the South China Sea are **shared or derived from the same stock** with high genetic variation among the sampling sites.
- The use of mtDNA as molecular marker was able to gives detailed results on variation among haplotype of the selected samples.

THANK YOU



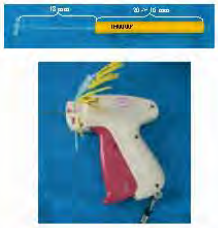


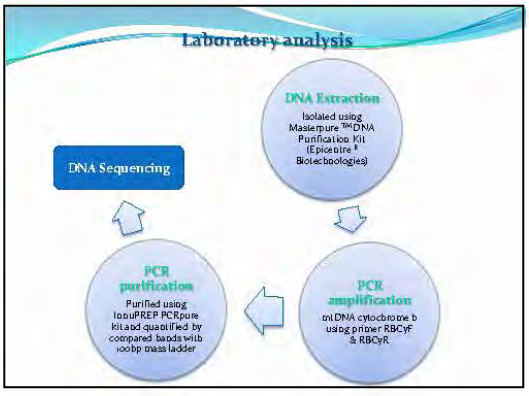
Rastrelliger brachysoma (Short mackerel)

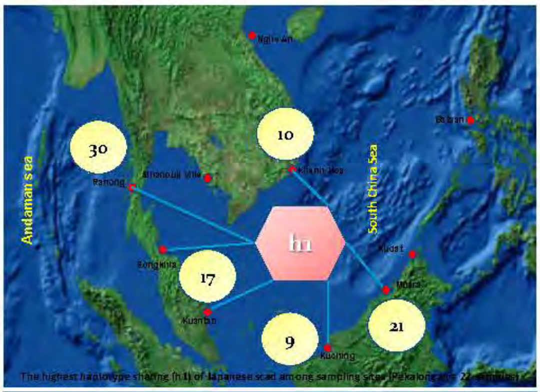
	SCS
No. of tagged fish	5220
No. of recaptured	12
Recovery rate (%)	0.23 %

Rastrelliger kanagurta (Indian mackerel)

	SCS	AS
No. of tagged fish	7642	6636
No. of recaptured	16	8
Recovery rate (%)	0.21 %	0.15 %







Conclusions

- This study provided the genetic structure of ***Rastrelliger kanagurta*** and *Decapterus maruadsi.*
- It shows that **Indian mackerel in the South China Sea** and Andaman Sea and Japanese scad in the South China Sea are **shared or derived from the same stock** with high genetic variation among the sampling sites.
- The use of mtDNA as molecular marker was able to gives detailed results on variation among haplotype of the selected samples.

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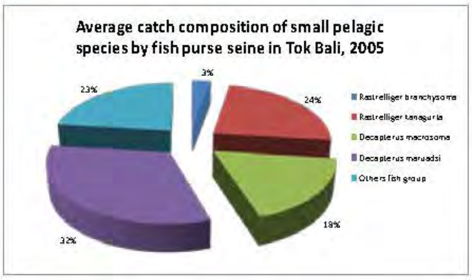

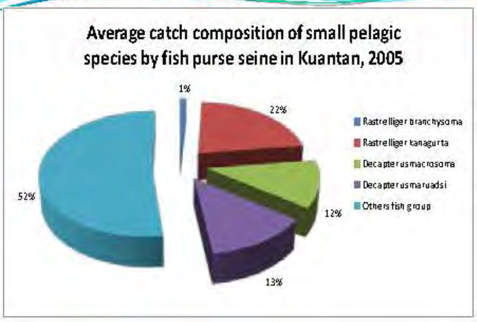

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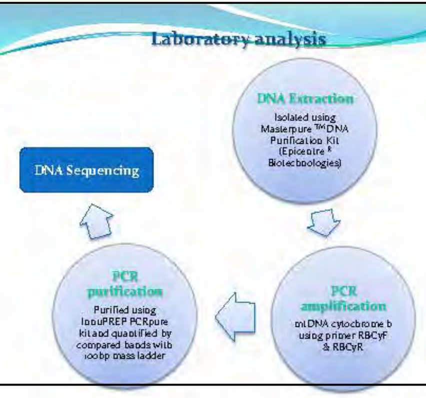


AIB SPECIES MANAGEMENT IN THE GULF OF THAILAND

AIB Species Management in the Gulf of Thailand

Experts Group Meeting on Stock Status and Geographical Distribution of Anchovy, Indo-Pacific mackerel and Blue Swimming Crab (AIB) Species in the Gulf of Thailand

22-23 September 2016
Century Park Hotel, Bangkok, Thailand

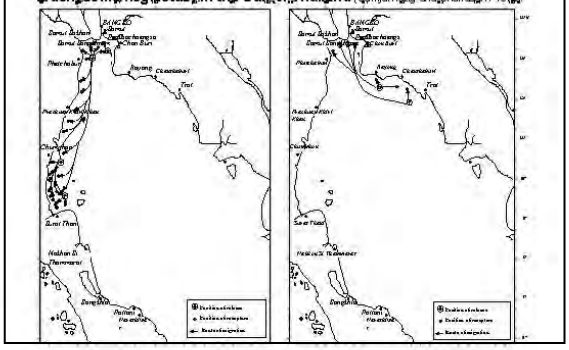
Pirochana Saikliang
Advisor (Marine Fisheries), Department of Fisheries

Scope of Talk

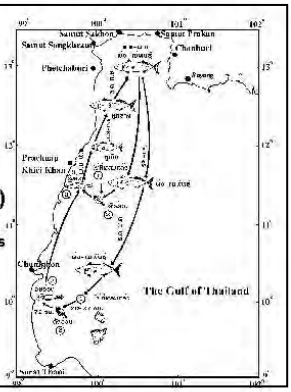
1. Abundance and Distribution of Anchovy, Indo-Pacific mackerel and Blue swimming crab
2. AIB Species Management in Thailand
   - 2.1 Anchovy
   - 2.2 Indo-Pacific mackerel
   - 3.3 Blue swimming crab

Marine Resource Survey Station in Thai Waters by DoF Research Vessel

The migratory route of tagged Indo-Pacific mackerel (*Rastrelliger brachysoma/neglectus*) in the Gulf of Thailand (Somjaiwong and Chullasorn 1976)

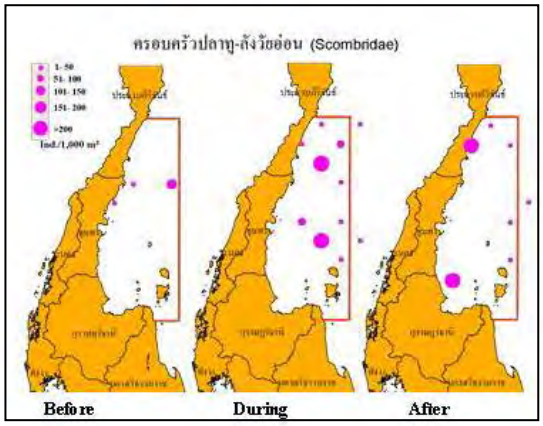


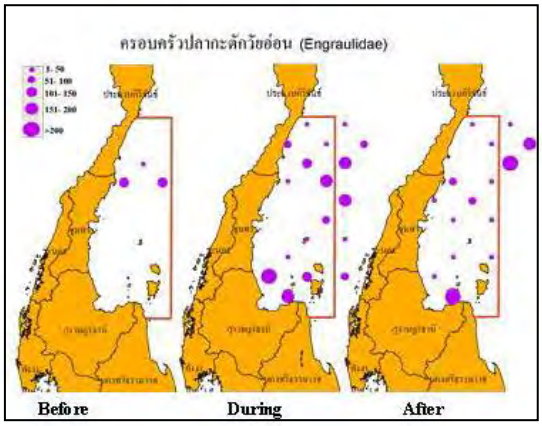
Life cycle of Indo-Pacific mackerel (*Rastrelliger brachysoma/neglectus*) in the Gulf of Thailand (courtesy of the Marine Fisheries Division)

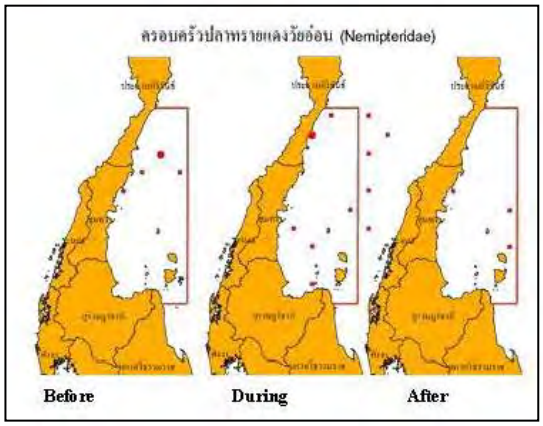


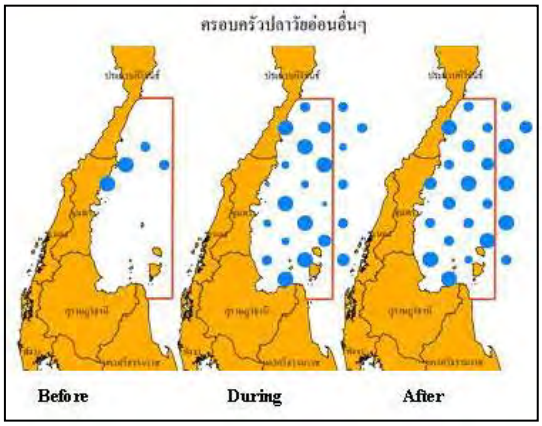
Research vessel survey during peroid of closed

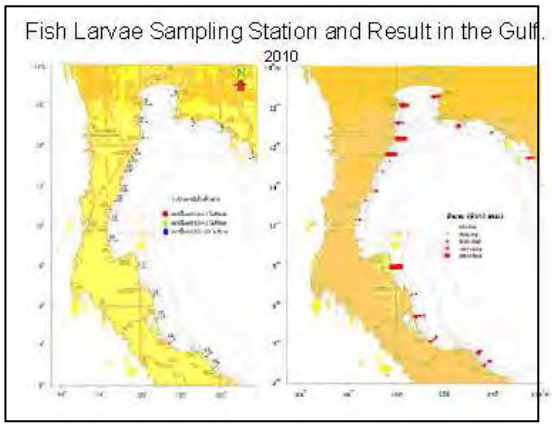
Survey station 23 st.

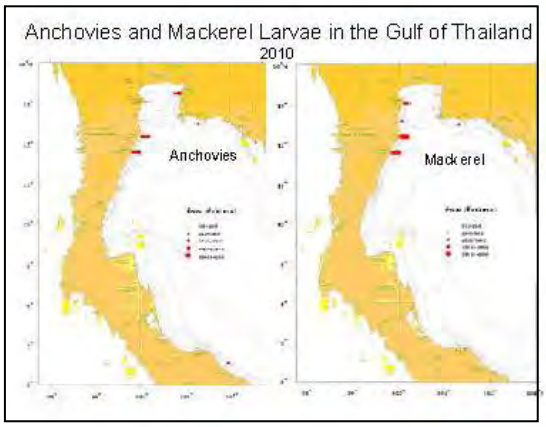

ครอบครัวปลาทู-ถังวัยอ่อน (Scombridae)
Before
During
After

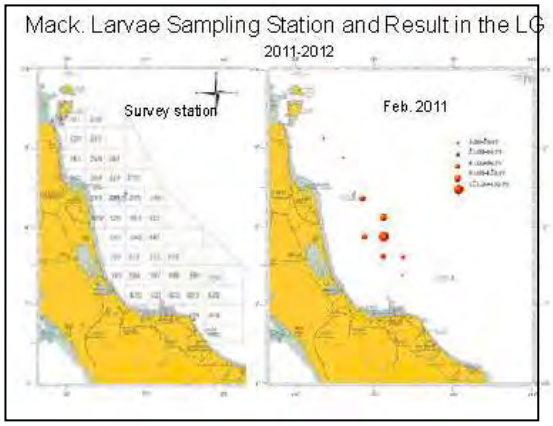

ครอบครัวปลากะตักวัยอ่อน (Engraulidae)
Before
During
After

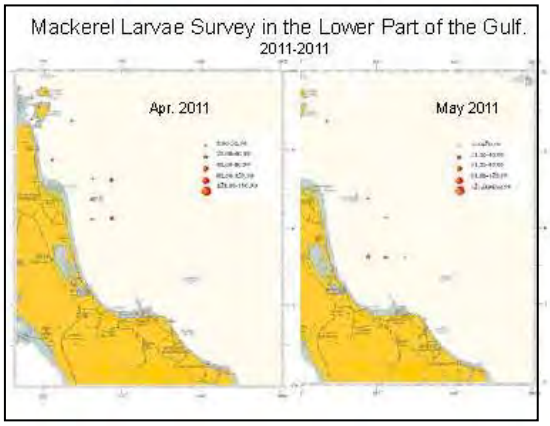

ครอบครัวปลาทรายแดงวัยอ่อน (Nemipteridae)
Before
During
After


ครอบครัวปลาวัยอ่อนอื่นๆ
Before
During
After


Fish Larvae Sampling Station and Result in the Gulf.
2010

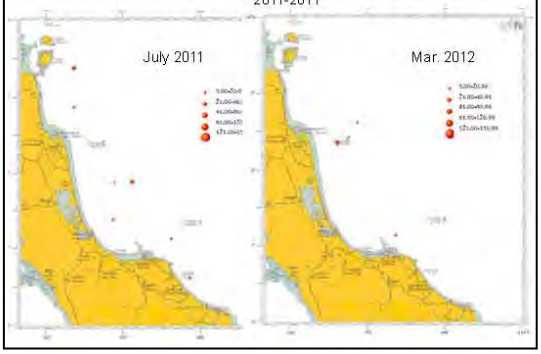

Anchovies and Mackerel Larvae in the Gulf of Thailand
2010
Anchovies
Mackerel


Mack. Larvae Sampling Station and Result in the LG
2011-2012
Survey station
Feb. 2011


Mackerel Larvae Survey in the Lower Part of the Gulf.
2011-2011
Apr. 2011
May 2011

Mackerel Larvae Survey in the Lower Part of the Gulf.

2011-2011



Fisheries Management Tools

1. The Act Governing the Right to Fish Within Thai Fishery Waters, B.E.2482
2. The Royal Ordinal on Fisheries 2015
3. The Promotion Act of Marine and Coastal Management Act 2015

Notification of Agriculture and Cooperative or Notification of Ministry of Natural Resources and Environment
Notification of Provincial and
Notification of DoF and DMCR

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Anchovy

- No person shall use a falling net or lift net with an electricity generator in fishing anchovy and a surrounding net to fish anchovy at day time of which the meshes are 0.6 cm and smaller.
- Fishing efforts were limited the number of anchovy fishing vessels through a limit license scheme.
- Zoning System

Indo-Pacific mackerel

Prohibition of the use of certain types of fishing gear during the spawning and breeding season and nursery ground of some commercial species for example

1. Gulf of Thailand 26,400km2 1953
2. Phang-nga Bay 4,960 km2 1985

For nursery ground

3. Inner Gulf of Thailand 4,940.6 km2, 2013

Main Gears prohibited:-

- -All type of trawler and Push net
- -All type of purse seine
- -Mackerel encircling gill net
- -Anchovy falling net with light luring
- -Gill net

Otter board trawl

Pair trawl

Swimming crab

- No person shall catch berried female crab (October-December : 11 July 1983)
- No person shall use collapsible trap crab of which all mesh size less than 2.5 inch

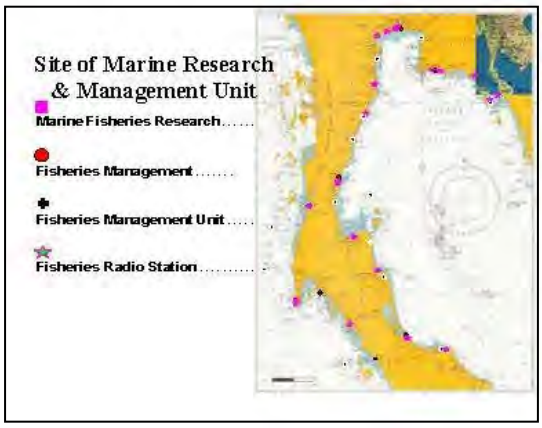
Prohibitation of certain types fishing gear in some area

- This regulation prohibits fishing by trawlers, push nets and any kind of shellfish rack within a distance of 3,000 m from the shoreline along the entire coastline of Thailand, both in the Gulf of Thailand and the Andaman Sea.

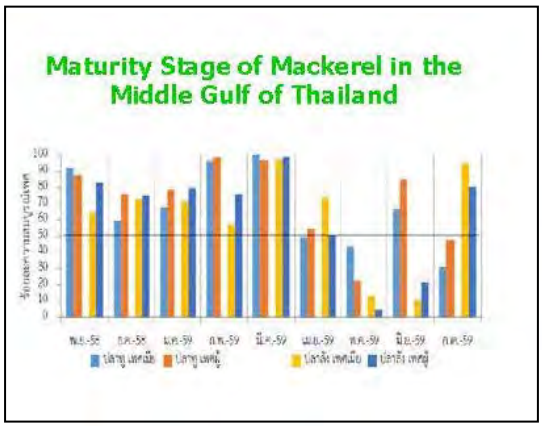
Declaration of protected areas

- Ministerial Regulations of 27 February and 15 May 1989

These regulations declared the areas around Khai, Charakhay, Thalao, Khalok and Hin Phae Islands off the coast of Chumphon Province in the Gulf of Thailand and coral reefs at Patong Bay of Phuket Province along the Andaman Sea coastline as protected areas for the conservation of coral reefs.

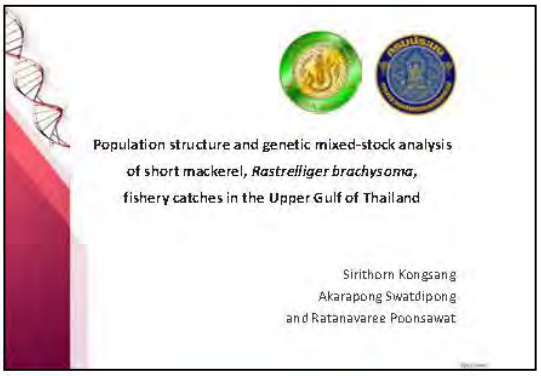

Site of Marine Research
& Management Unit
Marine Fisheries Research.....
Fisheries Management.....
Fisheries Management Unit.....
Fisheries Radio Station.....

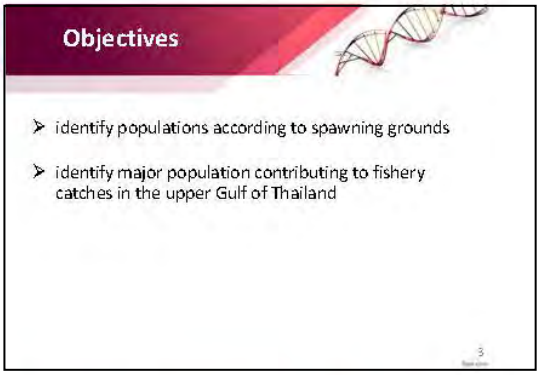

THANK YOU

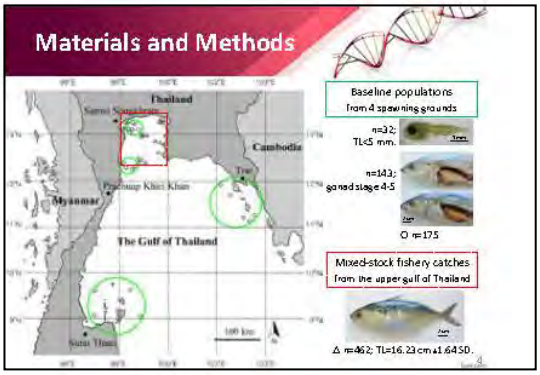

Maturity Stage of Mackerel in the
Middle Gulf of Thailand

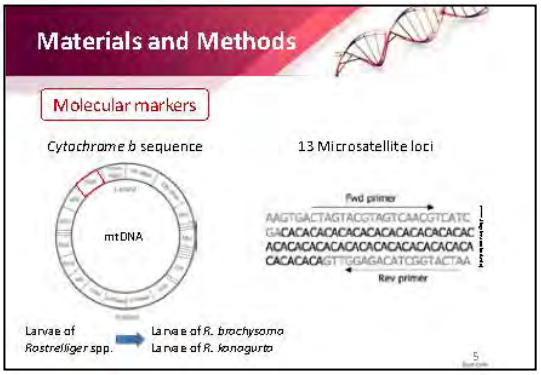
Annex 11

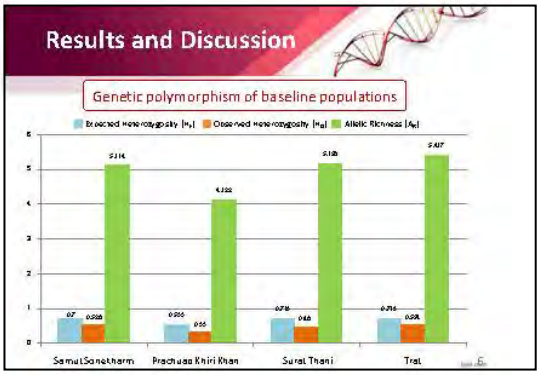
POPULATION STRUCTURE AND GENETIC MIXED _ STOCK ANALYSIS OF SHORT MACKEREL, *Rastrelliger brachysoma*, FISHERY CATCHES IN THE UPPER GULF OF THAILAND



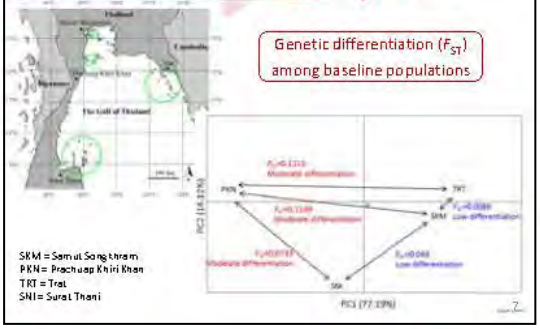




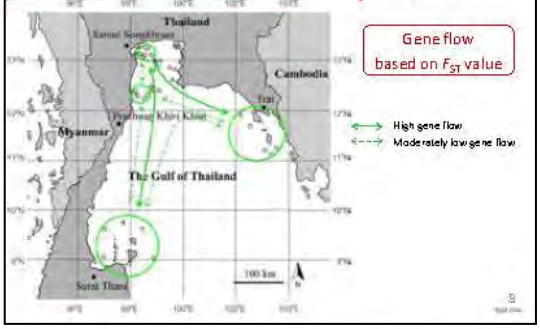




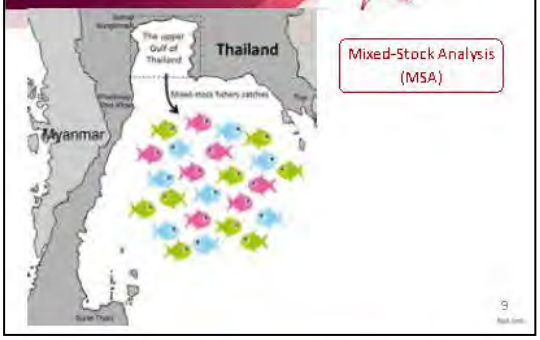
Results and Discussion



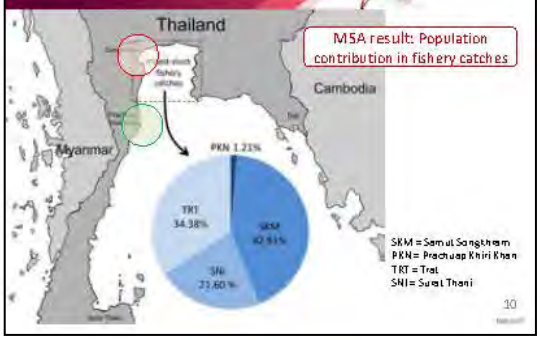
Results and Discussion



Results and Discussion



Results and Discussion



Conclusion

- Four populations are identified according to their spawning grounds.
- Samut Songkhram population is the major contributor to fishery catches in the upper gulf of Thailand.
- Trat and Surat Thani populations are the second and third large contributors and also provide gene flow to Samut Songkhram population.
- Prachuap Khiri Khan population is the smallest contributor and has low gene flow to others.
- These information is envision to assist sustainable fishery management in the upper gulf of Thailand.

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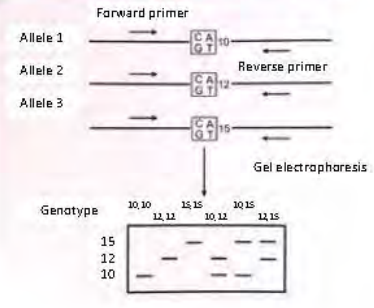
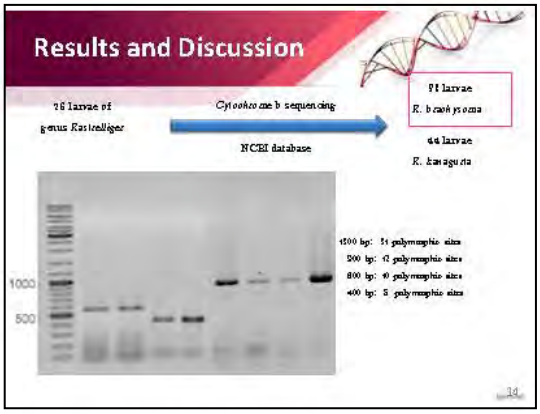
Thank you for your attention

Microsatellite marker

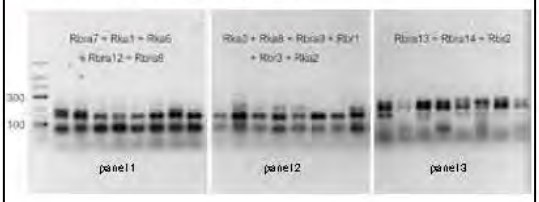


Results and Discussion



Results and Discussion

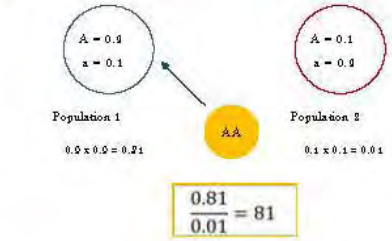
Microsatellite genotyping



15

Results and Discussion

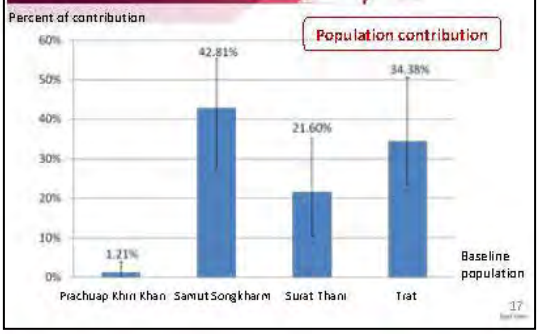
Mixed-stock analysis: 1 locus



$$\frac{0.81}{0.01} = 81$$

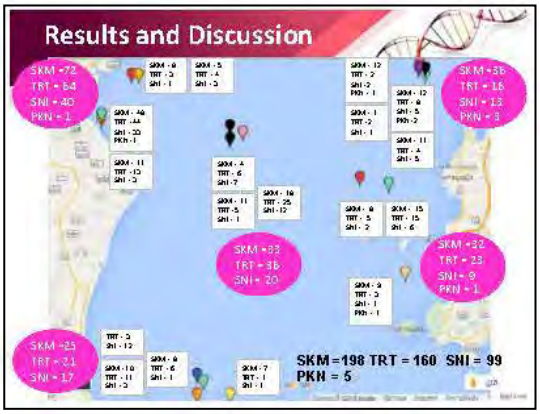
16

Results and Discussion



17

Results and Discussion



Results and Discussion

Species	Position										
	47	83	104	149	158	260	287	302	308	323	386
Rastrelliger brachysoma	C	T	T	T	A	C	C	C	T	A	T
Rastrelliger kanagurta	T	C	C	C	G	T	T	T	C	C	C
Scomber japonicus	T	T	C	T	C	C	T	C	C	C	A
Thunnus orientalis	C	G	C	T	C	C	T	C	T	C	A
Euthynnus alletteratus	T	A	T	T	C	A	C	A	C	T	A

Species	Position										
	410	443	455	536	557	558	617	620	623	696	677
Rastrelliger brachysoma	C	A	A	A	T	T	T	T	T	A	C
Rastrelliger kanagurta	T	T	G	C	C	C	C	A	C	G	T
Scomber japonicus	C	A	G	C	C	G	A	T	C	A	C
Thunnus orientalis	C	T	T	T	A	G	T	T	C	A	C
Euthynnus alletteratus	T	A	A	C	A	A	A	C	C	A	C

Species	Position								
	762	803	824	863	890	896	899	902	926
Rastrelliger brachysoma	T	T	C	C	C	C	G	G	A
Rastrelliger kanagurta	C	C	T	T	T	T	A	A	G
Scomber japonicus	C	A	C	C	C	C	A	A	A
Thunnus orientalis	C	T	C	T	T	C	A	A	A
Euthynnus alletteratus	C	C	C	A	C	C	A	A	A

Results and Discussion

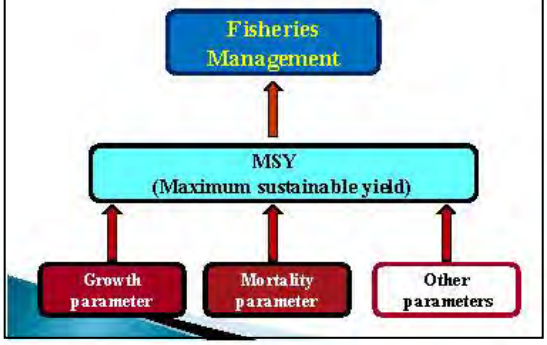
Annex 12

STOCK DISCRIMINATION OF INDO – PACIFIC MACKEREL BY OTOLITH SHAPE ANALYSIS TECHNIQUES

Indo-Pacific Mackerel Stocks Discrimination by Otolith Shape Analysis Technique

Sansanee Srichanngam,
Suchart Sangchan, Udomsin Auksompaob
Nuntachai Boonjorn and Sakda Wungchay
Department of Fisheries, Thailand

Introduction



Introduction

Growth parameter
Mortality parameter
} Stock specific

Thus, correct stocks discriminate leading to accurate MSY for fisheries management

Introduction

- Indo-Pacific mackerel (*Rastrelliger brachysoma*) is an important economic species in Thailand and also in this regions

Otolith

Introduction

- A structure of the inner ear, part of balance organ
- Found in the fish's skull, the rear of the brain
- There are 3 pairs of otolith
  - Sagitta,
  - Asteriscus and
  - Lapillus
- Contain a lot of information about the lives of fish
  - Stock structure
  - Hatching date
  - Estimate age and growth rates

Otolith

Introduction

Stock discrimination

- Edge and shape are changed because external outline generated from daily increments represent growth variation between stocks

Introduction

Objectives

To investigate

- Morphological parameters
- Otolith shape

for stock discrimination

Methods

Sampling Site

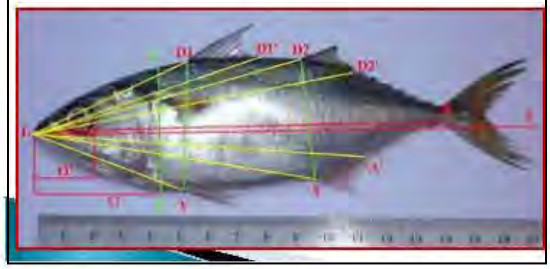
- September 2010 to July 2011

Samples of 2 stocks based on assumption that Growth rates are different due to differences of living environment

Methods

Morphological measurements

- Species identification
- Measured 15 parameters
- Maturity stage (5); I to II ⟹ Immature, III to V ⟹ Mature

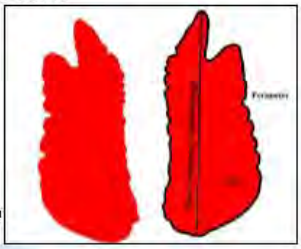


Methods

Otolith measurement

- Photographs of otoliths were taken at 40x microscope magnification and 3.2X digital camera
- Right otolith in posterior view
- ImageJ program (Rasband, 1997-2008)
  - Area
  - Perimeter
  - Feret's diameter (otolith length)
  - Circularity

$$Circularity = 4\pi\left(\frac{Area}{Perimeter^2}\right)$$



Suitable descriptors analysis by ImageJ

Methods

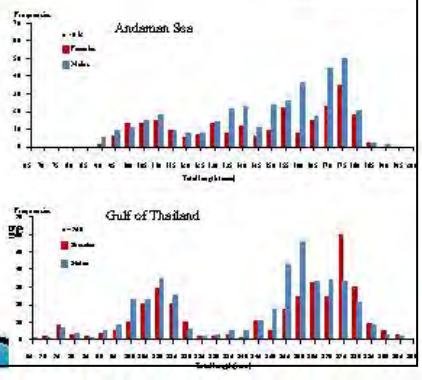
Otolith shape analysis

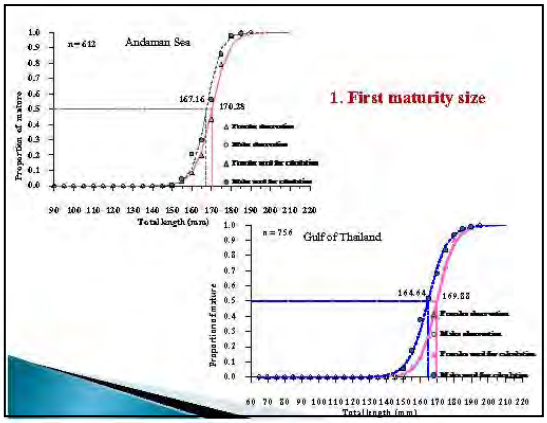
- Elliptical Fourier descriptors used to describe the right otolith contour
- 40 descriptors
- SHAPE program (Iwata and Ukai, 2002) a_n b_n and c_n d_n coefficients values for each descriptors expansion to x-coordinates and y-coordinates

Data analysis

1. First maturity size calculation by logistic curve- non linear
2. Stock discrimination by morphological +otolith shape analysis
   - 2.1 Test for the relationship between each parameters & Total length
   - 2.2 Test parameters for differences between 2 stocks (t-test) significant difference = Discrimination Function (DF)
   - 2.3 DF were test for effect of maturity between Immature and Mature group (MANOVA) for each stocks
   - 2.4 Discriminant Analysis were analyzed

Results & Discussion

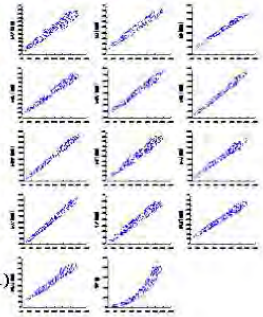




1. First maturity size

2. Morphological parameters for stock discrimination

- n = 1,368
- Total 14 standardized parameters (standardized by total length)
- 11 parameters showed significant differences between 2 stocks (t-test) (Discrimination Function,DF=11)



2. Morphological parameters for stock discrimination

- 11 DF were test for effect of maturity (MANOVA) for each stock and showed significant differences between Immature and Mature group

Stocks	Comparing	Wilk's λ	*F* value	df		*p* value	
				Effect	Error		
Andaman Sea	Immature&Mature	0.261	154.569	11	600	0.000	*
Gulf of Thailand	Immature&Mature	0.281	173.187	11	744	0.000	*

- Discriminant Analysis were analyzed by separate between Immature and Mature group

2. Morphological parameters for stock discrimination

Immature

$Score_{Andaman\ Sea}$ = (-4,581.395)+(8,859.312stdLB)+(2,043.179stdLG)+(1,298.299stdLO')
+(426.193stdLD1)+(572.775stdLD1')+(486.289stdLA)+(471.301stdLV)
+(-489.525stdYJ')+(-536.632stdDIV)+(2,571.286stdD2A)+(305.167stdTW)

$Score_{Gulf\ of\ Thailand}$ = (-4,615.700)+(8,912.705stdLB)+(1,996.769stdLG)+(1,217.548stdLO')
+(466.483stdLD1)+(584.955stdLD1')+(513.815stdLA)+(426.735stdLV)
+(-449.296stdYJ')+(-630.503stdDIV)+(2,591.155stdD2A)+(309.551stdTW)

Mature

$Score_{Andaman\ Sea}$ = (-2,977.881)+(6,139.268stdLB)+(-1,201.245stdLG)+(223.769stdLO')
+(-301.046stdLD1)+(834.010stdLD1')+(203.647stdLA)+(1,347.067stdLV)
+(2,858.104stdYJ')+(-1,694.392stdDIV)+(460.083stdD2A)+(181.110stdTW)

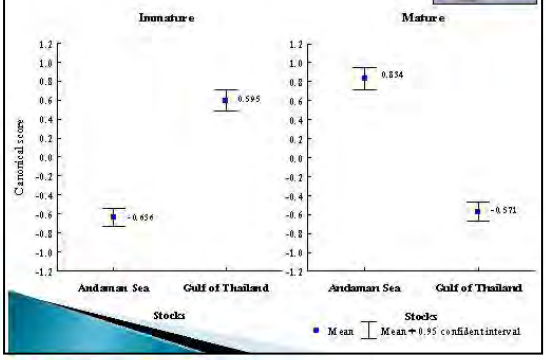
$Score_{Gulf\ of\ Thailand}$ = (-2,958.691)+(6,176.033stdLB)+(-1,203.876stdLG)+(135.777stdLO')
+(-331.108stdLD1)+(884.937stdLD1')+(163.966stdLA)+(1,336.948stdLV)
+(2,799.427stdYJ')+(-1,760.287stdDIV)+(509.947stdD2A)+(160.040stdTW)

2. Morphological parameters for stock discrimination

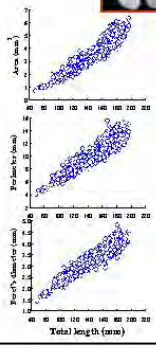
Statistical for justify results

- Chi square test
  - Significantly different between 2 stocks for both
    Immature (χ^2 = 231.13, *p-value*<0.05)
    Mature (χ^2 = 247.73, *p-value*<0.05)
- Percentage of correct classifications

	Immature	Mature
Andaman Sea	72.080	65.517
Gulf of Thailand	73.867	82.940
Average	73.003	75.857



- n = 1,331
- Total 163 parameters
  - 4 otolith measurements
  - 159 coefficients values of EFDs shape analysis
- 56 parameters showed significant differences between 2 stocks (t-test) (Discrimination Function, DF= 56)



3. Otolith shape analysis for stock discrimination

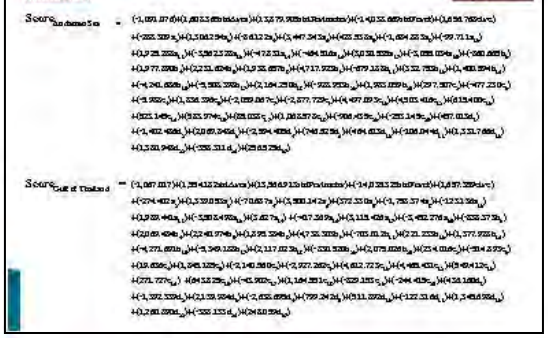
- 56 DF were test for effect of maturity (MANOVA) for each stock and showed significant differences between Immature and Mature group

Stocks	Comparing	Wilk's λ	*F* value	df		*p* value	
				Effect	Error		
Andaman Sea	Immature&Mature	0.303	22.274	56	541	0.000	*
Gulf of Thailand	Immature&Mature	0.255	35.200	56	676	0.000	*

- Discriminant Analysis were analyzed by separate between Immature and Mature group

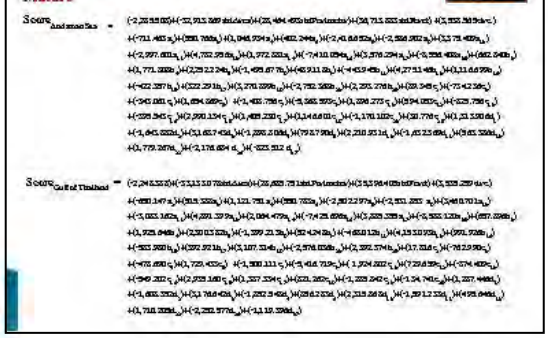
3. Otolith shape analysis for stock discrimination

Immature



3. Otolith shape analysis for stock discrimination

Mature

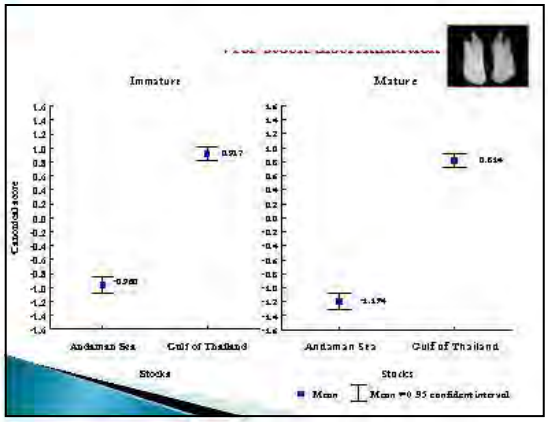


3. Otolith shape analysis for stock discrimination

Statistical for justify results

- Chi square test
  - Significantly different between 2 stocks for both
    Immature ($\chi^2 = 425.186$, *p-value*<0.05)
    Mature ($\chi^2 = 407.911$, *p-value*<0.05)
- Percentage of correct classifications

	Immature	Mature
Andaman Sea	77.551	77.255
Gulf of Thailand	84.401	88.235
Average	81.054	83.784



Conclusion

- First maturity size of male and female Indo-Pacific mackerel

Andaman Sea	167.16	and	170.28 mm
Gulf of Thailand	164.64	and	169.88 mm

- Both morphological parameters and otolith shape analysis can use for Indo-Pacific mackerel stock discrimination

	Immature	Mature
Morphological	73.003	75.857
Otolith	81.054	83.784

- Otolith shape analysis technique was higher percentage of correct classification than morphological analysis
- Mature group resulting higher correct percentage than the small size in the immature group

Otolith shape analysis provided
a new approach
to discriminate Indo-Pacific mackerel stocks

Annex 13

AGE AND GROWTH DETERMINATION OF INDO – PACIFIC MACKEREL USING OTOLITH MICROSTRUCTURE TECHNIQUE

Age and Growth Determination of Indo-Pacific Mackerel Using Otolith Microstructure Technique

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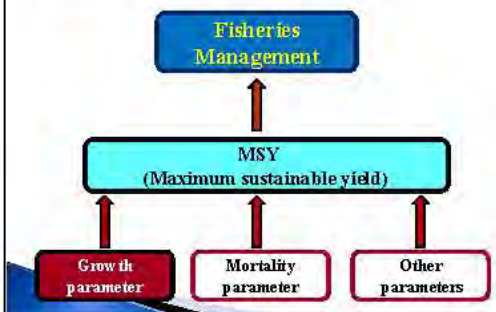
Suchart Sangchan, Udomsin Auksornpaob
Nuntachai Boonjorn and Sakda Wungchay
Department of Fisheries, Thailand

Outline of presentation

- Introduction
- Methodology
- Result & Discussion
  1. Age of Indo-Pacific mackerel
  2. Average growth index
  3. Growth parameter and growth equation
  4. Morphological and otolith growth
  5. Length-weight relationship
- Conclusion

Introduction



Growth parameter estimation

- Length based method
  - Length frequencies data
  - Mode of length frequencies of the tropical fish are unclear due to spawn many times in a year
- Age based method
  - More accurate
  - More time investment
  - Estimated from counting increments in hard parts of body e.g. bone, scale and otolith (the most reliable indicator for age (Jones, 1992))

Otolith

- A structure of the inner ear, part of balance organ
- Located in the fish's skull, behind the brain
- There are 3 pairs of otolith
  - Sagitta,
  - Asteriscus and
  - Lapillus
- Contain a lot of information about the lives of fish
  - Stock structure
  - Hatching date
  - Age and growth rate

Daily increment

- Deposition of calcium carbonate and organic matrix over a daily period (24 hr)

  calcium carbonate → Incremental zone (broad, translucent)

  organic matrix → Discontinuous zone (narrow, opaque)
- Many studies revealed daily increment in tropical fish
- The first daily increment was formed in the evening of the first day after hatching

This study based on assumption that one increment equivalent to one day

Introduction

- Indo-Pacific mackerel (*Rastrelliger brachysoma*) is an important economic species in Thailand and also in this regions

- This study is the first report for ageing of Indo-Pacific mackerel using otolith microstructure technique

Methods

Data collection and Sampling Site

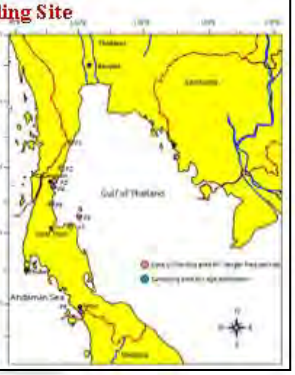
From fishing gears targeting Indo-Pacific mackerel on September 2010 to July 2011

Ageing study

2 stocks
- Gulf of Thailand
- Andaman Sea

Growth parameter

2 methods used to estimate sample from the Gulf of Thailand
- Age based
- Length based



Methods

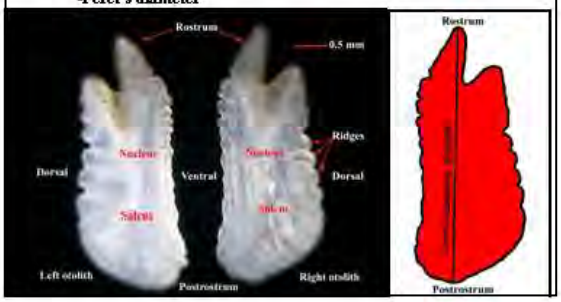
Collecting of Otolith

- Cut skull from back to front
- Otolith located in the cranial cavity
- Collected the sagitta
- Washed with distilled water
- Dried in the air

Methods

Otolith measurement

- Photographs of otoliths were taken at 40x microscope magnification
- Right otolith in posterior view
- ImageJ program (Rasband, 1997-2008)
- Feret's diameter



Methods

Age estimation

Grinding
- 10% sub-sampling at each length class interval for male and female separately
- Right otoliths were mounted on cover slide with thermoplastic resin
- Posterior side grinded under distilled water
- Used sand paper with 30 µm grit size and polish membrane with 12, 3, 0.3 µm grit size

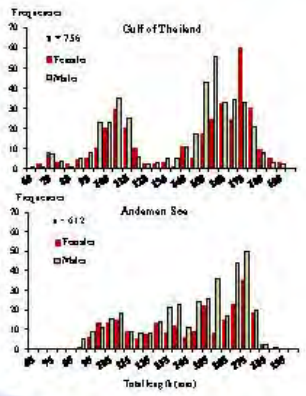
Counting increments
- Photographs under 200x magnification
- Series of photographs were stitched together into montages
- Increments were counted manually from the nucleus to the lateral edge

Results & Discussion

Summary of Samples

Gulf of Thailand (GOT)
- 756 were sampled
- TL of males and females were similar size range (68-197 mm)

Andaman Sea (ADM)
- 612 were sampled
- TL of males and females were similar size range (92-191 mm)



Results & Discussion

1. Age of Indo-Pacific mackerel

Relationship between TL (mm) and number of increments on the otolith of Indo-Pacific mackerel

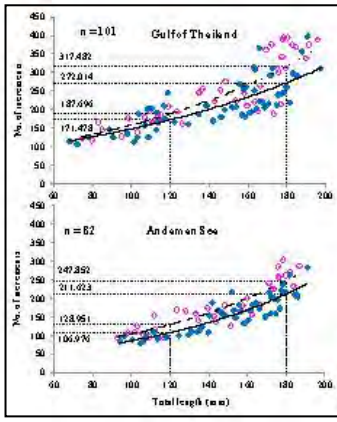
GOT Male Increments = $68.146\ e^{0.00769 * TL}$ $R^2 = 0.708$

Female Increments = $65.603\ e^{0.00876 * TL}$ $R^2 = 0.771$

ADM Male Increments = $27.336\ e^{0.01137 * TL}$ $R^2 = 0.833$

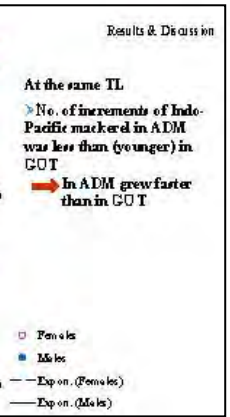
Female Increments = $34.905\ e^{0.01089 * TL}$ $R^2 = 0.822$

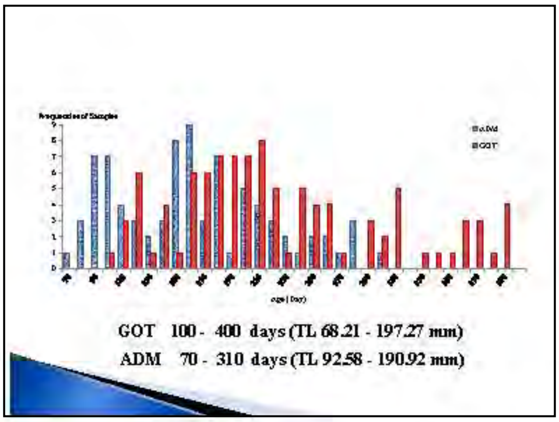
Results & Discussion

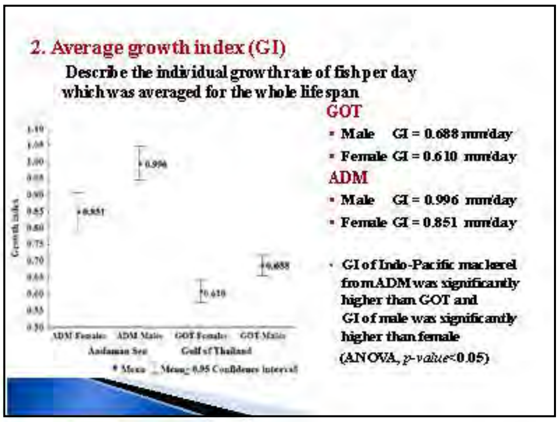


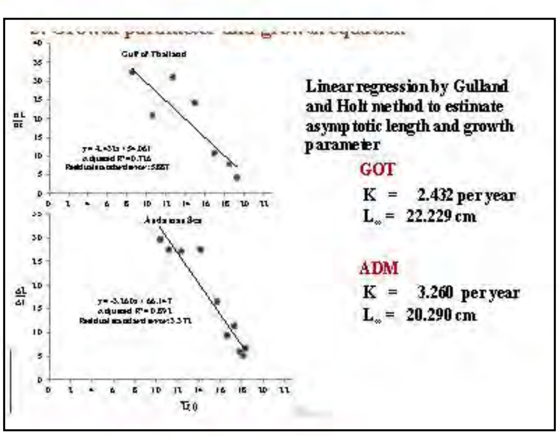
At the same TL

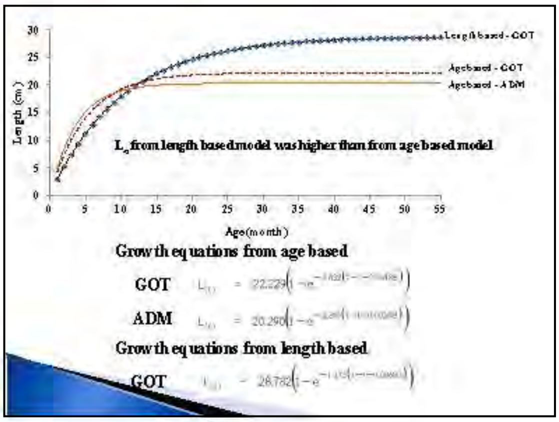
- No. of increments of Indo-Pacific mackerel in ADM was less than (younger) in GOT
- ➡ In ADM grew faster than in GOT

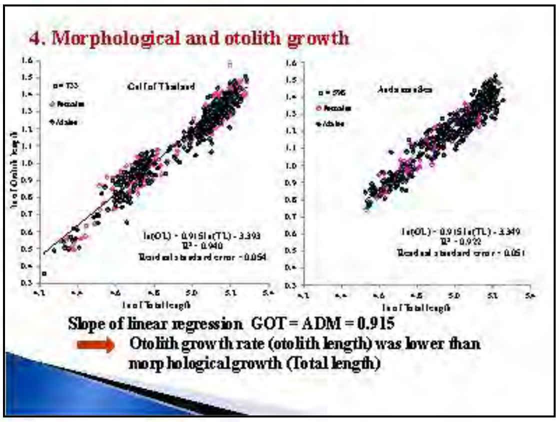


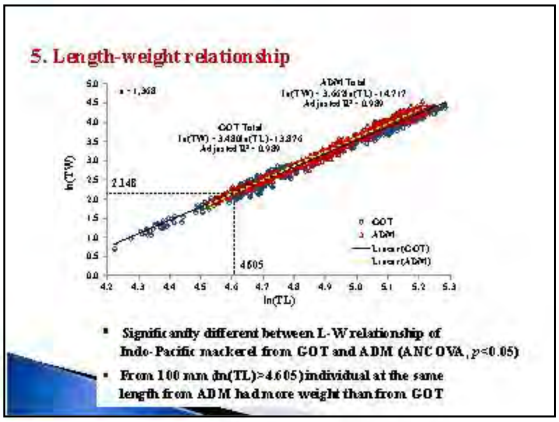

Frequencies of Samples
ADM
GOT
age (Day)
GOT 100 - 400 days (TL 68.21 - 197.27 mm)
ADM 70 - 310 days (TL 92.58 - 190.92 mm)

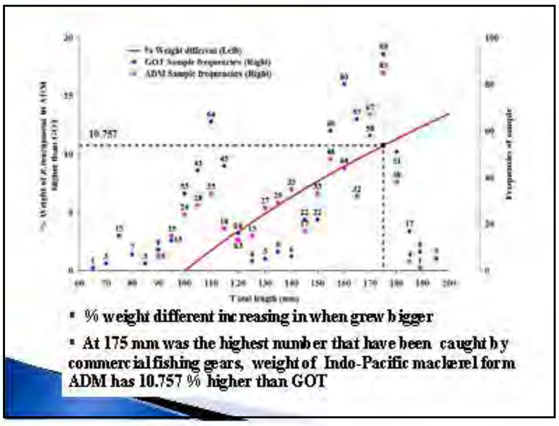

2. Average growth index (GI)
Describe the individual growth rate of fish per day which was averaged for the whole life span
Growth index
0.851
0.996
0.610
0.688
ADM Female ADM Male GOT Female GOT Male
Andaman Sea Gulf of Thailand
Mean Mean ± 0.95 Confidence interval
GOT
Male GI = 0.688 mm/day
Female GI = 0.610 mm/day
ADM
Male GI = 0.996 mm/day
Female GI = 0.851 mm/day
GI of Indo-Pacific mackerel from ADM was significantly higher than GOT and
GI of male was significantly higher than female
(ANOVA, p-value<0.05)

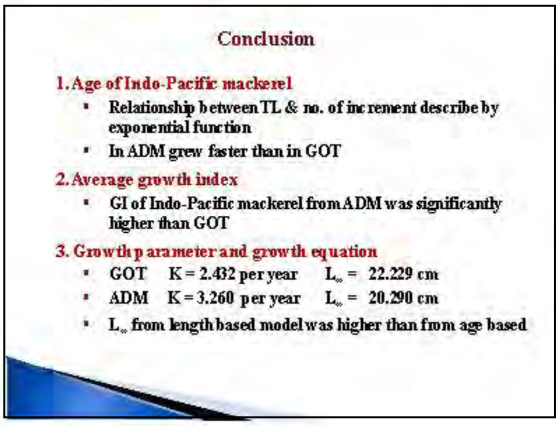

Gulf of Thailand
Andaman Sea
TL0
Linear regression by Gulland and Holt method to estimate asymptotic length and growth parameter
GOT
K = 2.432 per year
L∞ = 22.229 cm
ADM
K = 3.260 per year
L∞ = 20.290 cm


Length based - GOT
Age based - GOT
Age based - ADM
Length (cm)
L∞ from length based model was higher than from age based model
Age (month)
Growth equations from age based
GOT
ADM
Growth equations from length based
GOT


4. Morphological and otolith growth
Gulf of Thailand
Andaman Sea
Females
Males
ln of Otolith length
ln of Total length
ln(OL) = 0.915 ln(TL) - 3.393
R² = 0.940
Residual standard error = 0.054
ln(OL) = 0.915 ln(TL) - 3.349
R² = 0.922
Residual standard error = 0.051
Slope of linear regression GOT = ADM = 0.915
Otolith growth rate (otolith length) was lower than morphological growth (Total length)


5. Length-weight relationship
ADM Total
GOT Total
ln(TW)
ln(TL)
2.148
4.605
GOT
ADM
Linear(GOT)
Linear(ADM)
Significantly different between L-W relationship of Indo-Pacific mackerel from GOT and ADM (ANCOVA, p<0.05)
From 100 mm (ln(TL)>4.605) individual at the same length from ADM had more weight than from GOT


% Weight different (Left)
GOT Sample frequencies (Right)
ADM Sample frequencies (Right)
10.757
Total length (mm)
Frequencies of sample
% weight different increasing in when grew bigger
At 175 mm was the highest number that have been caught by commercial fishing gears, weight of Indo-Pacific mackerel form ADM has 10.757 % higher than GOT


Conclusion
1. Age of Indo-Pacific mackerel
Relationship between TL & no. of increment describe by exponential function
In ADM grew faster than in GOT
2. Average growth index
GI of Indo-Pacific mackerel from ADM was significantly higher than GOT
3. Growth parameter and growth equation
GOT K = 2.432 per year L∞ = 22.229 cm
ADM K = 3.260 per year L∞ = 20.290 cm
L∞ from length based model was higher than from age based

Conclusion

4. Morphological and otolith growth

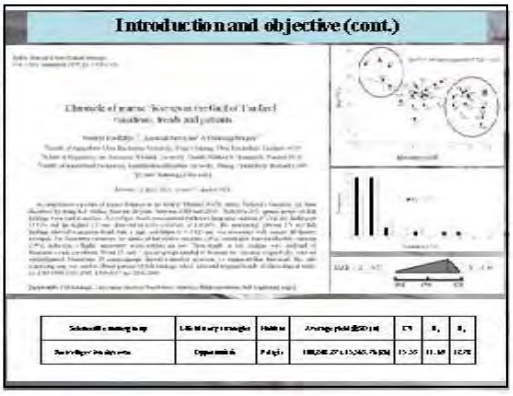
- Otolith growth rate was lower than morphological growth

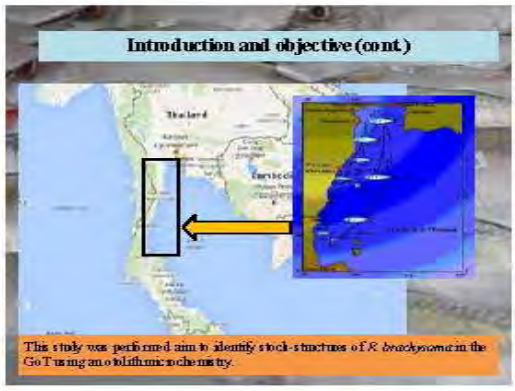
5. Length-weight relationship

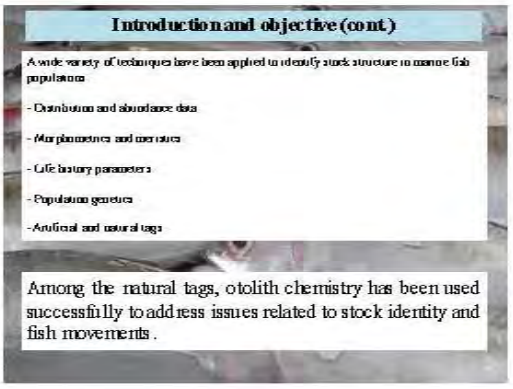
- Significantly different between L-W relationship of Indo-Pacific mackerel from GOT and ADM
- From 100 mm individual at the same length from ADM had more weight than from GOT
- At 175 mm was the highest number that have been caught by commercial fishing gears, weight of Indo-Pacific mackerel form ADM has 10.757 % higher than GOT

Annex 14

STOCK IDENTIFICATION OF SHORT MACKEREL IN THE GULF OF THAILAND: AN OTOLITH MICROCHEMISTRY APPROACH





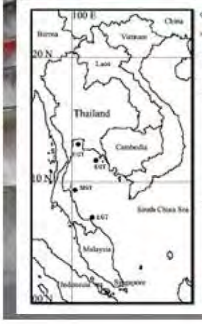


Introduction and objective (cont.)

Fish otoliths are metabolically inert aragonite structures with a composition that is influenced by the physical and chemical properties of the environment.

Furthermore, otoliths grow continuously and record information on life histories in a chronological manner, making it possible to retrieve information on environmental conditions experienced by individual fish from hatching to capture.

Methods



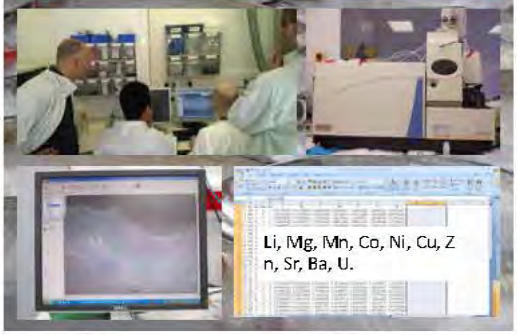
Collection location, sex, mean and standard deviation (SD) of fish total length (Lt) in mm and sample size (n) of *Rastrelliger brachysoma*.

Collection location (abbreviation)	Sex	L_t (mm) Mean	SD	n
Eastern Go I (EGI)	male	147	12	7
	female	185	2.8	9
Upper Go I (UGI)	male	131	14	7
	female	183	7.7	8
Middle Go I (MGI)	male	175	5.5	6
	female	187	1.6	6
Lower Go I (LGI)	male	181	7.2	6
	female	184	4.3	6

Total 55 samples

Methods (Cont.)

Methods (Cont.)



Methods (Cont.)

Data: microchemistry elements compared to Ca concentration from the sectioned otolith material

To detect differentiations, we used

- Analysis of Variance (MANOVA)

To examine the relative importance of variable, we used

- Principal Component Analysis (PCA)

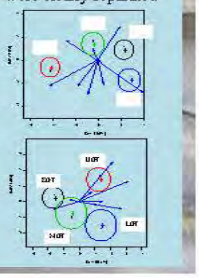
To classify fish stocks, we used

- Linear Discriminant Function Analysis (LDFA)

Results

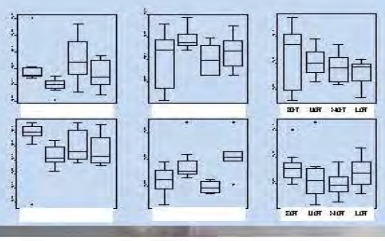
1.The edge otoliths micro-chemical structures in 4 sample sites (i.e. Eastern, Upper, Central, and Lower of GoT) were clearly separated for both sexes (MANOVA, $p<0.01$).

df	MANOVA F	p
Edge (male)	4.93	<0.01
Edge (female)	2.54	<0.01



Results (Cont.)

2. In the edge otoliths, by PCA, three variables, i.e. Sr:Ca, Na:Ca and K:Ca showed highly fluctuated among sites for both sexes.



Results (Cont.)

3. The LDFA using 8 micro-chemical structures, i.e. Li:Ca, Mg:Ca, K:Ca, Mn:Ca, Ni:Ca, Cu:Ca, Sr:Ca, Ba:Ca, in edge zone showed high classification accuracy of *R.brachysoma* to their collected locations.

Male

Collection location group	Predicted group membership (%) 1	2	3	4
1	100	0	0	0
2	0	100	0	0
3	33	0	67	0
4	17	0	0	83

Female

Collection location group	Predicted group membership (%) 1	2	3	4
1	89	0	11	0
2	0	100	0	0
3	16.5	16.5	67	0
4	0	0	17	83

1=Eastern Go I (EGI)
2=Upper Go I (UGI)
3=Middle Go I (MGI)
4=Lower Go I (LGI)

Results (Cont.)

4. The LDFA using 8 micro-chemical structures, i.e. Li:Ca, Mg:Ca, K:Ca, Mn:Ca, Ni:Ca, Cu:Ca, Sr:Ca, Ba:Ca, in Whole otolith showed high classification accuracy of *R. brachysoma* to their collected locations.

Male

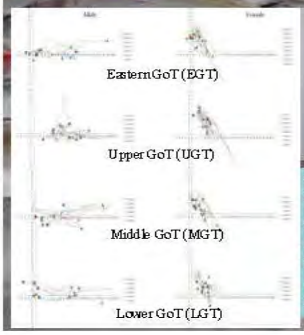
Collection location group	Predicted group membership (%)			
	1	2	3	4
1	86	0	14	0
2	0	100	0	0
3	17	0	83	0
4	17	17	0	67

Female

Collection location group	Predicted group membership (%)			
	1	2	3	4
1	89	11	0	0
2	0	88	0	12
3	0	17	83	0
4	17	0	0	83

1=Eastern GoT (EGT)
2=Upper GoT (UGT)
3=Middle GoT (MGT)
4=Lower GoT (LGT)

Results (Cont.)



The result of LDFA Tracking from core (birth) to edge (death) of each sectioned otolith (i.e. each individual fish) showed complexity of fish life span in each collected locations.

Conclusion

1. There are 4 stocks of *R. brachysoma* in the Gulf of Thailand (i.e. Eastern, Upper, Central and Lower stocks).

2. Fish member in each stock comprised individual fish from different origin of the larvae but grouped together at least last 41% (male) and 67% (female) of their life span.

Acknowledgement

Financial support from the Thailand Research Fund, through the Royal Golden Jubilee Ph.D. Program (Grant No. PHD/0172/2554), to Sontaya Koolkalya and Tuantong Jutagate is acknowledged.

End of presentation,

Thank you for your attention.