Improved Time Series of Fisheries Catch Data for Estimating Potential Yields

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Information on production from the exploitation of marine and freshwater resources as well as from aquaculture is vital for developing economic and social plans as well as management programs. In the Southeast Asian region, the existing systems for collecting fisheries data and information still reflect the traditional monitoring practices that focus on total catch and value. Moreover, in the synthesis of the region's fisheries production, small-scale fisheries are often not being given due attention may be because there has been no proper monitoring of this particular fisheries. Considering that small-scale fisheries constitute the biggest chunk of the region's fisheries, it is therefore necessary that multi-sectoral approaches in collecting fisheries data be actively developed including the compilation of information on the socio-economic and livelihood aspects of small-scale fisheries. Therefore, in order to fully support development plans and implementation of sound policies and sustainable management, appropriate indicators should be developed and their utilization optimized to be able to present circumstances behind the region's fisheries development. SEAFDEC has been playing an important role in compiling fisheries data and information of Southeast Asia, and publishing such data into the annual SEAFDEC Fishery Statistical Bulletin of Southeast Asia which has become one of the recognized sources of fishery information. The fisheries data in the Statistical Bulletin are also available in the Fisheries Statistical Database maintained by the SEAFDEC Training Department (TD). In spite of certain shortcomings, attempts have been made by SEAFDEC/TD to use the existing database in estimating the potential yields from fisheries in Southeast Asia, as summarized in this paper. Furthermore, in addressing the aforementioned concerns, SEAFDEC is also spearheading a regional approach in the compilation of relevant information from small-scale fisheries of the Southeast Asian region, and organizing such data into time series to estimate the potential fisheries yields.

The SEAFDEC Fishery Statistical Bulletin of Southeast Asia, which is published annually by SEAFDEC since 1979, aims to provide fisheries data for management planners, administrators and scientists engaged in research, development and conservation of the fisheries resources, based on standardized classifications and definitions to facilitate data comparison and analysis. The data and information contained in the Bulletin are provided by the Southeast Asian countries based on their respective systems of collecting fishery statistics. The SEAFDEC Secretariat also attempted in 2012 to assemble the compiled information into the status and trend of the region's fisheries resources (SEAFDEC, 2012). During the period from 1976 to 2007, the said Fishery Statistical Bulletin covered the South China Sea Area designated as FAO Fishing Area 71 and the territorial waters of the Andaman Sea belonging to Malaysia and Thailand. Recognizing that the usefulness of the data set is not only for regional management purposes but also for the benefit of transboundary countries sharing the same waters in a particular sub-region, *e.g.* Gulf of Thailand, Andaman Sea, Sulu-Sulawesi Sea, the Southeast Asian countries, SEAFDEC and FAO harmonized in 2008 the minimum requirements and data set while agreeing to the coverage of the Bulletin which should be the Southeast Asian countries only. The fishery statistical items and data sets collected by Southeast Asian countries could differ in accordance with their respective priority needs and objectives. Thus, harmonization was deemed necessary to address the need for fishery statistics which does not only occur at national but also at regional and international levels, especially in analyzing the over-all status and trends of fisheries for development planning and fisheries management from the global point of view.

General Review of the Fishery Statistics of Southeast Asia

The interpretation or translation of important fishery statistics could be summarized taking into account the importance of fish as a main agricultural commodity that provides significant contributions to food security. From the compiled fishery statistics, it could be gleaned that the Southeast Asian countries provided about 19% to the world's total fisheries production in 2010 (**Fig. 1**). The fisheries production trend of the Southeast Asian countries from 2001-2010 is shown in **Table 1**.

The Southeast Asian countries have always recognized the importance of fishery statistics, even if some countries still do not have their fisheries statistical collection systems properly in place. Nevertheless, during the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium *"Fish for the People"* in 2001 and the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 *"Fish for the People 2020: Adaptation to a Changing Environment"* in 2011, the ASEAN-SEAFDEC Member

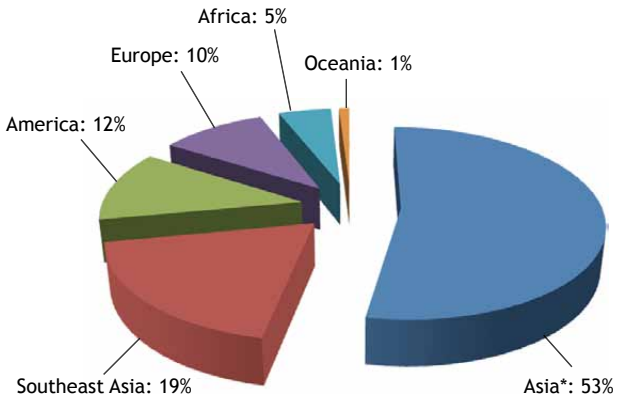

Fig. 1. Contribution of Southeast Asian fisheries to the world's total fisheries production (2010)

Sources: *Fishery Statistical Bulletin of Southeast Asia 2010; FAO FishStat Plus-Universal Software for Fishery Statistical Time Series*
(Note: Asia does not include Southeast Asia)*

Countries reaffirmed the importance of fishery statistics and information (SEAFDEC, 2011). Thus, the SEAFDEC Secretariat put more efforts in strengthening national fishery statistical systems, maximizing their usage for fisheries planning and management, and developing standard definitions and classifications to facilitate the exchange of regional and international fishery statistics and information.

The region's fishery statistics shown in **Table 1** indicate that the top producing countries in 2010 were Indonesia, Philippines, Vietnam, Myanmar, and Thailand in that order. These countries attained increasing trends in their respective annual production except Thailand, where its decreasing production could be assumed as mainly due to overfishing in the Gulf of Thailand.

The region's fisheries production comes from three main sub-sectors, namely: marine capture which accounts for a major portion of the production although the trend seemed to have declined starting in 2009; inland capture which has played a very important role as main source of protein for the poor and rural people; and aquaculture now being regarded as a very important sub-sector for economic development since large portion of its production is bound for the export market. **Fig. 2** shows the contribution of these sub-sectors to the total fisheries production of Southeast Asia in 2010.

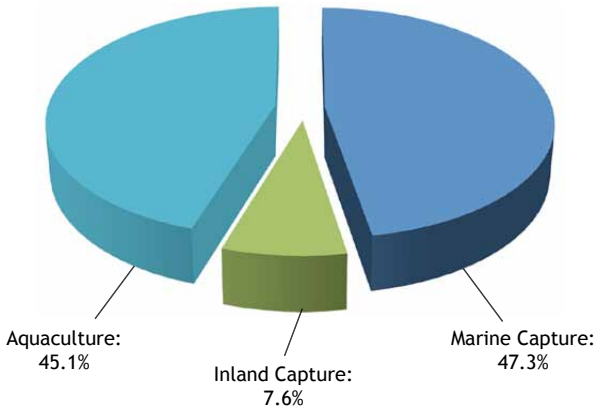

Fig. 2. Contribution of fisheries sub-sectors to the total fisheries production of Southeast Asia in 2010

Source: *Fishery Statistical Bulletin of Southeast Asia 2010 (SEAFDEC, 2010)*

Table 1. Fisheries production of the Southeast Asian countries* ('000 metric tons)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Brunei Darussalam	1.6	2.2	2.2	3.1	3.1	3.0	3.2	2.7	2.4	2.8
Cambodia	441.0	424.4	390.7	343.4	546.0	661.5	525.1	536.3	515.0	551.5
Indonesia	5,353.5	5,515.7	5,916.0	6,005.6	6,646.9	7,183.5	7,510.8	9,054.9	10,064.1	11,664.5
Lao PDR	-	-	-	94.7	107.8	107.8	91.7	93.5	105.0	113.2
Malaysia	1,411.8	1,467.5	1,484.0	1,537.9	1,402.4	1,596.1	1,654.2	1,639.0	1,729.0	1,807.6
Myanmar	1,474.5	1,606.2	1,987.0	2,148.5	2,581.8	2,818.0	2,808.0	3,147.6	3,491.1	3,904.2
Philippines	3,166.5	3,369.5	3,619.3	3,926.1	4,161.9	4,412.2	4,711.0	4,964.7	5,084.7	5,156.6
Singapore	7.8	7.8	7.1	7.6	7.9	11.7	8.0	5.2	5.7	5.2
Thailand	3,648.4	3,797.0	3,914.0	4,137.1	4,132.8	4,051.8	3,675.4	3,204.2	3,137.7	3,115.5
Vietnam	2,434.7	2,647.4	2,859.2	2,944.0	3,397.2	3,656.2	4,315.5	4,559.7	4,782.4	5,127.8
Region's Total	17,939.8	18,837.7	20,179.5	21,148.0	22,987.8	24,501.8	25,302.9	27,207.8	28,917.1	31,448.9
World's Total**	130,700.0	133,000.0	132,200.0	134,300.0	136,400.0	137,100.0	139,800.0	142,300.0	145,100.0	164,800.0
% of world's total	13.7%	14.2%	15.3%	15.7%	16.9%	17.9%	18.1%	19.1%	20.0%	19.0%

* ***Sources:*** *Fishery Statistical Bulletin for the South China Sea Area (SEAFDEC, 2001-2007)*
Fishery Statistical Bulletin of Southeast Asia (SEAFDEC, 2008-2010)
** ***Source:*** *FAO Fisheries and Aquaculture Information and Statistics Services*

Production from Marine Capture Fisheries

While the production trend of the global marine capture fisheries seems to have slightly declined, the region's production trend has been increasing by about 1.8% per year and contributed about 18% to the global marine capture fisheries production in 2009 (SEAFDEC, 2012). Indonesia has been the largest producer accounting for about one third of the region's production while the Philippines contributed 17%, Vietnam 15%, Myanmar 13%, Thailand 11%, and Malaysia 9%. The main species produced by marine capture fisheries have not been classified but reported only as miscellaneous fishes which comprised about one third of the total catch. A big portion of the production came largely from pelagic fishes such as mackerels, tunas, jacks, sardines and anchovies, and from non-fish groups, *e.g.* cuttlefish, squids, shrimps, and other crustaceans.

Production from Inland Capture Fisheries

Large numbers of the people in Southeast Asia are living near seashores and directly dependent on fisheries for food and income. Another large group of people inhabit the countryside near rivers and other inland waters, and are mainly dependent on freshwater fish and fisheries products as source of their protein requirement, and thus, a large portion of catch from inland capture fisheries is directly utilized for household consumption without proper recording. Therefore, most of the current information on inland capture fisheries is based mainly on available recorded statistics, and based on recorded information, the region's production from inland capture fisheries is said to have contributed about 8% to the total fisheries production of Southeast Asia in 2009 (SEAFDEC, 2012). Myanmar, Indonesia and Cambodia are the top producers of freshwater fish from inland capture fisheries (**Table 2**).

Currently, only eight Southeast Asian countries could provide production data from inland capture fisheries. Production of Singapore and Brunei Darussalam is negligible or non-significant, since inland fishing activities in these countries are minimal, where rivers and lakes could have been preserved as source of freshwater supply. Nevertheless, the total production from inland capture fisheries of the Southeast Asian countries in 2010, which was about 2.4 million metric tons, contributed about 8% to the region's total fisheries production. Moreover, the region's inland capture fisheries are generally characterized as multi-gear and multi-species, involving mainly the small-scale fishers, with most of the catch utilized directly for household consumption.

Production from Aquaculture

Aquaculture in Southeast Asia has been rapidly growing and its production in 2009 accounted for about 23% of the world's total aquaculture production. The regional aquaculture production has significantly increased from 4.3 million metric tons in 2001 to 14.2 million metric tons in 2010. Specifically in 2010, mariculture accounted for about 49% of the region's total production from aquaculture, followed by freshwater culture by 29% and brackishwater culture by about 22%. Aquaculture has the potentials to fill the gap in food fish supply considering the unstable fisheries production from nature, especially from marine and inland capture fisheries. However, since fish meal is still an essential component of most aquaculture feeds, such situation is expected to create some impacts on the fishing effort and incessant destruction of the natural fisheries resources until such time that other sources of protein, *i.e.* from plants, are uncovered to serve as substitutes for fish meals.

The major species cultured in the region vary in accordance with the geographical area and the preference of the countries. In Indonesia, for example, the main aquaculture commodity is seaweeds which accounts for about 62% of country's total aquaculture production, followed by freshwater fishes 20%. Similarly for the Philippines, the main commodity cultured are species of seaweeds

Table 2. Production from inland capture fisheries of Southeast Asian countries ('000 metric tons)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	360.0	360.3	308.8	250.0	444.0	559.6	420.0	430.6	390.0	405.0
Indonesia	310.3	305.0	308.7	330.9	297.4	293.9	310.5	497.7	494.6	355.0
Lao PDR	-	-	-	-	29.8	29.8	28.4	29.2	30.0	30.9
Malaysia	3.5	3.6	3.8	4.1	4.6	4.2	4.3	4.4	4.5	4.6
Myanmar	254.9	289.9	454.3	502.6	631.1	718.0	717.6	814.7	899.4	1,002.5
Philippines	136.4	131.7	133.3	142.0	143.8	165.1	168.3	179.5	188.4	185.4
Thailand	202.5	198.7	198.4	199.6	198.8	214.0	225.6	228.6	245.5	209.8
Vietnam	243.6	227.0	208.6	-	138.8	152.3	133.6	144.8	144.8	194.2
Total	**1,511.2**	**1,516.2**	**1,615.9**	**1,429.2**	**1,888.3**	**2,136.9**	**2,008.3**	**2,329.5**	**2,397.2**	**2,387.4**

Sources: *Fishery Statistical Bulletin for the South China Sea Area (SEAFDEC, 2001-2007)*
Fishery Statistical Bulletin of Southeast Asia (SEAFDEC, 2008-2010)

(*e.g. Encheuma cottonii* and *Encheuma denticulatum*) representing about 59% and 5%, respectively of the country's total aquaculture production, the rest of which are milkfish and tilapia. Vietnam's main aquaculture commodities are the Panga catfish accounting for about 41% of the country's total aquaculture production, other freshwater fishes 36% and tiger shrimp 12%. Thailand's main commodity is the white leg shrimp representing about 38% of the country's total aquaculture production, followed by green mussel at 17%, tilapia 15%, catfish hybrid 10%, and other species. Myanmar's main commodities are rohu (*Roho labeo* or *Labeo rohita*) which contributes about 67% to the country's total production from aquaculture, other freshwater fishes 18%, *Penaeus monodon* (tiger shrimp) 6%, and tilapia 5%. Although the region's production of aquatic plants or seaweeds had been increasing during the past decade, utilization of these commodities does not directly contribute to food production. However, it could be assumed that derivatives from seaweeds of about 50% of the total quantity produced are used for human consumption which in the end, also contribute to food security.

Time Series of Existing Fisheries Production Data

The fisheries data in the Fishery Statistical Bulletin for the South China Sea Area published by SEAFDEC from 1976 to 2007 include annual total landings provided by some Southeast Asian countries, as well as those for Taiwan and Hong Kong in the South China Sea area. During such time, some countries in the region provided incomplete data, but such data had been useful in terms of time series. Nevertheless, as the region's statistical information system develops, compilation of fisheries data had been improved especially during the past decade.

The fisheries data and information compiled into the Fishery Statistical Bulletin of Southeast Asia indicate a time series of the catch which could serve as one of the indicators for determining the status of the biomass or stocks of the fisheries resources. The trend of such data could also fulfill the attempts to detect and interpret the biomass of fully assessed stocks. Hence, the Fishery Statistical Bulletin is still a major source of fisheries data and information for analyzing and interpreting fisheries production trend that could be used for national planning and management of fisheries, especially fishery stocks that are shared between and among countries in the same sub-region. Considering that the set of data in the Fishery Statistical Bulletin are secondary data provided by the countries, accuracy and veracity should be rechecked by each country taking into consideration the data provided by adjacent or neighboring countries in shared waters.

In the past, Taiwan and Hong Kong provided very good time series of their respective data which could be utilized in analyzing the status of the fisheries resources in that relevant part of the South China Sea area. In the recent issues of the Bulletin, Indonesia, Malaysia, Philippines, Singapore, and Thailand provided almost all the necessary data over the past 30 years (1977-2007) which are useful for the time series. Although Brunei Darussalam also provided data over the past 30 years, its data set in the earlier years included volumes of imported fish and fisheries products. Vietnam and Cambodia provided only rough estimates of their respective catch starting in 1977, but after harmonizing data collection systems, Vietnam now provides more reliable data and in the same manner, Cambodia also.

From the available data, provisional estimates of the potential yields based on catch data in 1977-2007 could be

Table 3. Status of Southeast Asia's marine fisheries resources based on maximum catch from 1976 to 2007

Country	Maximum Catch (A)	Estimated maximum potential yield	Estimated potential yield (B) = Ax0.8	Average catch for the last 3 years (C)	A-C	B-C
Brunei Darussalam	6,600	6,600	5,280	2,417	4,183	2,863
Cambodia	60,500	60,500	48,400	58,483	2,017	-10,083
Indonesia	4,734,280	4,729,399	3,787,424	4,557,655	176,625	-770,231
Malaysia	1,381,424	1,380,106	1,105,139	1,323,628	57,796	-218,489
Myanmar	1,525,000	1,524,751	1,219,803	1,462,137	62,863	-242,334
Philippines	2,327,815	2,352,239	1,881,791	2,201,616	126,199	-319,825
Singapore	25,042	25,042	20,034	2,848	22,194	17,186
Thailand	2,827,447	2,836,068	2,268,854	2,393,240	434,207	-124,386
Vietnam	1,987,400	1,988,532	1,590,818	1,864,818	122,582	-274,000
Total	**14,875,508**	**14,903,237**	**11,927,543**	**13,866,842**	**1,008,666**	**-1,939,299**

Source: *Calculations from the time series of the total catch of the Southeast Asian countries in 1976-2007, based on data in the SEAFDEC Fishery Statistical Bulletin*

attained, as shown in **Table 3**. The negative value implies that the resources are over-exploited while the positive value denotes under-exploitation. Most of the Southeast Asian countries have enough data for the time series over the last 30 years, but Vietnam has data available only for 1987-2007 while Myanmar has the necessary data from 1997 to 2007. Therefore, the estimated maximum potential yields for Vietnam, Myanmar and Cambodia were calculated for the period from 1997 to 2007 only, as earlier data were only estimates and not supported by landing surveys. For Singapore and Brunei Darussalam, Maximum Catch (A) was used as the Estimated Maximum Potential Yield as their fisheries structure and situation of fisheries are different from the other Southeast Asian countries while their landings had been fluctuating. Therefore, only about eighty percent of the Estimated Maximum Potential Yields could be considered as Estimated Potential Yield (B) as indicated in **Table 3**.

While the region's total means from the last three-year's catch was 13,866,542 metric tons but the estimated potential yield was 11,927,543 metric tons, this implies an over-exploitation of 1,939,299 metric tons. Moreover, the difference between the region's maximum catch of 14,875,508 metric tons and the average catch for the last three years of 13,866,842 is +1,008,666 metric tons, which means that production from the last three years was within maximum limit. However, the fisheries resources of seven countries (Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam) appeared to be over-exploited since the differences between their respective estimated potential yields and average catch over the last three years are negative. As a result, the general situation of the region's marine fisheries resources could be seen as over-exploited, while only Brunei Darussalam and Singapore have the potential to increase their catch. Nevertheless, it should be noted that other influential factors in marine capture fisheries should be taken into consideration before any final conclusion could be made. Thus, using the estimated potential yield method, the overall picture of the status of the region's marine fisheries resources could be established as shown in the **Table 3**. However, since details of single species analysis could not be reflected from the data, the results are based only on aggregates of the entire fisheries where the total potential yields reflect all species caught in the fisheries.

Although the use of the entire fisheries potential yields could be misleading, it is also well known that tropical fisheries are multi-species with complex composition of various fish species. So that even if only few species may be severely over-exploited and/or depleted, but compensations for the fast growing under-utilized species could give high total weight of the catch. Therefore, extended periods of excess fishing pressure can greatly modify the species composition of the catch, leading to reduced abundance of more valuable large species but proliferation of lower-value small species. However, under heavy fishing pressure, even the small, usually highly productive species start to decline so the fisheries usually provide declining production data.

By major species groups, *i.e.* trash fish, miscellaneous fishes, and some other economically-important commodities, status and potential yields could be estimated following the same assumption applied to the total catch as shown in the abovementioned calculations. However, these estimations may over- or under-estimate the potential yields depending on the quality of the data provided. In the past, stock assessment models based on single species model had been derived by Beverton and Holt, Schaefer and Fox, among others, but using their models would require biological information of particular species such as growth and growth rate, length-weight relationship, lifespan, maturity, mortality, and so on. Currently however, many assumptions and methods have been applied to examine the status of stocks such as the use of catch data to indicate whether the status of the fisheries resources is considered as undeveloped, developing, fully exploited, over-exploited or collapsed. For example, Froese and Kesner-Reyes (2002) established that the maximum catch (C_{max}) is highly correlated with the maximum sustainable yield (MSY) and proposed that catches between 0.5 and 1.0 C_{max} are indicative of fully exploited stocks while also implicitly assumed that MSY would be normally found within this range. Therefore, it is justifiable to assume that in marine fisheries, catch levels of 0.5–1.0 C_{max} are indicative of fully exploited stocks. In surplus production models, catch is a predictor of two equilibrium biomasses: either above or below the biomass that can produce the maximum sustainable yield (B_{MSY}) as manifested in **Equation 1**:

$$\frac{B}{B_{MSY}} = 1 \pm \sqrt{1 - \frac{Y}{MSY}}$$

Based on Equation 1, it is assumed that stock biomass in a year before C_{max} is above B_{MSY}, and below thereafter. Consequently, over-exploited (catch between 0.1and 0.5 of C_{max}) and collapsed stocks (catch less than 0.1 C_{max}) would only occur the year after a peak catch, whereas before the C_{max} the same ranges could indicate developing and undeveloped stocks, respectively. The assumption could also be applied to major species groups, where the result from the application of this model compared with the estimation using the potential yield method shown earlier, was found to be the same. Using the data sheets (**Box 1 series**) on the status of each major species group by country (SEAFDEC, 1978-2007; SEAFDEC, 2008-2010), the relationship between C_{max} and B_{MSY} is determined using the Froese and Kesner-Reyes Model (**Table 4**).

Box 1A. Production data sheet (in metric tons): Trash Fish, Misc. Fishes Nei									
Year	Trash Fish				Misc. Fishes Nei				
	Malaysia	Philippines	Thailand	TOTAL	Indonesia	Malaysia	Philippines	Thailand	TOTAL
1978	161,889	4,789	847,421	1,014,099	182,514	33,157	13,903	95,746	325,320
1979	167,282	19,823	784,267	971,372	-	34,378	3,244	77,392	115,014
1980	159,026	15,914	786,858	961,798	259,755	10,546	2,262	80,922	353,485
1981	158,902	4,880	796,747	960,529	204,243	21,216	4,528	79,307	309,294
1982	144,805	5,229	812,789	962,823	206,575	25,256	6,581	82,048	320,460
1983	146,664	5,612	803,337	955,613	236,980	31,422	3,356	73,352	345,110
1984	111,975	4,449	757,637	874,061	492,689	24,954	2,034	92,713	612,390
1985	117,447	2,986	776,421	896,854	473,551	24,739	2,628	106,487	607,405
1986	133,407	6,948	976,236	1,116,591	323,530	22,061	2,877	120,204	468,672
1987	223,822	7,866	1,105,654	1,337,342	341,391	36,070	2,953	128,678	509,092
1988	202,481	13,367	956,113	1,171,961	334,496	39,617	3,085	132,075	509,273
1989	266,314	7,608	980,344	1,254,266	331,626	42,391	2,900	103,948	480,865
1990	314,809	6,808	978,313	1,299,930	301,997	52,443	3,845	108,524	466,809
1991	266,326	6,885	981,840	1,255,051	334,382	46,418	6,565	129,873	517,238
1992	269,892	5,274	1,001,390	1,276,556	329,587	38,956	7,357	164,551	540,451
1993	296,378	5,055	1,026,552	1,327,985	400,399	36,120	10,743	181,164	628,426
1994	314,364	10,126	172,248	496,738	-	45,954	13,857	172,248	232,059
1995	318,695	13,707	915,944	1,248,346	381,065	48,831	9,796	160,863	600,555
1996	294,739	32,709	864,130	1,191,578	433,473	58,100	8,613	175,474	675,660
1997	333,668	7,869	822,110	1,163,647	433,415	-	4,823	162,199	600,437
1998	331,702	-	764,991	1,096,693	456,546	51,100	-	191,215	698,861
1999	318,065	-	765,209	1,083,274	470,576	52,693	-	235,274	758,543
2000	348,203	8,732	775,079	1,132,014	508,966	64,796	6,595	197,877	778,234
2001	347,606	11,073	738,538	1,097,217	568,594	67,840	8,103	246,822	891,359
2002	358,345	11,811	696,641	1,066,797	528,604	87,000	8,965	241,283	865,852
2003	353,810	11,069	697,145	1,062,024	762,421	76,644	8,076	267,242	1,114,383
2004	362,519	10,660	771,723	1,144,902	-	301,396	-	754,416	1,055,812
2005	301,396	-	754,416	1,055,812	816,334	70,527	15,690	185,891	1,088,442
2006	356,875	-	672,686	1,029,561	602,864	72,595	14,848	157,272	847,579
2007	342,972	-	583,076	926,048	523,159	68,744	16,671	140,413	748,987
2008	-	-	-	0	469,361	413,932	150,467	549,230	1,582,990
2009	-	-	-	0	402,417	373,982	16,243	542,228	1,334,870
TOTAL	7,824,378	241,249	24,365,855	32,431,482	12,111,510	2,373,878	361,608	6,136,931	20,983,927

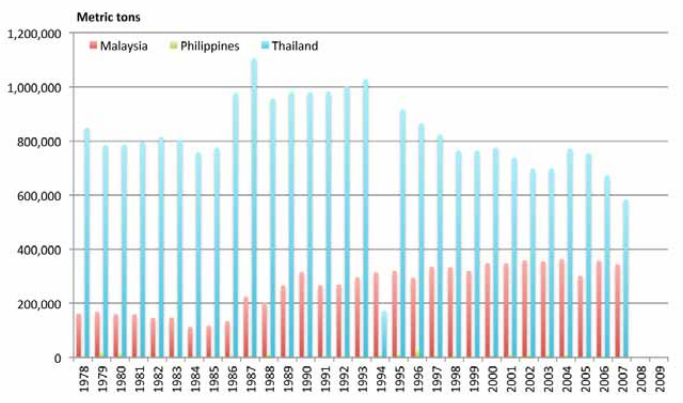

Fig. 3 Production trend: Trash Fish

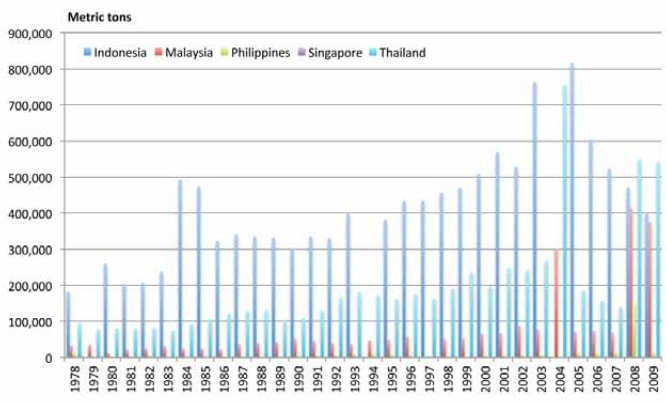

Fig. 4 Production Graph: Miscellaneous Fishes

Box 1B. Production data sheet (in metric tons): Sardines, Round Scad												
Year	Sardines						Round Scad					
	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	130,411	17,500	154,029	276	145,278	447,494	40,872	88,741	18,256	1,187	22,612	171,668
1979	-	15,363	106,403	261	161,892	283,919	-	83,092	17,896	1,093	43,083	145,164
1980	132,097	15,332	117,348	224	105,413	370,414	9,027	78,365	16,824	1,086	17,631	122,933
1981	152,886	18,505	136,871	276	139,800	448,338	63,891	74,727	17,244	1,193	31,256	188,311
1982	160,995	23,801	147,746	374	116,898	449,814	66,342	76,031	18,618	1,489	26,035	188,515
1983	195,517	24,355	151,484	418	124,881	496,655	63,971	67,541	17,592	1,667	22,410	173,181
1984	-	14,849	109,027	493	117,323	241,692	54,442	55,975	15,588	2,179	22,452	150,636
1985	-	11,071	81,927	350	97,742	191,090	67,880	11,276	34,407	729	19,609	133,901
1986	186,740	10,505	73,303	481	121,242	392,271	-	-	-	-	-	0
1987	179,828	28,134	98,694	206	127,208	434,070	-	-	-	-	-	0
1988	228,720	24,129	96,405	398	123,739	473,391	59,994	70,963	13,862	-	88,962	233,781
1989	241,275	16,868	122,468	323	145,038	525,972	58,019	92,450	14,065	-	11,851	176,385
1990	248,487	16,719	156,748	357	120,546	542,857	55,894	90,540	12,359	-	12,138	170,931
1991	281,681	20,120	158,622	379	140,912	601,714	58,079	68,708	13,623	-	11,932	152,342
1992	276,374	23,585	195,879	315	163,527	659,680	63,967	19,880	18,074	-	103,495	205,416
1993	274,599	26,938	256,744	-	152,303	710,584	59,739	22,814	16,688	-	103,583	202,824
1994	313,669	34,681	259,849	-	154,624	762,823	-	-	-	-	-	0
1995	280,650	38,993	264,675	-	195,212	779,530	-	-	-	-	-	0
1996	267,597	44,525	257,804	-	214,857	784,783	76,198	17,236	14,759	-	181	108,374
1997	295,550	-	302,341	-	201,792	799,683	86,512	15,024	16,337	-	8,089	125,962
1998	210,977	46,315	-	-	185,858	443,150	-	-	-	-	-	0
1999	276,181	45,517	-	-	182,813	504,511	98,026	12,256	-	-	2,252	112,534
2000	284,724	33,613	298,466	-	164,014	780,817	105,569	31,359	16,357	-	2,273	155,558
2001	310,023	40,747	282,955	-	145,032	778,757	101,627	27,584	19,693	-	1,724	150,628
2002	332,870	40,611	254,054	-	128,877	756,412	103,078	25,769	22,800	-	1,865	153,512
2003	309,406	40,830	242,968	-	124,919	718,123	100,679	35,619	22,597	-	2,517	161,412
2004	270,484	41,657	270,484	-	119,901	702,526	110,034	41,901	22,818	-	2,648	177,401
2005	302,742	42,243	336,304	-	297,382	978,671	100,038	24,766	23,154	-	2,013	149,971
2006	371,116	54,731	303,755	-	109,508	839,110	-	-	-	-	-	0
2007	380,658	42,889	313,082	-	97,448	834,077	122,128	29,173	23,068	-	1,153	175,522
2008	-	-	369,199	-	78,859	448,058	-	-	-	-	-	0
2009	-	-	467,853	-	96,426	564,279	-	-	-	-	-	0
TOTAL	6,896,257	855,126	6,387,487	5,131	4,601,264	18,745,265	1,726,006	1,161,790	426,679	10,623	561,764	3,886,862

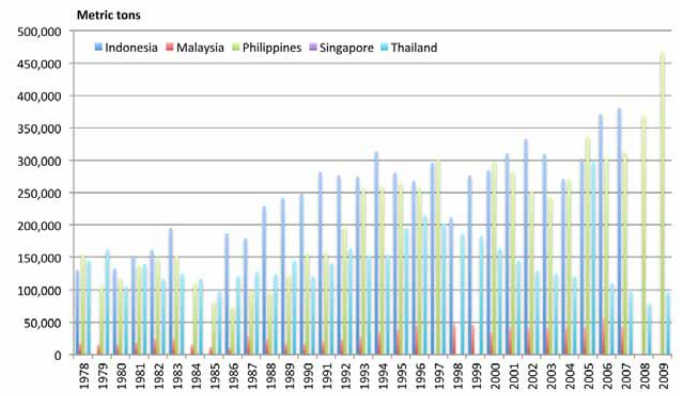

Fig. 5. Production Graph: Sardines

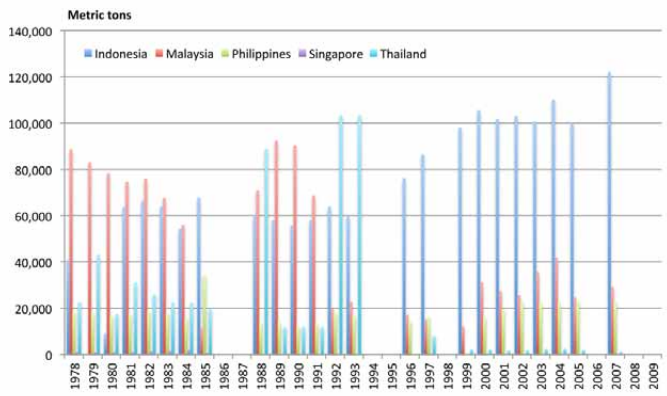

Fig. 6. Production Graph: Round Scad

Box 1C. Production data sheet (in metric tons): Anchovies, Indian Mackerel												
Year	Anchovies						Indian Mackerel					
	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	105,388	18,734	96,408	166	10,308	231,004	-	40,933	45,936	102	37,005	123,976
1979	-	37,514	70,488	114	20,214	128,330	-	20,471	38,972	132	29,221	88,796
1980	96,147	30,487	80,163	108	20,299	227,204	-	-	-	-	-	0
1981	65,637	25,361	149,947	-	37,376	278,321	-	-	-	-	-	0
1982	97,072	23	25,947	-	151,623	274,665	93,593	71,303	24,229	221	21,487	210,833
1983	104,690	35,613	91,420	451	40,619	272,793	95,738	91,478	38,226	224	53,247	278,913
1984	109,299	23,500	99,545	592	90,087	323,023	114,281	87,054	33,192	475	33,436	268,438
1985	106,887	16,776	109,885	496	104,196	338,240	124,988	83,029	37,445	414	36,970	282,846
1986	111,800	18,252	99,687	761	58,987	289,487	132,000	43,993	38,942	371	41,891	257,197
1987	117,995	28,153	108,373	567	57,769	312,857	121,265	71,459	42,726	242	39,876	275,568
1988	115,601	32,065	126,373	543	69,378	343,960	127,505	57,452	51,768	146	25,808	262,679
1989	119,696	30,523	122,250	458	97,080	370,007	145,670	57,120	51,661	115	35,127	289,693
1990	127,797	30,338	107,036	421	123,958	389,550	145,377	68,920	66,278	138	32,293	313,006
1991	135,633	22,185	100,882	470	127,089	386,259	144,094	62,553	61,726	140	32,558	301,071
1992	133,910	38,270	84,652	359	159,884	417,075	177,092	77,250	62,395	110	40,124	356,971
1993	142,786	24,785	81,437	205	165,335	414,548	173,946	67,975	57,246	101	49,729	348,997
1994	150,568	22,363	67,507	170	169,359	409,967	194,882	93,646	57,445	210	64,593	410,776
1995	157,216	22,563	71,516	143	167,987	419,425	193,890	126,170	51,352	151	70,456	442,019
1996	161,779	24,361	71,456	155	161,970	419,721	188,912	95,364	46,264	12	42,099	372,651
1997	183,591	23,772	78,678	150	157,341	443,532	201,404	86,801	54,732	51	42,676	385,664
1998	166,808	25,651	-	73	157,214	349,746	204,763	102,072	-	165	43,682	350,682
1999	163,117	23,045	-	84	134,740	320,986	201,466	111,365	-	129	47,885	360,845
2000	173,944	22,516	79,630	70	143,105	419,265	207,037	98,055	53,715	97	35,203	394,107
2001	190,182	17,723	100,899	62	145,501	454,367	214,387	99,469	60,709	68	31,949	406,582
2002	168,959	23,683	74,095	54	151,731	418,522	221,634	87,910	70,279	35	32,761	412,619
2003	161,141	20,319	71,101	25	153,660	406,246	194,427	124,856	77,120	27	34,190	430,620
2004	154,811	23,449	71,498	24	163,237	413,019	201,882	141,632	75,403	44	34,889	453,850
2005	151,926	16,887	68,947	17	159,685	397,462	222,032	131,272	84,266	31	45,705	483,306
2006	165,024	19,258	70,568	36	157,784	412,670	254,960	132,605	89,089	21	40,473	517,148
2007	175,522	23,975	76,041	32	145,587	421,157	259,458	156,685	88,001	40	32,404	536,588
2008	-	-	-	-	119,964	119,964	15,432	-	91,272	-	15,214	121,918
2009	-	-	-	-	144,056	144,056	-	-	-	-	-	0
TOTAL	4,014,926	722,144	2,456,429	6,806	3,767,123	10,967,428	4,572,115	2,488,892	1,550,389	4,012	1,122,951	9,738,359

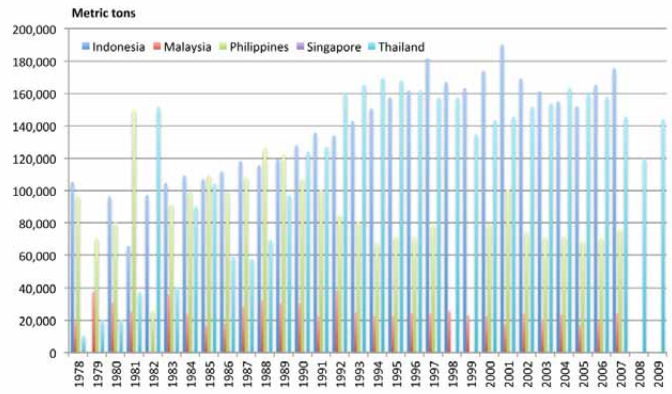

Fig. 7. Production Graph: Anchovies

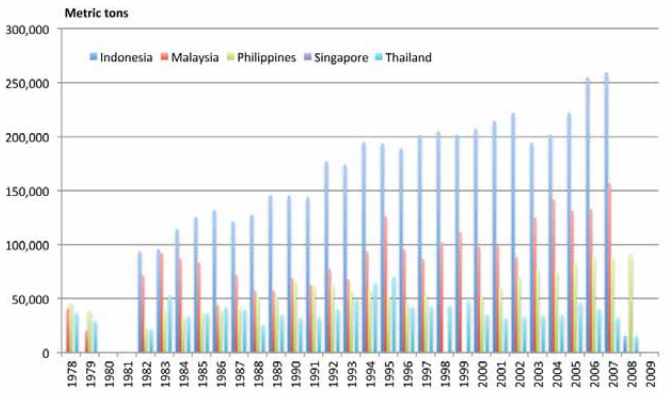

Fig. 8. Production Graph: Indian Mackerel

Box 1D. Production data sheet (in metric tons): Penaeid Shrimps, Non-Penaeid Shrimps											
Year	Penaeid Shrimps						Non-Peaneid Shrimps				
	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Tha.	TOTAL
1978	40,872	88,741	18,256	1,187	22,612	171,668	87,294	-	10,055	98,304	195,653
1979	-	83,092	17,896	1,093	43,083	145,164	-	1,063	5,844	69,257	76,164
1980	9,027	78,365	16,824	1,086	17,631	122,933	121,890	1,612	9,327	92,646	225,475
1981	63,891	74,727	17,244	1,193	31,256	188,311	68,165	10	19,563	106,465	194,203
1982	66,342	76,031	18,618	1,489	26,035	188,515	97,072	23	25,947	151,623	274,665
1983	63,971	67,541	17,592	1,667	22,410	173,181	46,650	7,215	10,110	126,492	190,467
1984	54,442	55,975	15,588	2,179	22,452	150,636	46,513	7,535	7,792	101,097	162,937
1985	67,880	11,276	34,407	729	19,609	133,901	53,313	17,650	17,865	91,347	180,175
1986	-	-	-	-	-	0	84,440	17,000	18,197	110,488	230,125
1987	-	-	-	-	-	0	66,868	45,522	14,670	115,142	242,202
1988	59,994	70,963	13,862	-	88,962	233,781	80,192	10,601	16,350	19,030	126,173
1989	58,019	92,450	14,065	-	11,851	176,385	72,322	14,909	17,260	97,850	202,341
1990	55,894	90,540	12,359	-	12,138	170,931	76,452	8,717	18,810	93,957	197,936
1991	58,079	68,708	13,623	-	11,932	152,342	78,215	27,516	18,287	115,938	239,956
1992	63,967	19,880	18,074	-	103,495	205,416	83,461	104,421	21,351	11,969	221,202
1993	59,739	22,814	16,688	-	103,583	202,824	79,714	81,858	16,214	13,662	191,448
1994	-	-	-	-	-	0	158,753	75,400	15,809	120,962	370,924
1995	-	-	-	-	-	0	81,261	69,902	18,997	128,542	298,702
1996	76,198	17,236	14,759	-	181	108,374	89,215	82,228	18,657	128,819	318,919
1997	86,512	15,024	16,337	-	8,089	125,962	96,790	75,479	15,562	54,982	242,813
1998	-	-	-	-	-	0	87,200	67,157	-	57,272	211,629
1999	98,026	12,256	-	-	2,252	112,534	103,372	77,176	-	81,644	262,192
2000	105,569	31,359	16,357	-	2,273	155,558	98,880	63,456	20,122	83,241	265,699
2001	101,627	27,584	19,693	-	1,724	150,628	113,161	48,875	23,061	85,118	270,215
2002	103,078	25,769	22,800	-	1,865	153,512	95,561	48,507	17,131	82,120	243,319
2003	100,679	35,619	22,597	-	2,517	161,412	100,221	33,631	16,995	76,205	227,052
2004	110,034	41,901	22,818	-	2,648	177,401	95,907	35,503	15,403	107,069	253,882
2005	100,038	24,766	23,154	-	2,013	149,971	71,473	26,469	14,002	74,114	186,058
2006	-	-	-	-	-	0	93,083	31,523	15,706	68,448	208,760
2007	122,128	29,173	23,068	-	1,153	175,522	90,107	40,981	12,914	57,499	201,501
2008	-	-	-	-	-	0	-	-	-	-	
2009	-	-	-	-	-	0	-	-	-	-	
TOTAL	**1,726,006**	**1,161,790**	**426,679**	**10,623**	**561,764**	**3,886,862**	**2,517,545**	**1,121,939**	**452,001**	**2,621,302**	**6,712,787**

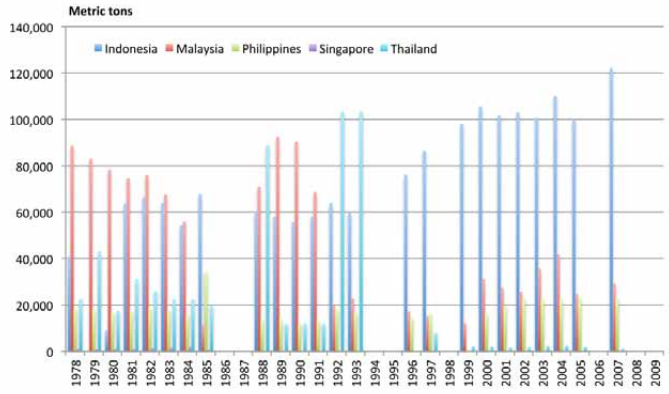

Fig. 9. Production Graph: Penaeid Shrimps

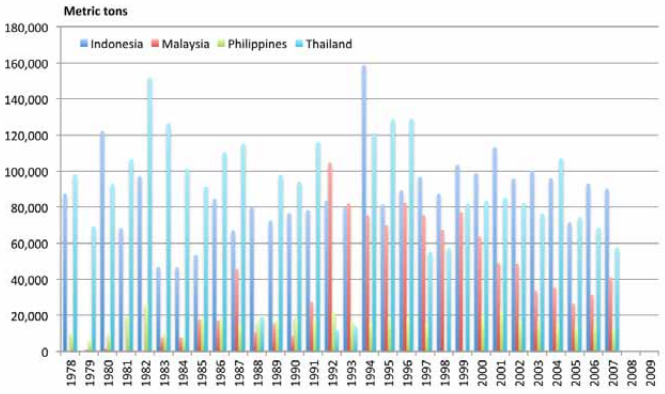

Fig. 10. Production Graph: Non-Penaeid Shrimps

Box 1E. Production data sheet (in metric tons): Eastern Little Tuna, Squids												
Year	Eastern Little Tuna						Squids					
	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	55,244	3,755	26,452	-	10,353	95,804	8,691	17,996	31,416	390	52,067	110,560
1979	-	3,088	23,094	0	4,342	30,524	-	17,202	25,495	347	42,287	85,331
1980	66,582	2,716	24,730	-	5,012	99,040	12,812	8,831	27,011	303	39,854	88,811
1981	8,867	13,574	27,980	357	48,021	98,799	87,667	1,878	30,891	-	10,709	131,145
1982	78,190	3,106	45,533	-	25,891	152,720	11,626	10,028	20,989	507	70,583	113,733
1983	103,878	3,372	48,880	-	32,015	188,145	10,420	10,481	30,741	503	76,489	128,634
1984	103,179	6,871	41,899	-	32,640	184,589	8,615	10,298	20,314	694	66,340	106,261
1985	111,630	3,315	41,060	-	38,881	194,886	10,531	9,148	24,623	712	63,996	109,010
1986	116,975	2,713	42,445	-	45,473	207,606	10,000	9,704	26,632	409	71,344	118,089
1987	122,675	4,528	46,934	-	36,708	210,845	11,164	21,430	26,431	322	75,420	134,767
1988	117,898	6,322	56,266	-	53,450	233,936	14,088	20,243	28,835	270	67,176	130,612
1989	135,332	4,058	57,899	-	47,525	244,814	15,606	31,068	26,639	218	69,840	143,371
1990	139,967	3,336	43,762	-	60,759	247,824	15,262	35,069	26,574	259	64,370	141,534
1991	78,383	-	95,594	-	-	173,977	14,084	33,570	26,672	256	69,367	143,949
1992	155,661	-	31,943	-	94,627	282,231	18,365	34,402	39,402	226	64,774	157,169
1993	160,950	-	26,670	-	87,175	274,795	20,914	32,622	55,790	246	72,162	181,734
1994	186,486	-	46,221	-	84,273	316,980	26,216	35,924	49,043	1,000	72,226	184,409
1995	184,400	-	27,308	-	74,443	286,151	27,575	31,254	56,415	679	78,109	194,032
1996	208,504	-	24,345	-	68,450	301,299	29,167	36,270	52,458	546	79,235	197,676
1997	212,511	-	26,573	-	61,980	301,064	41,755	38,491	54,155	470	78,948	213,819
1998	236,673	-	-	-	61,147	297,820	31,850	38,697	-	462	92,908	163,917
1999	236,111	-	-	-	59,873	295,984	36,707	40,283	-	376	83,135	160,501
2000	250,522	-	27,963	-	53,428	331,913	39,838	54,339	46,778	348	86,203	227,506
2001	233,051	-	27,280	-	45,650	305,981	60,529	45,282	41,964	186	77,460	225,421
2002	266,955	-	34,681	-	51,489	353,125	62,133	52,483	50,612	185	89,505	254,918
2003	267,339	10,467	38,675	-	44,865	361,346	51,482	49,908	53,100	135	80,462	235,087
2004	133,000	10,137	44,875	-	54,887	242,899	69,357	52,208	56,181	181	81,267	259,194
2005	86,459	8,771	77,673	-	58,004	230,907	58,433	44,335	59,802	124	75,488	238,182
2006	118,470	18,560	78,377	-	50,458	265,865	57,821	67,606	57,584	224	76,202	259,437
2007	143,101	13,634	73,094	-	45,600	275,429	63,425	59,729	64,139	148	66,885	254,326
2008	-	-	-	-	-	0	-	-	-	-	-	0
2009	-	-	-	-	-	0	-	-	-	-	-	0
TOTAL	4,318,993	122,323	1,208,206	357	1,437,419	7,087,298	926,133	950,779	1,110,686	10,726	2,094,811	5,093,135

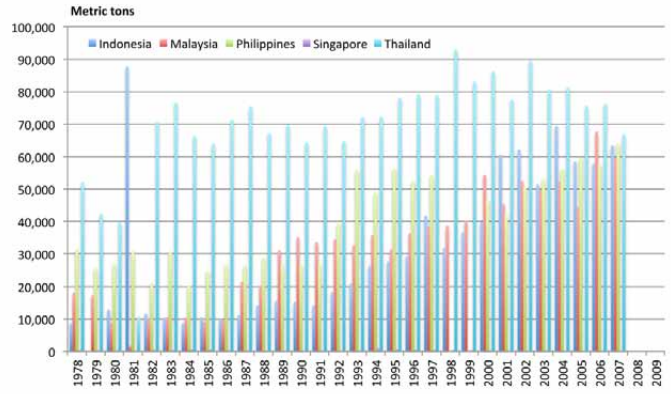

Fig. 11. Production Graph: Eastern Little Tuna

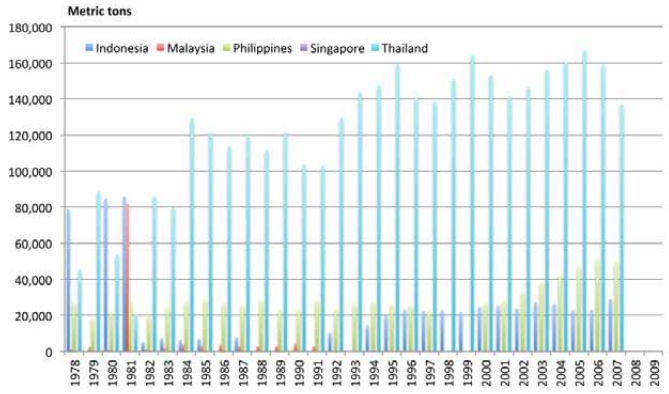

Fig. 12. Production Graph: Squids

Box 1F. Production data sheet (in metric tons): Indo-Pacific Mackerel, Selar Scad												
Year	Indo-Pacific Mackerel						Selar Scad					
	Ind	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	78,790	1,448	27,278	-	45,271	152,787	69,284	30,451	57,213	258	-	157,206
1979	-	2,328	17,914	-	88,720	108,962	-	26,491	47,027	301	11,129	84,948
1980	84,485	1,050	22,208	-	53,424	161,167	78,162	22,821	47,032	286	11,105	159,406
1981	85,747	81,831	28,425	194	20,542	216,739	99,681	34,852	72,745	168	14,488	221,934
1982	5,049	1,138	19,507	-	86,136	111,830	53,581	27,953	27,232	575	17,460	126,801
1983	7,122	1,765	24,672	-	79,803	113,362	64,737	35,628	22,502	534	23,342	146,743
1984	6,100	3,717	27,650	-	129,094	166,561	55,811	29,019	37,513	781	25,284	148,408
1985	6,796	3,068	28,929	-	121,107	159,900	64,430	30,224	33,481	769	18,418	147,322
1986	-	3,731	26,534	-	113,497	143,762	67,880	11,276	34,407	729	19,609	133,901
1987	7,522	2,856	25,327	-	119,182	154,887	72,977	18,861	35,461	630	25,960	153,889
1988	-	3,049	28,323	-	111,657	143,029	80,467	33,597	36,530	438	18,882	169,914
1989	-	3,218	23,301	-	121,041	147,560	88,761	37,333	38,614	359	21,408	186,475
1990	-	4,051	23,031	-	103,537	130,619	90,147	35,670	41,255	424	31,586	199,082
1991	-	2,932	28,297	-	102,977	134,206	95,989	38,402	36,264	195	22,308	193,158
1992	10,256	-	23,703	-	129,551	163,510	100,472	40,384	37,766	345	25,541	204,508
1993	-	-	26,234	-	143,982	170,216	105,946	49,979	33,438	331	22,448	212,142
1994	14,326	-	27,592	-	147,520	189,438	113,930	47,042	50,288	352	39,567	251,179
1995	19,873	-	26,200	-	159,225	205,298	116,769	42,738	43,582	285	40,223	243,597
1996	23,097	-	25,224	-	140,826	189,147	116,193	17,185	43,660	312	26,517	203,867
1997	22,250	-	22,978	-	138,621	183,849	125,504	52,309	313	-	24,092	202,218
1998	22,746	-	-	-	151,010	173,756	128,459	22,233	-	234	28,761	179,687
1999	21,674	-	-	-	164,110	185,784	128,785	23,954	-	175	-	152,914
2000	24,449	-	26,771	-	152,884	204,104	129,913	71,234	71,365	139	32,255	304,906
2001	25,056	-	28,091	-	141,315	194,462	132,998	65,037	80,858	66	32,595	311,554
2002	23,554	-	32,657	-	146,422	202,633	149,193	66,469	100,786	69	34,699	351,216
2003	27,204	-	38,294	-	156,223	221,721	154,866	61,228	103,975	56	44,588	364,713
2004	26,220	-	42,760	-	160,398	229,378	138,923	67,301	103,358	47	40,741	350,370
2005	22,903	-	46,810	-	166,766	236,479	143,105	72,571	91,534	31	41,284	348,525
2006	23,081	-	50,809	-	158,979	232,869	145,210	70,868	93,920	70	36,873	346,941
2007	28,928	-	49,494	-	136,839	215,261	142,706	70,007	95,028	62	34,732	342,535
2008	-	-	-	-	-	0	-	-	-	-	-	0
2009	-	-	-	-	-	0	-	-	-	-	-	0
TOTAL	**617,228**	**116,182**	**819,013**	**194**	**3,690,659**	**5,243,276**	**3,054,879**	**1,253,117**	**1,517,147**	**9,021**	**765,895**	**6,600,059**

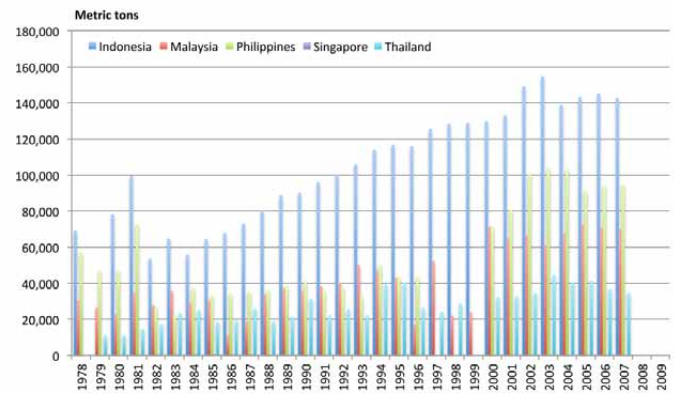

Fig. 13. Production Graph: Indo-Pacific Mackerel

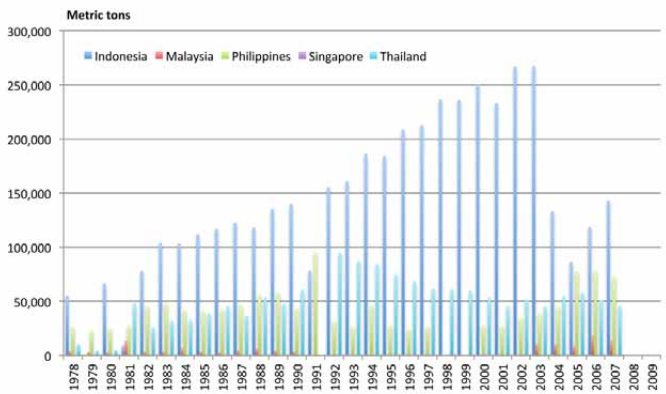

Fig. 14. Production Graph: Selar Scad

Box 1G. Production data sheet (in metric tons): Skipjack Tuna, Threadfin Breams												
Year	Skipjack Tuna						Threadfin Breams					
	Ind	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	33,515	-	34,597	40	-	68,152	8,778	12,601	35,129	414	23,678	80,600
1979	-	-	45,084	39	-	45,123	-	12,263	32,471	428	20,425	65,587
1980	42,834	-	31,178	35	-	74,047	9,859	10,635	37,457	381	18,016	76,348
1981	-	969	18,962	-	71,701	91,632	37,382	15,974	16,897	-	13,689	83,942
1982	47,140	-	50,795	25	-	97,960	9,869	12,588	30,883	629	17,340	71,309
1983	76,890	-	57,151	7	-	134,048	10,823	11,621	34,348	756	16,276	73,824
1984	80,658	-	44,671	81	-	125,410	10,282	11,215	41,321	938	15,052	78,808
1985	87,448	-	60,536	36	-	148,020	10,013	8,865	43,977	939	17,096	80,890
1986	98,500	-	77,031	32	-	175,563	11,000	11,217	46,476	886	26,801	96,380
1987	102,559	-	73,751	16	-	176,326	9,529	21,384	46,448	725	34,134	112,220
1988	127,543	-	55,940	-	-	183,483	-	-	-	-	-	0
1989	113,844	-	64,654	-	-	178,498	16,903	23,584	43,060	408	33,674	117,629
1990	114,168	-	99,705	130	-	214,003	17,573	26,435	44,068	325	31,139	119,540
1991	150,439	1,994	47,850	-	67,399	267,682	18,722	27,415	45,644	257	47,030	139,068
1992	152,038	-	83,179	-	-	235,217	20,248	28,999	31,196	128	65,377	145,948
1993	147,291	-	68,081	-	-	215,372	24,520	30,761	40,079	125	75,327	170,812
1994	157,663	-	84,560	6	-	242,229	25,278	29,263	34,177	305	75,110	164,133
1995	159,667	-	110,111	5	-	269,783	27,460	31,323	35,538	255	93,785	188,361
1996	182,147	-	110,004	5	-	292,156	31,593	29,534	32,884	209	89,592	183,812
1997	187,206	-	110,097	47	-	297,350	29,340	31,052	29,839	239	87,717	178,187
1998	227,068	-	-	12	-	227,080	30,937	40,327	-	158	96,595	168,017
1999	244,842	-	-	23	-	244,865	39,197	39,694	-	128	93,037	172,056
2000	34,218	32,510	29,487	96	102,282	198,593	34,218	32,510	29,487	96	102,282	198,593
2001	214,077	-	105,484	10	-	319,571	37,179	28,910	27,079	48	106,658	199,874
2002	203,102	-	109,977	6	-	313,085	39,566	30,519	49,257	33	121,376	240,751
2003	208,626	-	138,319	4	-	346,949	44,958	30,147	40,514	18	112,501	228,138
2004	233,319	-	143,143	2	-	376,464	57,853	33,502	41,161	22	105,895	238,433
2005	252,232	-	143,064	4	-	395,300	62,228	35,450	45,253	15	104,636	247,582
2006	277,388	-	164,325	1	-	441,714	65,126	35,879	51,252	29	96,583	248,869
2007	301,531	-	185,864	-	-	487,395	70,890	36,200	55,563	71	92,461	255,185
2008	243,638	-	222,010	2	6,138	471,788	36,536	26,047	51,432	38	25,024	139,077
2009	300,740	4,460	251,524	2	7,532	564,258	47,970	39,722	47,238	27	40,046	175,003
TOTAL	4,802,331	39,933	2,821,134	666	255,052	7,919,116	895,830	795,636	1,140,128	9,030	1,898,352	4,738,976

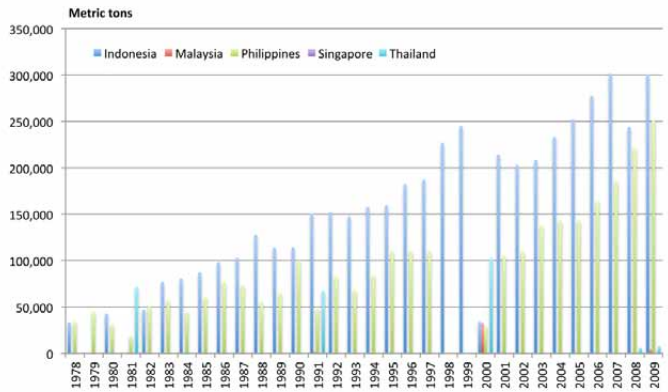

Fig. 15. Production Graph: Skipjack Tuna

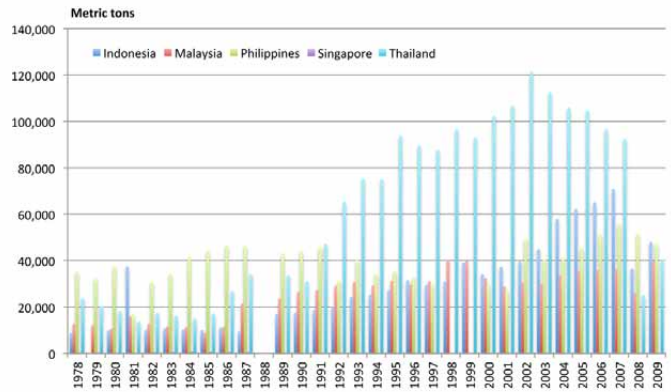

Fig. 16. Production Graph: Threadfin Breams

Box 1H. Production data sheet (in metric tons): Pony Fish; Jacks, Cavalla, Trevally												
Year	Pony Fish						Jacks, Cavalla, Trevally					
	Ind	Mal.	Phi.	Sin.	Tha.	TOTAL	Ind.	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	37,751	1,736	65,762	108	-	105,357	46,191	2,436	33,183	-	35,587	117,397
1979	-	1,586	72,468	80	-	74,134	-	3,060	32,468	-	21,082	56,610
1980	41,235	1,260	60,432	109	-	103,036	47,094	3,475	30,680	-	-	81,249
1981	25,239	-	94,615	504	-	120,358	53,498	-	38,439	55	-	91,992
1982	42,119	1,393	53,738	86	-	97,336	-	-	-	-	-	0
1983	36,602	1,742	59,191	64	383	97,982	13,988	4,076	40,723	-	23,344	82,131
1984	36,940	2,502	66,784	198	184	106,608	-	-	-	-	-	0
1985	38,663	2,620	65,316	156	377	107,132	13,087	4,212	42,350	-	52,111	111,760
1986	39,000	2,214	65,415	119	-	106,748	14,670	12,625	42,150	-	42,204	111,649
1987	36,203	1,677	61,738	85	243	99,946	14,257	18,788	44,189	-	43,197	120,431
1988	40,912	1,832	65,724	85	-	108,553	18,672	8,376	45,710	-	48,918	121,676
1989	42,413	1,837	63,475	68	-	107,793	20,427	6,399	37,284	-	53,765	117,875
1990	41,768	960	69,365	78	-	112,171	19,674	5,720	37,503	197	51,954	115,048
1991	43,353	1,475	69,955	81	-	114,864	22,704	6,763	39,939	-	43,478	112,884
1992	-	-	-	-	-	0	27,213	8,281	47,066	157	45,728	128,445
1993	52,800	1,918	60,169	57	-	114,944	26,905	8,683	44,631	138	56,528	136,885
1994	57,462	1,933	59,547	141	-	119,083	26,086	6,870	47,539	249	68,796	149,540
1995	-	-	-	-	-	0	29,025	7,651	39,682	209	55,682	132,249
1996	71,401	2,539	57,867	75	-	131,882	30,045	387	37,456	227	53,028	121,143
1997	89,403	2,362	61,254	63	-	153,082	32,097	-	32,175	212	49,747	114,231
1998	-	-	-	-	-	0	39,443	575	-	222	45,994	86,234
1999	91,219	3,049	-	47	-	94,315	34,220	681	-	156	50,295	85,352
2000	-	-	-	-	-	0	36,321	12,633	34,713	163	48,010	131,840
2001	87,757	2,283	65,007	23	-	155,070	37,988	11,948	42,442	106	55,484	147,968
2002	89,936	2,340	65,816	9	-	158,101	40,235	12,806	54,019	74	57,201	164,335
2003	92,838	1,698	69,841	10	-	164,387	41,170	14,379	56,093	65	48,539	160,246
2004	90,859	2,210	68,768	5	-	161,842	54,177	15,804	52,147	61	50,867	173,056
2005	88,665	2,533	67,654	10	-	158,862	60,427	12,889	55,344	55	48,124	176,839
2006	90,034	2,301	67,573	47	-	159,955	65,582	12,181	62,629	70	36,873	177,335
2007	-	-	-	-	-	0	64,327	11,083	64,993	77	38,418	178,898
2008	-	-	-	-	-	0	-	-	-	-	-	0
2009	-	-	-	-	-	0	-	-	-	-	-	0
TOTAL	1,404,572	48,000	1,577,474	2,308	1,187	3,033,541	929,523	212,781	1,135,547	2,493	1,224,954	3,505,298

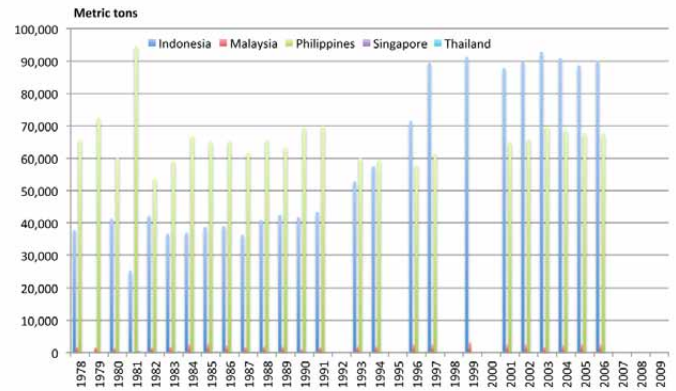

Fig. 17. Production Graph: Pony Fish

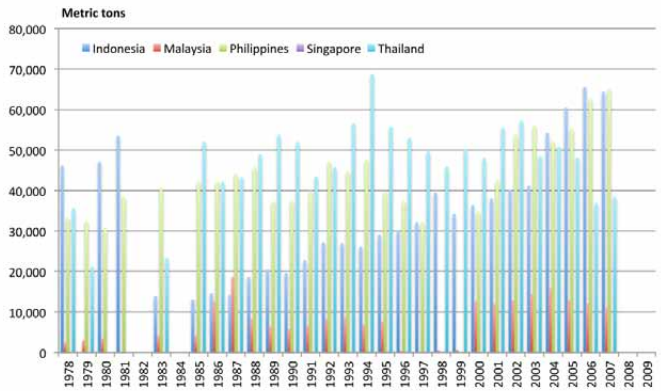

Fig. 18. Production Graph: Jack, Cavalla, Trevally

Box 1l. Production data sheet (in metric tons): Drums and Croakers						
Year	Drums and Croakers					
	Ind	Mal.	Phi.	Sin.	Tha.	TOTAL
1978	25,960	9,534	8,820	384	15,241	59,939
1979	-	8,891	5,828	438	11,036	26,193
1980	26,747	7,636	5,953	337	11,206	51,879
1981	-	-	78,248	-	-	78,248
1982	-	-	-	-	-	0
1983	-	-	-	-	-	0
1984	-	-	-	-	-	0
1985	-	-	-	-	-	0
1986	-	-	-	-	-	0
1987	-	-	-	-	-	0
1988	-	-	-	-	-	0
1989	-	-	-	-	-	0
1990	-	-	-	-	-	0
1991	-	-	-	-	-	0
1992	-	-	-	-	-	0
1993	36,360	17,314	7,795	280	20,533	82,282
1994	37,400	17,773	9,602	162	19,329	84,266
1995	-	-	-	-	-	0
1996	-	-	-	-	-	0
1997	-	-	-	-	-	0
1998	50,114	22,480	-	160	33,646	106,400
1999	56,991	22,188	-	114	36,591	115,884
2000	52,254	23,439	4,170	68	39,946	119,877
2001	49,647	28,762	4,898	45	44,932	128,284
2002	60,161	22,337	5,060	56	51,664	139,278
2003	55,896	23,242	5,844	37	48,262	133,281
2004	-	-	-	-	-	0
2005	60,177	23,911	4,249	40	49,717	138,094
2006	-	-	-	-	-	0
2007	-	-	-	-	-	0
2008	-	-	-	-	-	0
2009	-	-	-	-	-	0
TOTAL	511,707	227,507	140,467	2,121	382,103	1,263,905

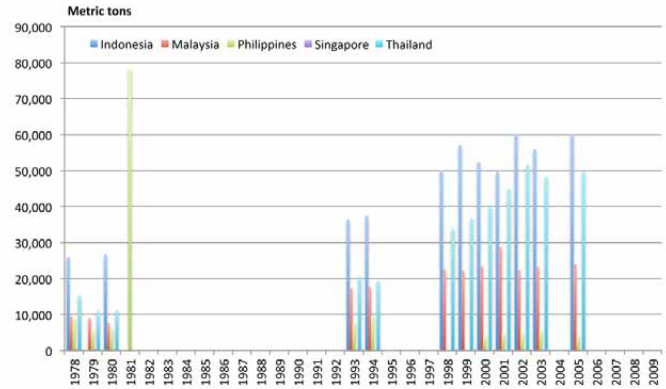

Fig. 19. Production Graph: Drum and Croakers

Based on **Table 4**, the levels of exploitation of the major groups of commodities could be determined as shown in **Box 2**, which could also be used as indicators to put into effect fisheries management measures. Since the statistical data in the Fishery Statistical Bulletin from 1976 to 2007 were collected using the same format without classifying the catch by species but instead by major groups of species, while there were no information on the fishing areas, it is quite difficult to specify the real situation of a single fish stock. This analysis could therefore be referred to as provisional detailed analysis of important fish stocks in each country of the Southeast Asian region.

The application of the potential yield method and the Froese and Kesner-Reyes Model are simple techniques for analyzing exploitation levels given poor catch data that are available. Nonetheless, attempts to develop the methodology for analyzing exploitation levels based on limited information and poor statistics have recently been introduced by the International Council for the Exploration of the Sea (ICES) of Denmark and the National Oceanic and Atmospheric Administration (NOAA) of the U.S.A.

Furthermore, Productivity and Susceptibility Assessment (PSA) is also one of the methods which can be applied to relatively poor data and is considered the best approach for determining the vulnerability of data-deficient stocks. PSA could be used to evaluate an array of productivity and susceptibility attributes for a stock, from which index scores for productivity and susceptibility could computed and displayed graphically.

The PSA has several characteristics such as: number of attribute scores could be expanded to consider direct and indirect impacts; attribute scores could be aligned with life history characteristics of fish species in tropical waters; attribute weighing system could be used to customize the analysis for a particular fishery; and data quality index and protocol for addressing stocks exploited by different sectors of a fishery could be established. After the introduction of this method by FAO in 2009, many scientists in Southeast Asia conducted trials to evaluate the status of several economically-important species. The results of such evaluation of each single species and each type of fishery by the SEAFDEC Member Countries as well as the regional evaluation using data from SEAFDEC Statistical Bulletin will help in unraveling the enigma for creating measures towards sustainable fisheries management in the region.

Another method which is also commonly used is the so-called depletion-corrected average catch (DCAC), an

Table 4. Exploitation levels based on fishery catch (C) relative to maximum catch (C_{max}), catch relative to MSY, and biomass B relative to B_{MSY} (relationship between C/MSY and B/B_{MSY} is derived from Equation 1)

Status of the fisheries	Year	C/C_{max}	C/MSY	B/B_{MSY}
Undeveloped/no information	Before C ≥ 0.5 C_{max}	<0.1	<0.2	
Developing		0.1-0.5	0.2-0.75	>1.5
Fully exploited	At/after C ≥ 0.5 C_{max}	>0.5	>0.75	≥0.5
Overexploited		0.1-0.5	0.2-0.75	<0.5
Collapsed		<0.1	<0.2	<0.1
Rebuilding	Years between collapsed and subsequent first fully exploited			
Final year rules: Developing Rebuilding	If C_{max} occurs in the final year, increase C_{max} by 50% and set its year of occurrence as final year plus one In the final year, accept C> 0.28 C/C_{max} as indicative of subsequent fully exploited status			

Source: *Adapted from the Model developed by Froese and Kesner-Reyes (2002)*

Box 2. Levels of exploitation of economically-important commodities in the Southeast Asian region

Commodities	Level of Exploitation	Remarks
Trash fish		
Malaysia, Philippines, Thailand	Over-exploited	The data set on trash fish shows that about 10-20% of the total catch make it to the top-rank in the major species group. Major portions of trash fish come from trawlers and some small purse seiners. However, some trash fishes are actually juveniles of commercially-important species, indicating that the capacity of such fishing boats and gears should be properly managed.
Miscellaneous fishes		
Cambodia, Vietnam, Myanmar	No indication	Miscellaneous fishes comprise about one-third of the total catch of Cambodia, Vietnam and Myanmar, but no conclusion could be arrived at because of the inadequate number of skilled officers capable of separating and identifying the fish species.
Indonesia, Malaysia, Philippines, Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Sardines		
Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Indonesia, Malaysia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Round scads		
Thailand, Indonesia, Malaysia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Anchovies		
Indonesia, Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Malaysia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Indian mackerel		
Indonesia, Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Malaysia, Philippines	Fully exploited/ harvested	Production of concerned countries could be already equal to the maximum sustainable yield.
Penaeid shrimps		
Thailand	Collapsed	Disruption of the biological mechanisms that sustain life-cycle closure of intra-population contingents, already occurred.
Indonesia, Malaysia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Non-penaeid shrimps		
Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Indonesia, Malaysia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Eastern little tuna		
Indonesia, Malaysia, Philippines, Thailand	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.

Box 2. Levels of exploitation of economically-important commodities in the Southeast Asian region (Cont'd)		
Commodities	**Level of Exploitation**	**Remarks**
Squids		
Thailand, Indonesia, Philippines, Malaysia	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Indo-Pacific Mackerel		
Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Indonesia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Selar scad		
Indonesia, Philippines, Malaysia, Thailand	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Skipjack Tuna		
Indonesia, Philippines	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Threadfin Breams		
Thailand, Indonesia	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Philippines, Malaysia	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Pony Fish		
Philippines, Indonesia, Malaysia	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Jacks, Cavalla, Trevally		
Thailand	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Philippines, Indonesia, Malaysia	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.
Drum and Croakers		
Philippines	Over-exploited	Production of concerned countries had been very high which could be beyond the long-term maximum potential yield.
Indonesia, Thailand, Malaysia	Fully exploited	Production of concerned countries could be already equal to the maximum sustainable yield.

extension of the potential-yield formula that could provide useful estimates of sustainable yields for data-deficient fisheries. Over an extended period (*e.g.* a decade or more), the catch is divided into sustainable yield component and unsustainable "windfall" component associated with a one-time reduction in stock biomass. The DCAC is calculated as the sum of catches divided by the sum of the number of years in the catch series and the windfall ratio is:

$$\frac{W}{Y_{pot}} = \frac{1}{M}$$

where Y_{pot} = potential yield; W = windfall harvest; and M = natural mortality rate. DCAC can be calculated as a point estimate using the most likely values of the input quantities, but this practice is not recommended unless it is meant for a quick approximation. However, a Monte Carlo exploration of the DCAC estimates could be conducted as it could provide useful information on precision and bias, including estimation of approximate confidence intervals, which are often lacking for data-deficient methods. Finally, sustainable yield can be calculated using:

$$Y_{sus} = \frac{\sum C}{n+\frac{1}{M}}$$

where Y_{sus} = sustainable yield; and M = natural mortality rate. This is one of the methods used when dealing primarily with a function of catch and is easily applied to catch data of each species which some of the countries in the region have already collected under its national statistics collection systems.

Conclusion

Fishery statistics is a tool used to facilitate development planning and management of fisheries. Fishery statistical items and data set collected by the Southeast Asian countries may differ, taking into account their respective priority needs, objectives and requirements. The use of

fishery statistics is not only for national purposes but also for regional and international actions where comparable and analysis of fisheries status and trends could be deduced and used for planning and management in a broader scope. Compilation of the region's fishery statistics has been regularly conducted by SEAFDEC over the past thirty years, initially in the form of the "Fishery Statistical Bulletin for the South China Sea Area" which later became the "Fishery Statistical Bulletin of Southeast Asia" taking into account the escalating situation in fisheries practices in the region and the new geo-political set-up of the ASEAN. This scenario has called for the need to improve the existing framework of the regional fishery statistics and usage of the Bulletin, and led to changes in the Fishery Statistical Bulletin in terms of the coverage area to cover only the Southeast Asian countries starting in 2008, as well as the data items and procedure that needed to be harmonized with those of the FAO.

Nevertheless, cognizant of the need for regional statistics, the Southeast Asian countries are still confronted with inadequate capacity to fill the gap in their respective statistical systems. The minimum requirements as the inputs for the Bulletin can only include some indicators which the Member Countries could use mainly for establishing the status and trends while scientific research on status of the stocks would need more information and statistics which may take time and effort to develop. Although it can be said that analysis of the status and trends has initially provided basis of a precautionary approach for planning, development and management of fisheries in the Southeast Asian countries, it has also facilitated cooperation for the sustainable development and management of fisheries in the region.

References

Froese, R. and K. Kesner-Reyes. 2002. Impact of fishing on the abundance of marine species. ICES Census of Marine Life Program, ICES CM (2002)/L: 12; 15 p

Gaertner, D., A. Fonteneaue and F. Laloe. 2000. Approximate estimation of the Maximum Sustainable Yield from catch data without detailed effort information: Application to tuna fisheries. Aquatic Living Resources 14 (2001); pp 1-9

Garcia S., P. Sparre, J. Csirke. 1989. Estimating Surplus Production and Maximum Sustainable Yield from Biomass Data when Catch and Effort Time Series are not Available. Fisheries Research, 8; pp 13-23

Jacquet J., D. Centre, D. Pauly. 2010, Counting fish: A typology for fisheries catch data. Journal of Integrative Environmental Sciences, Vol. 7, No. 2; pp 135-144

Lymer, D., S. Funge-Smith and W. Miao. 2010. Status and Potential of Fisheries and Aquaculture in Asia and the Pacific 2010. RAP Publication 2010/17 FAO Regional Office for Asia and Pacific, Bangkok, Thailand; 100 p

Patrick W.S., and P. Spencer. 2009. Use of Productivity and Susceptibility Indices to Determine Stock Vulnerability. NOAA Technical Memorandum NMFS-F/SPO-101; 90 p

Pornpatimakorn S. 2012. Approaches for the Sustainable Development and Management of Fisheries in Southeast Asian Region. *In:* Fish for the People, Vol. 10 No. 2 (2012), Southeast Asian Fisheries Development Center, Bangkok, Thailand. pp 2-12

SEAFDEC. 1979-2000. Fishery Statistical Bulletin for the South China Sea Area 1977-2007. Southeast Asian Fisheries Development Center, Bangkok, Thailand

SEAFDEC. 2008-2009. Fishery Statistical Bulletin of Southeast Asia 2008-2009. Southeast Asian Fisheries Development Center, Bangkok, Thailand

SEAFDEC. 2010. Fishery Statistical Bulletin of Southeast Asia 2010. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 135 p

SEAFDEC. 2011. ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 23 p

SEAFDEC. 2012. The Southeast Asian State of Fisheries and Aquaculture 2012. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 130 p

Yanagawa H. and P. Wongsanga. 1993. Review of Fishery Production, Provisional Estimation of Potential Yield and Situation of Fisheries in Southeast Asian Region 1976-1989. TD/SP/18 Training Department of the Southeast Asian Fisheries Development Center; 114 p

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