Asia Pacific Fishery Commission

A review and synthesis of capture fisheries data in Thailand

Large versus small-scale fisheries

In collaboration with

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A REVIEW AND SYNTHESIS OF CAPTURE FISHERIES DATA IN THAILAND

LARGE VERSUS SMALL-SCALE FISHERIES

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FOREWORD

Fisheries play a significant role in Thailand in terms of sustaining food security and contributing to the local and national economies. The consumption of fish in Thailand (per person) is double that of the world average, highlighting the general preference for fish as a source of protein in Thailand. During the period 2001 to 2003, Thailand was the second largest global exporter of fishery commodities (in terms of value), highlighting the importance of this sector in the Thai economy.

This report examines the current status of production and participation in large-scale and small-scale fisheries in Thailand. It also looks at both the marine and inland capture fisheries of the country and capture fisheries out of Thai waters by Thai fishing boats.

The main conclusion of this report is that inland capture fisheries are considered to be underestimated by a factor of at least five, suggesting considerable undervaluation of this resource. Furthermore, a large proportion of Thailand's reported marine capture production comes from outside the country's exclusive economic zone (EEZ) and is estimated at around 41 percent. The main fishing grounds for this production are within the EEZ of Indonesia and Myanmar. Inland capture fisheries are possibly overlooked in terms of food security and probably make a larger contribution to food security than the marine capture fisheries, especially as a significant proportion of the latter is targeted at the production of fish feed and animal feed.

He Changchui
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THAILAND'S CAPTURE FISHERIES

Fisheries play a very important role in food security in the Kingdom of Thailand as a food and income supplier and in the Thai economy as a provider of valuable export products. The average per capita consumption of fish in Thailand during the period 2000 to 2003 was 30.85 kg/year (Table 1). This is significantly higher than the world average of 16.3 kg/year (Table 1) and reflects the importance of fish in food security, as well as the general preference for fish as a source of protein in Thailand.

Table 1 Fish and seafood consumption per capita per year (kilogram)[1]

Area	Year			
	2000	2001	2002	2003
Thailand	30.6	31.3	30.9	30.6
East & Southeast Asia	25.3	26.7	26.3	26.0
World	16.2	16.5	16.3	16.1

Fisheries are also important in the local and national economies and in the country's international trade and the development of fisheries in Thailand has been heavily influenced by the global market. This is reflected in the rapid development of trawl fisheries in the 1970s, targeting shrimp for export and also in the relatively fast development of purse seine fisheries in the early 1980s, targeting pelagic species. As a result, during the period 2001 to 2003, Thailand was the second largest global exporter of fishery commodities.

There are two main fisheries sectors in Thailand, namely the capture fishery sector and the fish culture sector. For capture fisheries, the fishing gears employed both in marine and inland fisheries are many and varied, with the type of gear employed largely determined by the size of the fisheries being exploited, i.e. small-scale fisheries (SSF) and large-scale (commercial) fisheries (LSF). This report presents a detailed picture of the current status of SSF and LSF production of Thailand, as well as of participation in the country's marine and inland capture fisheries.

[1] FAO, *FAOStat Data – Food Supply* (3 March 2006 [cited 29 May 2006]); available from: http://faostat.fao.org

INLAND FISHERIES

Inland capture fisheries are an important sector of many local economies in Thailand and are considered to be important in sustaining the livelihoods of many rural communities. They are also important sources of domestic fish consumption. The importance of the inland fisheries sector has been highlighted in many reports and its significance in providing food security and generating local income is frequently highlighted.[2] The present official statistics report a contribution of inland fisheries production to domestic fish supply of around 200 000 tonnes per year, which is less than 10 percent of total fisheries production (from 1994 to 2005). The most recent national census in the agricultural sector throughout the country (2003) showed a high participation rate of Thai people in inland fisheries activities, with the main purpose of these fishing activities being for household consumption.

Inland capture fisheries production in Thailand is carried out nationwide and in a traditional way. As in many other countries in the region, it is difficult to collect data for statistical records when large numbers of people participate in traditional fishing activities. Hence, the inland capture fisheries production reported has not been reliable and does not reflect the true status of this sector. It is believed that the figures for inland fisheries, especially production figures, are underestimated and thus undervalued.

Even though the figures for production and value in this sector are not high, it is still an important sector for local economies. The proportion of the population participating in this sector, and the various habitats they can access for freshwater fisheries resources in each region of the country are presented in Table 2. The results show that an average of 14 percent of the households in Thailand conducts inland fisheries activities. The major system of inland fisheries habitats is shown in Table 3. There are four major types of inland fisheries habitats. This detailed habitat information is also linked to the detailed fishing habitat information of an agricultural census.

[2] Coates (2002); Pawaputanon Na Mahasarakarm (2007); Blake and Pitakthepsombat (2006); Hortle and Suntornratana (2008).

Information on the inland capture fisheries sector in Thailand is usually presented in normal statistical formats and has been since the foundation of DoF. Even though there are many research surveys and studies, both published and ongoing, on inland fisheries in Thailand, most of them deal with specific locations and hence can be of only limited use in supporting a national fisheries statistics system and in obtaining a clear picture of the inland sector as a whole. The collection and compilation of inland capture fisheries statistics in Thailand started about 40 years ago and these activities may now be considered routine activities of DoF.

Table 2 Population, economic contribution of inland captures fisheries and habitats important for inland capture fisheries production

Region	Population	Households and percentage of fishing households	GPP inland capture fisheries (US$/year)	Major freshwater resources
Central (including Bangkok)	20 689 566 (2005)	7 413 300 (3.2%)	32 350 842 (2005)	The Central region occupies most of the area of the Chao Phraya Basin. Almost all of the mountainous part of northern Thailand is drained to the Chao Phraya river through the Ping, Wang, Yom and Nan rivers. The low-lying floodplain and delta of the Chao Phraya river in the Central Plain generate a huge amount of freshwater fish. Apart from the Chao Phraya river and its large lowland floodplain and delta area, large dams and reservoirs, including natural swamps in the Central Plain, are other important freshwater fisheries utilized by the rural people in this region.
North	11 883 517 (2005)	3 768 261 (17.9%)	86 064 311 (2005)	The four river basins of Ping, Wang, Yom and Nan in the north, the Salaween river basin in the northwest and the Mekong river in the northeast are all important river systems with abundant fish. Large dams, reservoirs and human-made waterbodies in all provinces generate fish production.
Northeast	19 953 411 (2005)	5 036 322 (31.8%)	154 356 259 (2005)	The Mekong main stream along the border between Thailand and Lao PDR and large tributaries of the Mekong are other important resources. Many of the Mekong tributaries are dammed and many weirs are found along the river and streams for fishing purposes.
South	8 516 860 (2005)	2 484 891 (14.5%)	52 120 955 (2005)	Fisheries resources are more limited on peninsular Thailand. Important inland fisheries habitats are small river basins and large freshwater lakes and a few large dams.
Total	**61 043 354**	**18 702 774 (14.5%)**		

Table 3 The major systems of inland fisheries habitats in Thailand included in the analysis

Environment	Detailed information related to habitat and fisheries	Area (ha)	Source
Rivers and streams	• River length includes perennial and seasonal flow of main rivers and streams. • There are a total of 25 major river basins in Thailand (Figure 1). • These river systems are important for inland fisheries production.	More than 56 137 km.	GIS database ESRI, Thailand
Inundated plains	• An inundated plain contains an area of riparian vegetation which is important for migratory species as it is a crucial habitat for spawning, nursing and also performs as a dry season refuge. • This habitat is important for fisheries production, especially in the rainy season. • Production in the floodplain area is found during the rainy season when the velocity in the main channel is very strong. The floodplain area generates high fisheries production.	No details.	
Swamps, marshes, lakes, reservoirs	• Considered to be good habitats for stock enhancement. • Sizes range from 0.01 to more than 1 000 ha.	28 956 3 198 342 826.5	• Virapat *et al.* (2000) • GIS database ESRI, Thailand • Database of water bodies from FITC (2005) which specific to reservoir and public pond
Wet rice inundated paddy fields	• Important habitat for many species that are highly tolerant/adapted to low oxygen and static water conditions. • Flooding of two to three months can provide a good environment for fishes to mature.	Estimated at 3 100 000 ha.	Virapat *et al.* (2000)

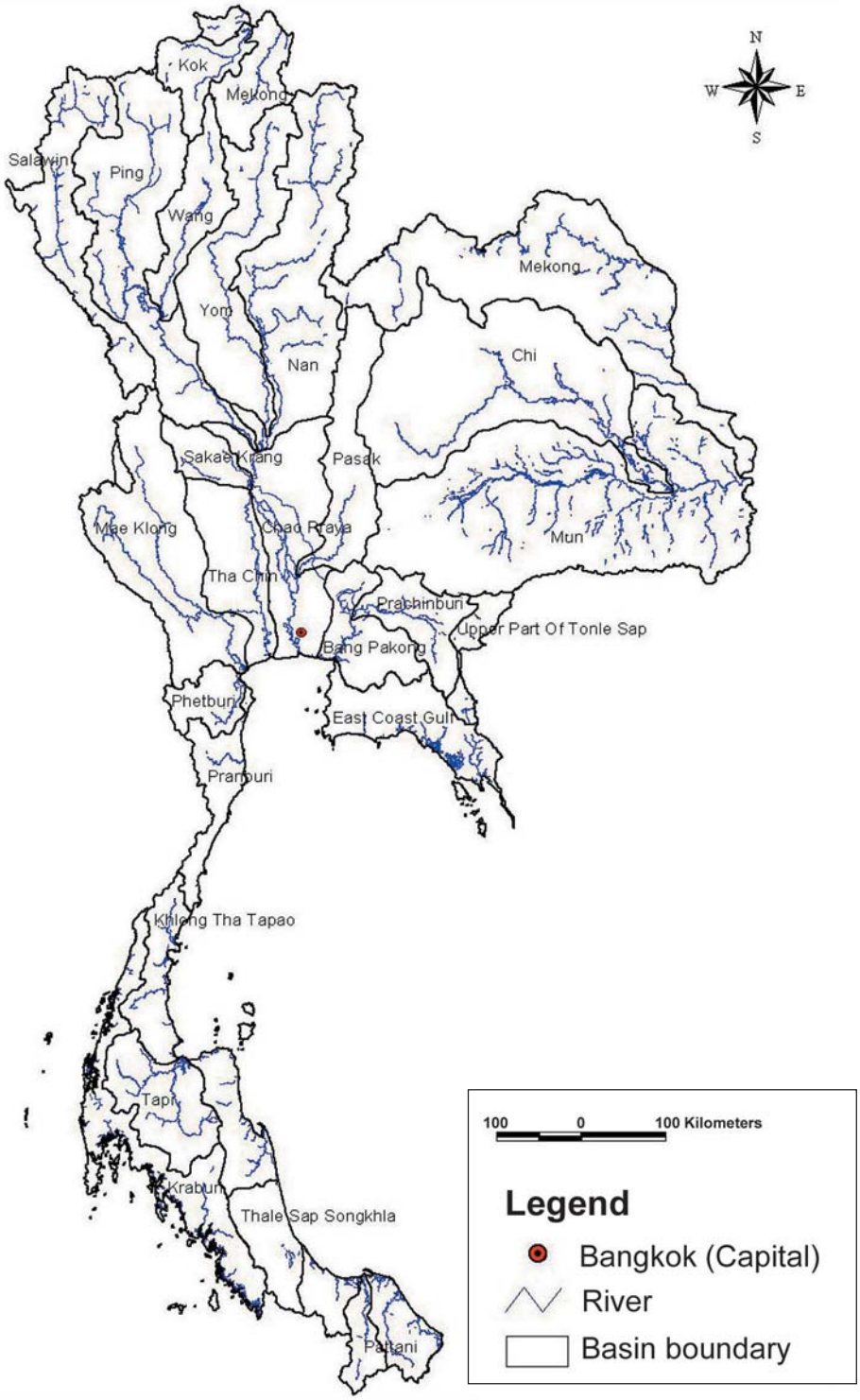


Figure 1 Map of 25 major river basins in Thailand

NATIONAL FISHERIES STATISTICS

There are two major categories of inland fisheries statistics: capture fisheries statistics and aquaculture production statistics. For each of these categories, yield and value are collected on a yearly basis and are used to indicate the status and trend in the fisheries sector at the national level.

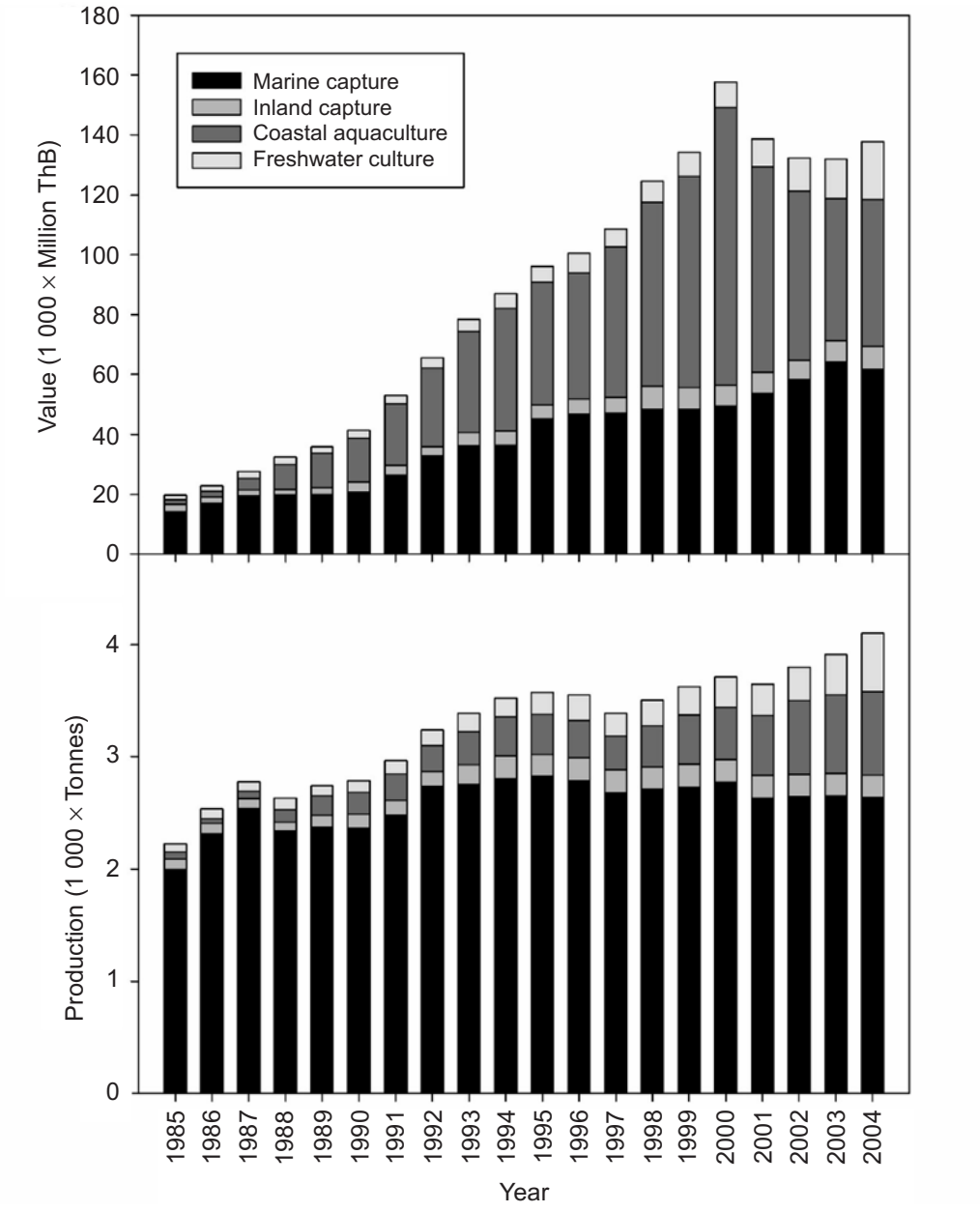


Figure 2 Fisheries production by sector, 1985 to 2004[3]

The reported total inland fisheries production (capture and aquaculture) is between 700 000 and 800 000 tonnes, of which 200 000 tonnes[4] are capture fisheries production. However, over the years it has been stated many times that the official figures for the inland freshwater sector probably underestimate the true figure. One reason for this could be the way in which the data are produced, i.e. data are collected

[3] DoF (2006a).
[4] DoF (2007).

mainly from major landing sites in large reservoirs. Furthermore, these data do not cover all the reservoirs in Thailand. The inland fisheries production data in Thailand has always been of doubtful reliability, but progress in resolving this issue has been slow.

The process of collecting fisheries statistics has been improved gradually over the years and there has been considerable support allocated to all the provincial fisheries offices to help in the collection of data for national statistics purposes, but it is still not clear if this process has improved reporting.

In Thailand, the rate of utilization of freshwater fish is high, as almost all kinds of fish are eaten. The freshwater fish base ensures food security for the steadily expanding population, especially the low-income rural communities and urban poor (Menasveta, 2000). Inland capture fisheries in Thailand are considered mostly to be SSF and, as stated above, contribute approximately 200 000 tonnes per year (Figure 2), which was valued at about 7 436 million baht in 2004 (Table 4, Figure 2). Although the share from inland fisheries is not high (comparing official inland capture fisheries production to official marine capture fisheries production), it is considered the most accessible and inexpensive source of protein for the majority of Thais (Pawaputanon, 2003).

Table 4 Total inland capture fisheries (1 000 tonnes) in Thailand from 1981 to 2005[5]

Year	Total production	Capture (1 000 tonnes)		% Inland production	Value (million baht)		Average value/kg of inland fishes
		Marine	Inland		Marine	Inland	
1981	1 989.0	1 756.9	116.5	8.3	no data	no data	no data
1982	2 120.1	1 949.7	87.7	6.3	no data	no data	no data
1983	2 255.4	2 055.2	108.4	6.9	no data	no data	no data
1984	2 134.8	1 911.5	114.4	7.7	no data	no data	no data
1985	2 225.2	1 997.2	92.2	7.5	no data	no data	no data
1986	2 536.3	2 309.5	98.4	7.4	16 976.3	2 069.9	21.0
1987	2 779.1	2 540.0	87.4	6.4	19 357.1	2 113.1	24.2
1988	2 629.7	2 337.2	81.5	7.0	19 823.0	1 784.7	21.9
1989	2 740.0	2 370.5	109.1	7.3	19 935.3	2 228.2	20.4
1990	2 786.4	2 362.2	127.2	8.3	20 738.4	3 301.7	26.0
1991	2 967.7	2 478.6	136	8.7	26 403.7	3 290.8	24.2
1992	3 239.8	2 736.4	132	8.5	32 833.0	2 998.8	22.7
1993	3 385.1	2 752.5	175.4	10.0	36 224.1	4 489.5	25.6
1994	3 523.2	2 804.4	202.6	10.6	36 337.2	4 805.6	23.7
1995	3 572.6	2 827.4	191.7	10.9	45 183.2	4 601.1	24.0
1996	3 549.2	2 786.1	208.4	12.3	46 815.3	4 995.4	24.0
1997	3 384.4	2 679.5	205	12.0	47 134.2	5 154.2	25.1
1998	3 505.9	2 709.0	202.3	12.2	48 380.8	7 687.5	38.0
1999	3 625.9	2 725.2	206.9	12.7	48 444.8	7 221.3	34.9
2000	3 713.2	2 773.7	201.5	12.7	49 401.8	7 024.8	34.9
2001	3 648.4	2 631.7	202.5	13.2	53 718.5	7 049.4	34.8
2002	3 797.0	2 643.7	198.7	13.0	58 374.5	6 290.3	31.7
2003	3 914.0	2 651.2	198.4	14.3	64 169.5	7 069.9	35.6
2004	4 099.6	2 635.9	203.7	17.7	61 800.5	7 436.2	36.5
2005	4 118.5	2 615.6	198.8	17.9	63 222.7	7 852.8	39.5

[5] Fishery Information Technology Centre, DoF, Thailand 2007.

Inland capture fishing activities in Thailand are carried out in natural and human-made freshwater bodies of various types, from rivers and their tributaries to reservoirs and fishponds. Fish caught from inland habitats are multispecies and vary in abundance depending on the productive status of the water bodies (Pawaputanon, 2003). The main fishing gears are fish trap, gill net, long line, hand line, cast net, harpoon and landing net. Silver barb, Nile tilapia, striped snake-head fish, Jullien's mud carp, walking catfish and common climbing perch generally are the dominant species in various freshwater bodies (Appendix 1 and Figure 3). The production and value of inland capture fisheries, particularly obtained from natural reservoirs, which are the main freshwater bodies, have been increasing (Appendix 2). Freshwater fish contributed more than 99 percent of total production, whereas most of the remainder, only 0.29 percent, consisted of shrimps (Figure 4).

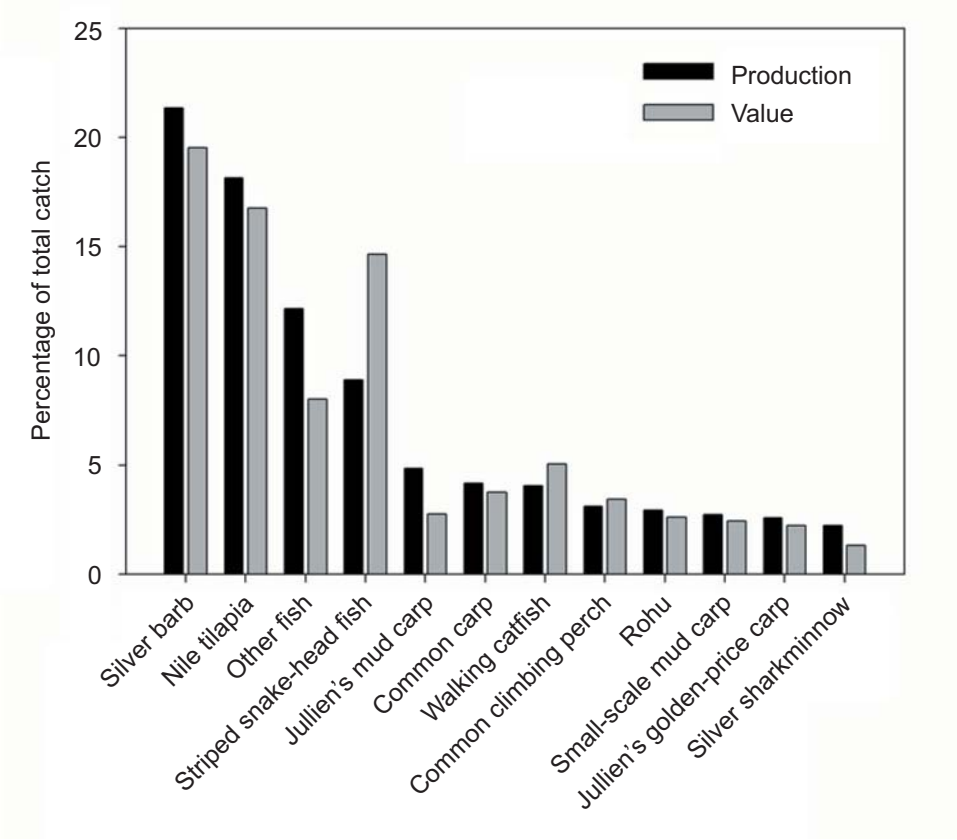


Figure 3 Production and value of 12 important species of inland capture fisheries obtained from natural reservoirs, freshwater landing places and pond traps, 2003[6]

In 2003 approximately 3.13 million fishers participated in fishing in inland capture fisheries. Most of them (60.49 percent) are located in the northeast of Thailand. The rest are in the northern (25.34 percent), central (9.15 percent) and southern (5.02 percent) parts of Thailand (Fishery Information Technology Center (FITC), 2007, personal communication). The fishers generally go fishing for periods of four to seven days per week. Approximately 2.72 million fisher households participated in fishing in inland capture fisheries. Of these households, 96.22 percent fished for food consumption, whereas the remainder (3.78 percent) fished for trade. There are no systematic records of the total number of fishing boats employed in inland capture fisheries. This is mainly because most of the fishing boats are small-scale and are not obliged to register. There are only occasional surveys of the number of fishing boats operating in some natural reservoirs. For instance, it was found that 300 fishing boats operated in Beung Boraped area (Nakhon Sawan Inland Fisheries Research and Development Center, 2007). There are also constraints in producing information on other key aspects of inland fisheries. The main constraints are lack of up-to-date basic data, lack of accuracy of the data collection, lack of knowledge of scientific data collection methodologies, as well as the data being scattered over a wide area (Pawaputanon, 2003).

[6] DoF (2005a), (2005b), (2005c).

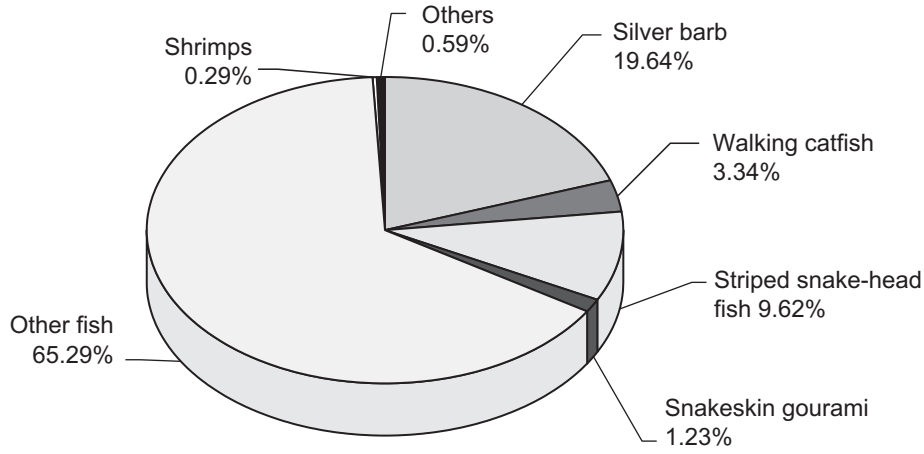


Figure 4 Composition of inland capture fisheries by species 2004

REVIEWED GROSS PROVINCIAL PRODUCT (GPP) SURVEY IN THE FISHERIES SECTOR

Gross domestic product (GDP) and gross provincial product (GPP) are used as national indicators of socio-economic status. According to the Office of the National Economic and Social Development Board (ONESDB), the objectives of using GDP and GPP are to determine the overall socio-economic status of Thailand and to indicate the trend and direction of economic growth.[7] Relevant government agencies are requested to provide detailed information on value added of various products at province level to help determine the province's socio-economic status.

Fish production contributed about 1.4 percent of the total GDP in 2003 (note that this figure is based on production estimates that are possibly underestimated). As fish production is one of many sectors to be combined for determining the status and trend of the national economy, the Fisheries Information Technology Center (FITC) of the DoF, Thailand has produced survey guidelines for carrying out the GPP survey since 2003. These guidelines have been distributed to all provinces that are to conduct surveys to gather data for GPP estimation. These guidelines provided details of survey techniques including forms for data collection, which have been categorized into marine and inland production. Furthermore, types of fisheries activities in each category are also divided into capture fisheries and aquaculture.

Fish production data are collected from sampled households by using statistical sampling techniques and interview forms to gather information on household production, fishing activities, fishing frequency, income and expenditure. There are five habitat types categorized under the agricultural census survey. These five habitat types are considered to be the most important habitats for freshwater fisheries production and fishing grounds for the rural people. Local communities normally have free access to these habitats for fisheries purposes. Hence, these habitats generate significant amounts of production.

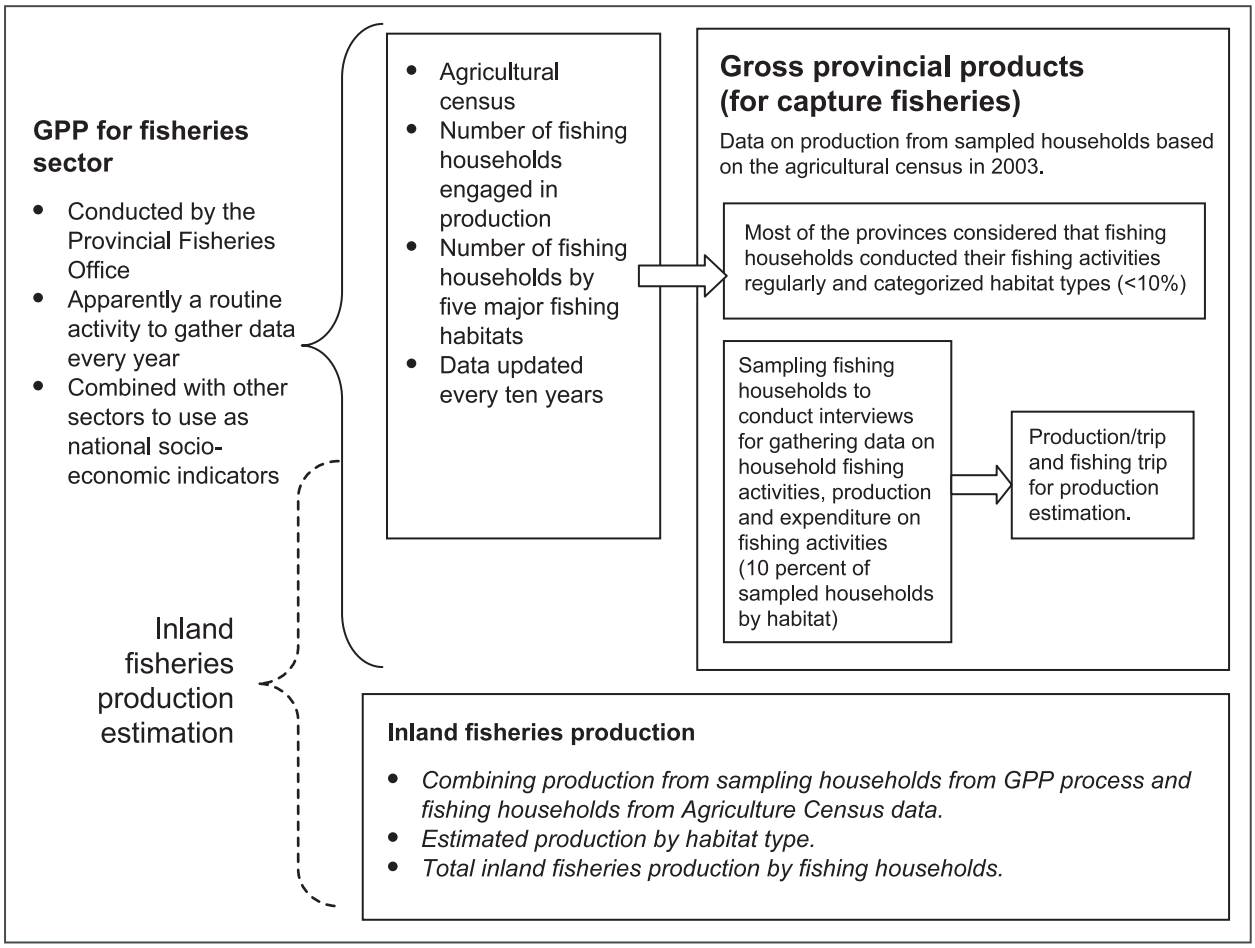
For the GPP survey, data on the value of inland capture fisheries are estimated for five different habitat types: river, pond trap, reservoir, natural swamp and community pond. Thereafter, the total production from all types of habitat is combined to present the total quantity of production with the value derived from the capture fisheries sector.

[7] ONESDB (2005).

FRAMEWORK FOR PREPARATION OF A NATIONAL SYNTHESIS ON INLAND CAPTURE FISHING IN THAILAND

The overall framework used for the estimation of inland capture fisheries production considered the production yield of fishing households rather than the production of professional fishers (Box 1). Fishing household could be commercial-scale, large-scale or medium-scale fishing households as well as a vast number of small-scale fishing households. The large and medium-scale fishing households are a group that uses large gear and conducts fishing to extract the resources for trade whereas the small-scale fishing households utilize the inland fisheries resources mainly for their own consumption.

Box 1 The overall framework for estimating inland capture fisheries production



In order to get detailed data on fishing households and participation in fisheries for the assessment of production, agricultural census data that provided information on fishing households at the village level were linked with the household production data from the GPP survey. Then the data from the different sources were combined and analyzed to quantify the total freshwater production yield of the fishing households.

A database was developed which effectively merged the data sets required for assessing inland capture fisheries. The data sets included in the database are: the agricultural census, the sample of fishing households under the GPP survey, census and GIS data on water bodies. These data sets were stored together and shared the same spatial references and were further linked to provincial political boundaries. In addition, data on household production and the household participation in the fisheries sector were matched with the GIS database for further spatial analysis. Using GIS gives considerable power in analyzing large data sets and the database also enabled overlay and mapping analysis. Hence, detailed

information on production status and trends of inland capture fisheries in Thailand could be more accurately presented and estimated and should therefore be more useful for fisheries resources management and policy.

DATA SETS USED IN THE ESTIMATION

In order to estimate the inland fisheries production, two major parts of official statistics and data sets were used to extrapolate inland capture fisheries production.

1. **Agricultural census** is a national official set of statistics that is collected every ten years by the National Statistical Office (NSO). The last updated survey was conducted in 2003. This survey included a few questions on inland fisheries as one economic agricultural activity. The agricultural census aimed at establishing the current status of the agricultural structure in Thailand. Statistics were collected from both capture and culture systems. The survey was conducted throughout the country at community level using the "Closed Segment Concept"[8], which considers data collection in those provinces where agricultural activities are carried out. In addition, this census data is now used as the database for surveying socio-economic conditions at provincial level.
2. **Gross provincial product (GPP)** is compiled from economic and social indicators at provincial level. This information requires routine surveys in each province. Data collection to determine valuation is carried out by various government agencies in order to cover the value of all types of product for both agricultural and non-agricultural sectors. The ONESDB provides budget and technical support to all agencies. The collection of data on the fisheries sector is under the responsibility of the Provincial Fisheries Office. Data collected cover various categories of marine and inland fisheries for both capture and aquaculture systems. It is worth noting that the process to collect data on capture fisheries sector is similar to the routine survey for annual inland capture fisheries production of DoF. The detailed process of the GPP data collection is shown in Box 1.
3. **GIS Database** is a geo-database used to support a mapping system. The database provided by the DoF is shared among various organizations. For this study, data on water bodies, watershed boundary and political boundary were extracted from the GIS database.
4. **Water bodies** are stored in a database from the DoF providing detailed names of the water bodies, their location, area and their status in terms of fisheries production. However, this data did not cover large dams and reservoirs.

INLAND CAPTURE FISHERIES PRODUCTION ESTIMATION

Before carrying out the "trial" estimate of inland capture fisheries production two main aspects were considered. First, data and information should be routinely collected to determine the status and trend of the fisheries sector. Second, the data should cover small-scale fishing households, which are always overlooked. Small-scale fishing households represent a large group of people in the rural area that utilize fisheries production for their own consumption and there is no useful statistical report of production from this sector. Therefore, the study aimed to cover all major groups of people who participate in the fisheries sector and to present more reliable information on inland fisheries production.

Besides strengthening inland capture fisheries information, the study also aimed to provide comments that could help to improve the process of fisheries data collection In addition, the information obtained

[8] "The idea of the closed segment is to account in a rigorous manner for all of the land, livestock, etc., within the boundaries of the segment at the time of the interview regardless of what farm, or part of a farm, may be involved. Thus, the basic unit for enumeration becomes a "tract" which is a farm or part of a farm within a sample segment." (Houseman and Becker, 1967, p. 19).

can help clarify the status and trend in the inland capture fisheries sector and ultimately help to determine two main indicators, namely, a) the participation in the fisheries sector (number of people); and b) the socio-economic value of this sector.

PARTICIPATION IN INLAND FISHERIES SECTOR

Data derived from the agricultural census in 2003 showed that about 13.9 percent of the total households, or 2.5 million households throughout Thailand, conducted fishing activities in various inland fisheries habitats (Figure 5). The highest participation in inland fishing activities is in the North and Northeast regions where people depend more on freshwater fisheries resources to meet their dietary needs. Figure 6 presents the number of fishing households at district level in Thailand.

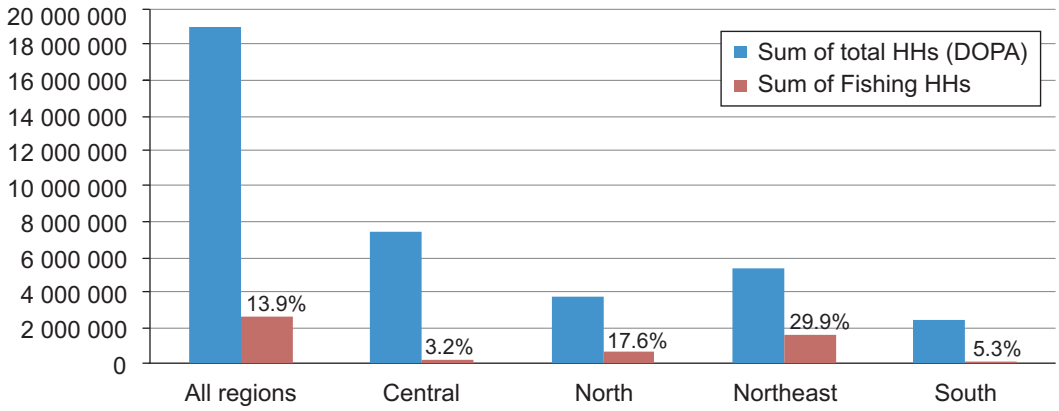


Figure 5 Total households and fishing households in Thailand and by region

SAMPLING OF FISHING HOUSEHOLDS

The trial study sampled fishing households that had been interviewed under the GPP survey of the inland capture fisheries sector. The sampled households had been asked to report the amount of household production, expenditure and income from fishing activities by habitat type. This survey was carried out throughout the country to estimate inland fisheries production and the value of this sector. Data from the GPP household survey of 2005 was used. After being checked, cleaned and stored in the database, a total of 2 215 households were available for analysis and used for production estimation and mapping.

DISTRIBUTION OF HOUSEHOLD PRODUCTION

The distribution of household production is shown in Figures 6 and 7. Household production by region varied widely among the small-scale and middle-scale to commercial-scale fishing households. Of the total 2 215 households, 77.1 percent reported production less than 300 kilograms (Figure 7). It could be assumed that one-third of the sampled fishing households' production is less than 25 kg/month.

Inland capture fisheries are very important to the livelihoods of the Thai people. Most of the households in the low-production group utilized their production mainly for household consumption, whereas the production from middle-scale to commercial-scale fishing was mainly for sale (Figure 8).

As in other studies/surveys in the fisheries sector, household production distribution from the GPP survey is skewed to the right. Mean production of the total 2 215 households is 401.6 $\pm$ 1 090.5 kg/year where half of the total sampled households (median of production distribution) reported their production less than 120 kg/year and 75 percent of the total sampled households reported their production less than 281 kg/year (Figure 9).

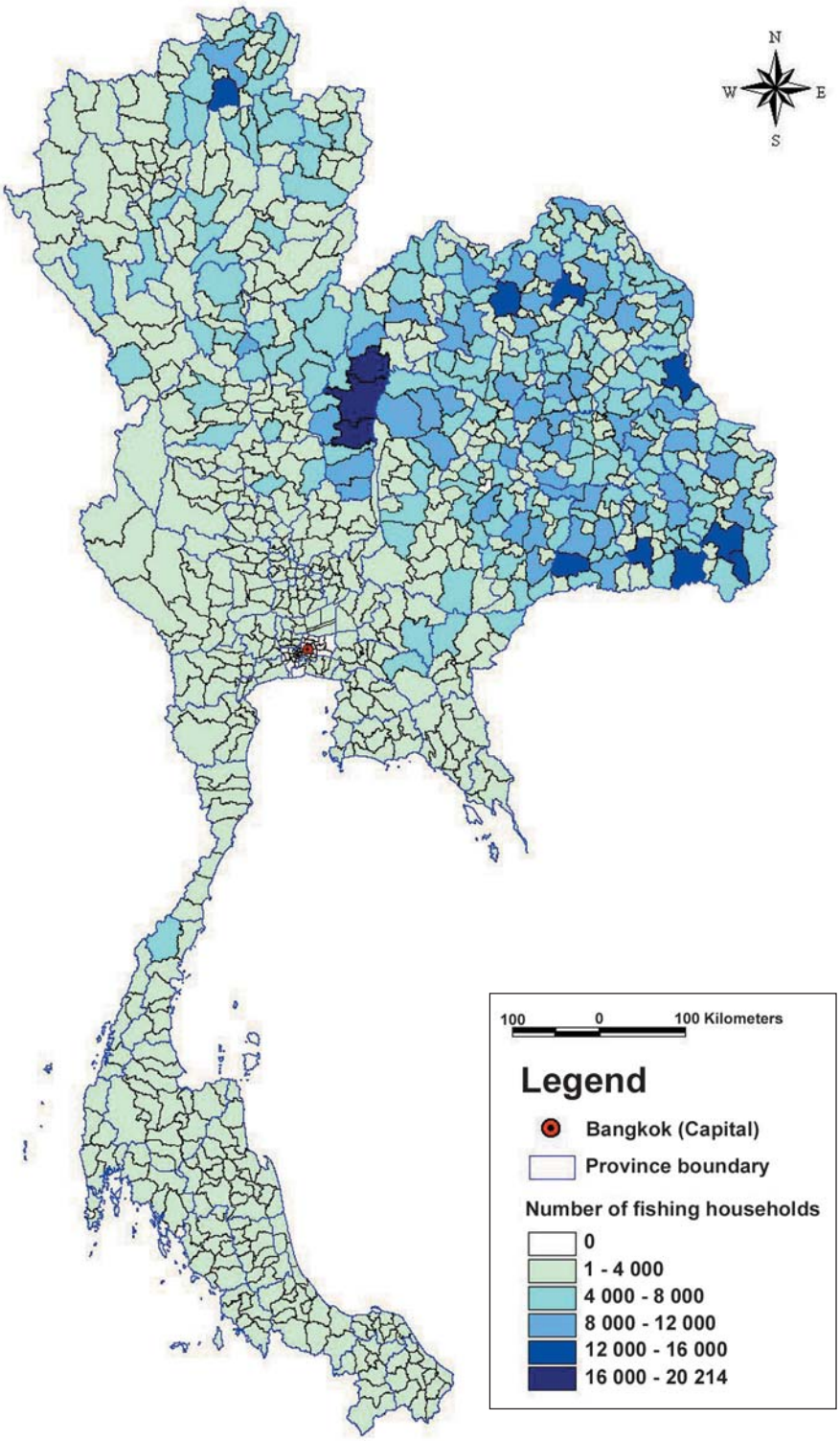


Figure 6 Distribution of fishing household in Thailand

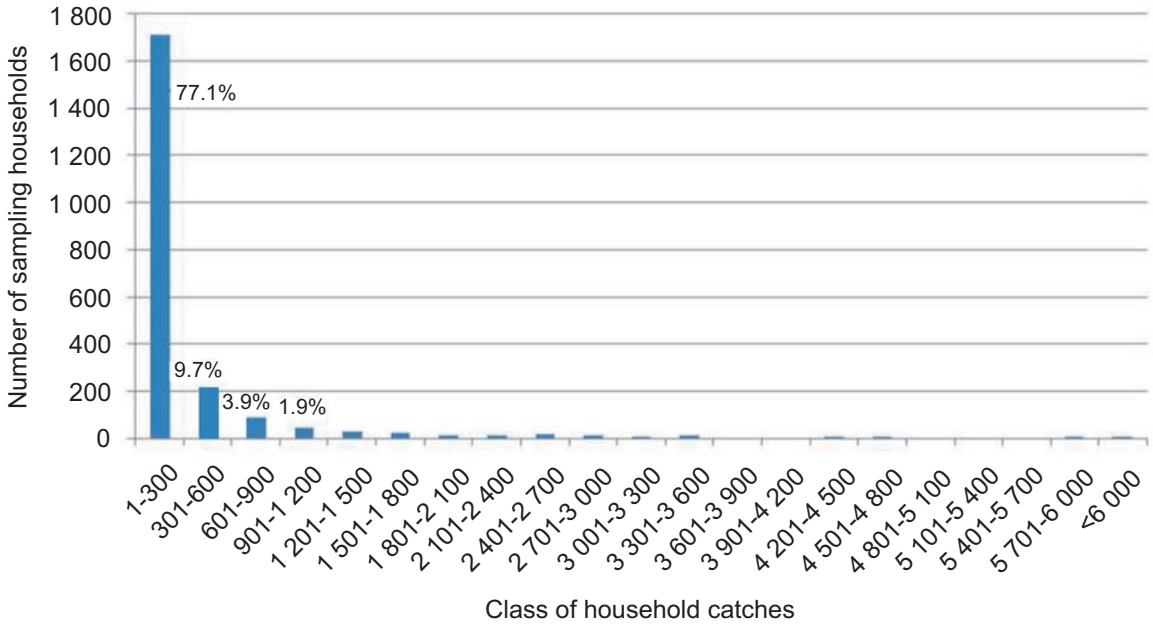
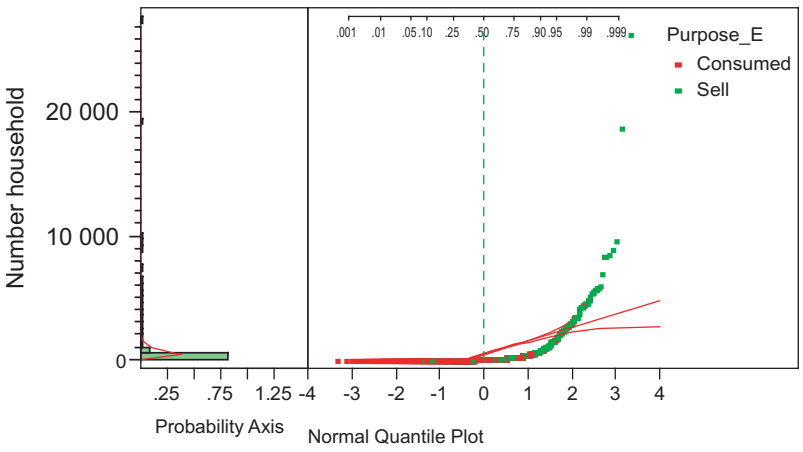


Figure 7 Distribution of household production of total 2 215 sample fishing households



Quantiles

100.0%	maximum	26 500
90.0%		828
75.0%	quartile	281
50.0%	median	120
25.0%	quartile	50
0.0%	minimum	2

Moments

Mean	401.6
Std Dev.	1 090.5
Std Err Mean	23.2
upper 95% Mean	447.1
lower 95% Mean	356.2
Skewness	10.8
Kurtosis	196.8
CV	271.5
N	2 215

Fitted Exponential

Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Scale	Theta	401.6939	384.9655	418.4224

Figure 8 Distribution of production of sampled households

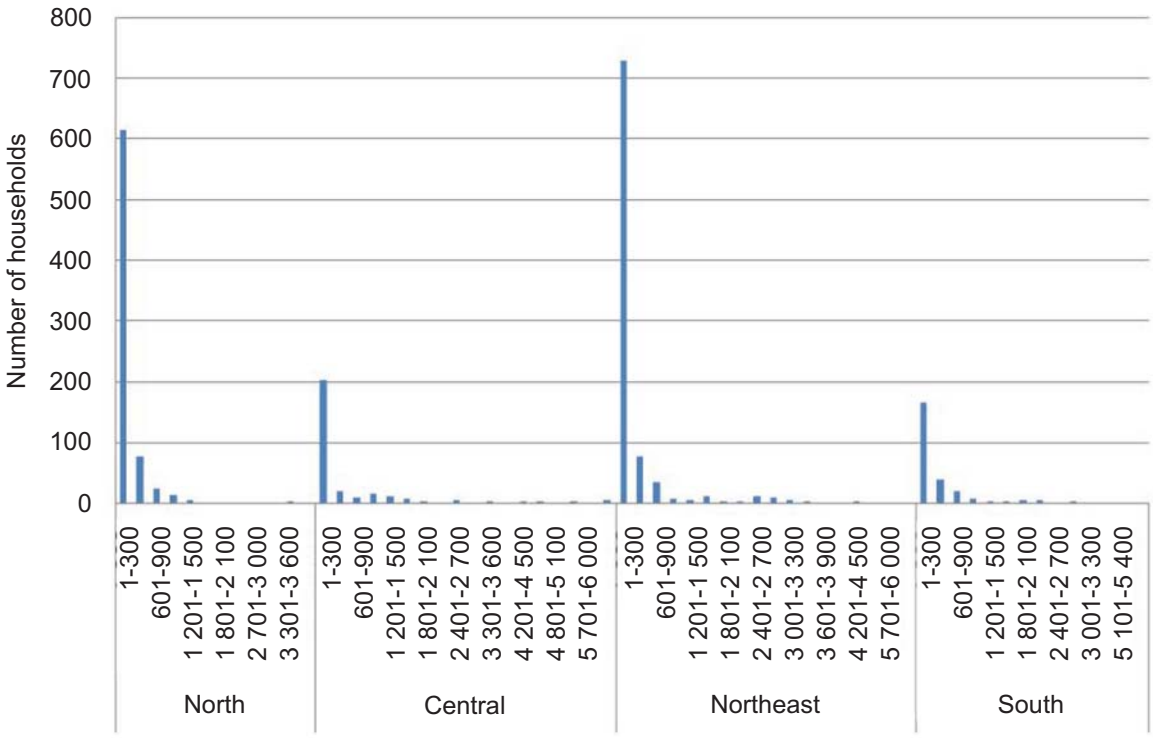
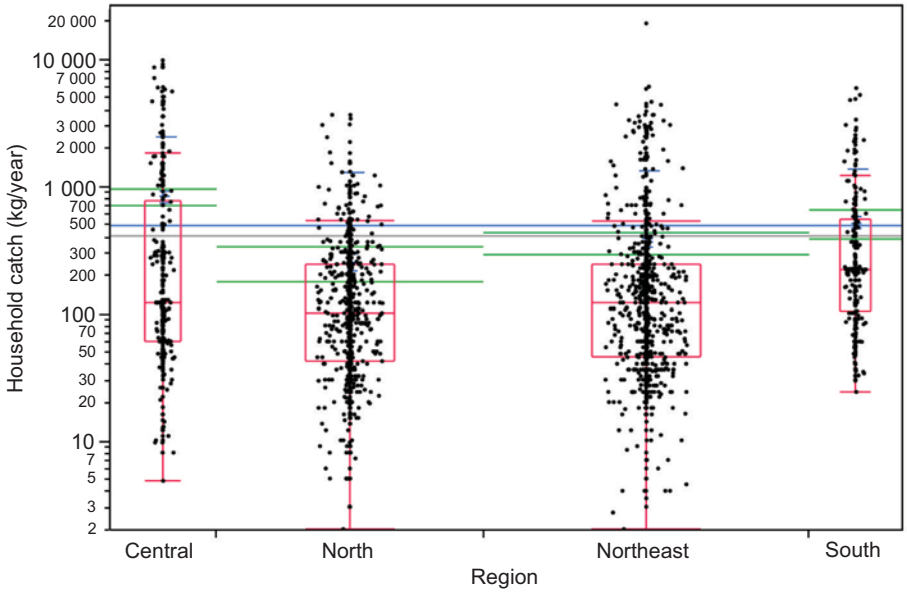


Figure 9 Distribution of household production by region



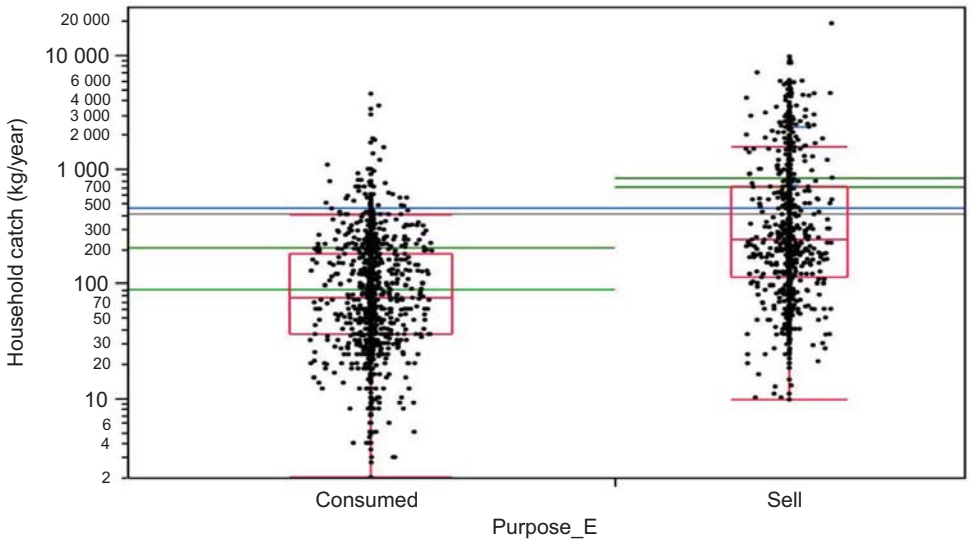
Quantiles							
Level	**Minimum**	**10%**	**25%**	**Median**	**75%**	**90%**	**Maximum**
Central	4.8	33.44	60	120	758.55	2 480	9 672
North	2	22.24	42	100	240	497	26 500
Northeast	2	25	45.4	120	240	700	18 900
South	24	56.12	103.575	218	542.5	1 309.9	5 850

Means and Std Deviations						
Level	**Number**	**Mean**	**Std Dev.**	**Std Err Mean**	**Lower 95%**	**Upper 95%**
Central	301	817.091	1 625.05	93.666	632.76	1 001.4
North	745	252.353	1 032.86	37.841	178.07	326.6
Northeast	911	355.601	935.80	31.004	294.75	416.4
South	258	511.056	828.60	51.586	409.47	612.6

Figure 10 Distribution of production of sampled households divided into four regions

The average household production is different in the four regions (Figure 10). Interestingly, the mean production is highest in the central and southern regions where there were a smaller number of sampled households.

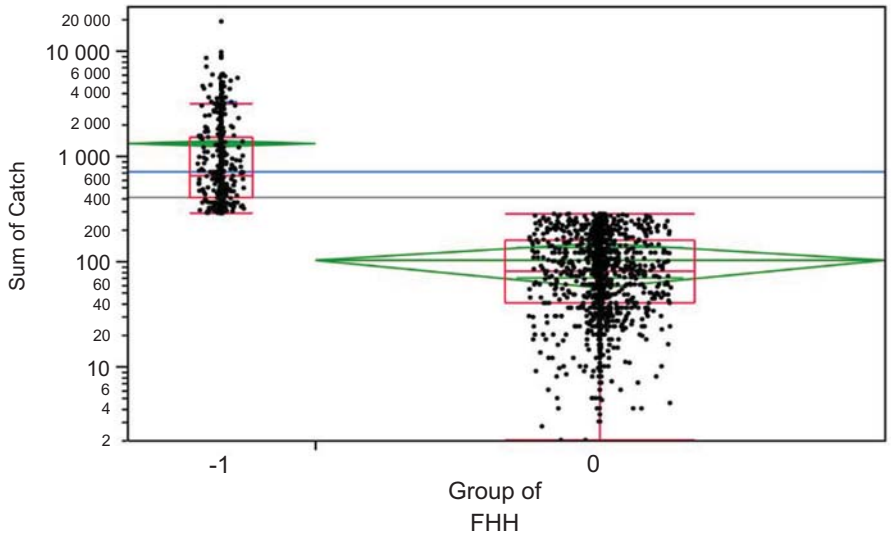
A comparison of the small-scale fishing households and the group of fishing households using larger gear or conducting fishing activities for commercial purpose reveals that the total production of the small-scale fishing households is lower (Figure 11).



Means and Std Deviations

Level	Number	Mean	Std Dev.	Std Err Mean	Lower 95%	Upper 95%
Consumed	1 291	145.470	265.29	7.383	130.99	159.96
Sell	924	759.686	1 591.86	52.368	656.91	862.46

Figure 11 Distribution of production of sampled households based on the utilization of production



Means and Std Deviations

Level	Number	Mean	Std Dev.	Std Err Mean	Lower 95%	Upper 95%
-1 (M/CFHHs)	552	1 305.62	1 916.14	81.556	1 202.5	1 420.9
0 (SSFHHs)	1 663	101.65	73.88	1.812	96.9	106.7

Figure 12 Distribution of production of sampled households divided into two groups based on amount of fish caught

Following the distribution analysis on household production, 75 percent of the sampled households' production was less than 281 kg/year. Therefore, the fishing households are separated into two groups based on production reported, i.e. households reporting a production over 281 kg/year (large catch households (LCH)) and households reporting a production less than 281 kg/year (small catch households (SCH)). All production amounts from each sampled household are summed even if they came from different fishing habitats. The mean production of the SCH is 101.6 kg/year and for the LCH the mean production is 1 305.6 kg/year (Figure 12). These mean productions are then used to calculate the total production by multiplying with the total number of households in small-scale fishing households (SSFHH) and medium-scale to commercial-scale fishing households (M/CSFHH) (Table 5).

Table 5 Average, median household production of all sampled households and average household production of small-scale and middle-scale to large-scale fishing households and inland fisheries production estimation (tonnes)

Item	Population	Estimated production from "median" production (tonnes)	Estimated production from "mean" production (tonnes)	Estimated production from "mean" of 75% SSFHHs (tonnes)	Estimated production from "mean" of 25% M/CSFHHs (tonnes)
Agricultural census					
Total fishing HHs			**2 639 582**	**1 979 687**	**659 896**
Central	7 413 300	234 171	234 171		
North	3 768 261	672 742	672 742		
Northeast	5 350 322	1 600 873	1 600 873		
South	2 484 891	131 796	131 796		
Purpose: for consumption	*18 702 774*	2 540 771 (96%)	2 540 771 (96%)		
GPP survey					
Total sampled HHs		**2 215**	**2 215**	**1 663**	**552**
Purpose: for consumption		1 297 (58%)	1 291 (58%)	1 133 (68%)	164 (30%)
Purpose: for sale		924 (42%)	924 (42%)	533 (32%)	391 (70%)
Average production (kg/year)		418.2	401.6	101.6	1 305.6
Std Dev.		1 088.9	1 088.9	73.9	1 916.1
Median		120			
Upper 95% mean			418.4	106.7	1 420.9
Lower 95% mean			385.0	96.9	1 202.5
% production			100.0	24.99	75.01
Estimated production					
Two groups of SSFHH and M/CSFHH (tonnes)				201 136	861.560
Total production from capture (tonnes)		316 749	**1 060 056**		1 062 696

AN ESTIMATION OF INLAND CAPTURE FISHERIES PRODUCTION

As stated, the estimation of the total production yield for Thailand is based on two data sets from two different surveys: the agricultural census and the GPP survey of inland capture fisheries. Table 5 summarizes the number of fishing households from the agricultural census and the results of the descriptive analysis of production of 2 215 sampled fishing households including the trial analysis of production. Two methods are used to estimate the total production: (1) estimation of production yield based on all sampled fishing households; and (2) estimation of production yield by separating fishing households into two groups of small-scale (SSFHHs) and medium-scale to commercial-scale fishing household (M/CSFHH).

Mean production derived from a descriptive analysis of the two methods is then multiplied by the number of fishing households from the agricultural census. Results from the two methods are summarized below.

Estimated production based on all sampled fishing households:

- The total number of fishing households in Thailand engaged in fishing in all type of habitat is estimated to be 2 639 582 households.
- The sampled fishing households surveyed under the GPP Survey and included in the trial analysis included a total of 2 215 fishing households and their production came from five major habitats of natural swamp and ponds, river and stream, reservoir, irrigation canal and pond trap accounting for 53, 29, 17, 1 and 0.004 percent of total production, respectively.
- The arithmetic mean of the annual production per household is 401.6 kg, with a 95 percent confidence interval of 385.0 to 418.4 kg.
- The total number of fishing households derived from the agricultural census in 2005 is 2 639 582 households.
- The total production from the GPP survey conducted in 2005 in four regions (which included all provinces) is estimated to be 2 639 582 *401.6 = 1 060 056 tonnes/year.
- Estimated inland fisheries production yield from various habitat types is approximately 1 060 056 tonnes/year, with a 95 percent confidence interval of 1 016 239 to 1 104 401 tonnes/year.

Estimated production based on two separate groups of small-scale and medium-scale to commercial-scale sampling fishing households:

- The total number of households in the two groups of SSFHHs and M/CSFHHs provided the arithmetic mean of annual production per households of 101.6 and 1 305.6 kg with a 95 percent confidence interval of 96.9 to106.7 kg and 1 202.5 to1 420.9 kg.
- Assuming 75 percent of total fishing households from agricultural census, this gives 1 979 687 households engaged in small-scale fishing and the remaining 659 896 or 25 percent of households conducted fishing for sale or falling into the M/CSFHHs group.
- The total production of SSFHHs or low-fish production group from the GPP survey is estimated to be 1 979 686 * 101.6 = 201 136 tonnes/year whereas the total production from the M/CSFHHs or high-fish production group is estimated to be 659 896 *1 305.6 = 861.560 tonnes/year.
- Estimated inland fisheries production yield from two groups of SSFHHs and M/CSFHHs is approximately 1 062 696 tonnes/year, with a 95 percent confidence interval of 939 828 to 1 140 878 tonnes/year.

The use of production data estimated from fishing households multiplied by the total number of fishing households could be a proper approach for estimating capture fisheries production. Range of fisheries production yield from various habitats including river and stream, reservoir, canal, natural swamp and

man-made fish pond, etc. could be estimated to produce about 901 974 to 1 158 592 tonnes per year. This is a little higher than the production estimated in the previous study by Coates (2002) which was from five major habitats types and stated to be 472 314 to 1 118 909 tonnes per year and other estimates (Table 6).

Table 6 Reported and estimated production from inland capture fisheries

Sources of reported production	Officially reported annual production (tonnes)	Factor increase from reported to estimated production	Basis of the indicative figures
(a) National total (1999) Primarily reservoirs	226 510	0.54-1.4	The Thai figures apply mainly to reservoirs, which are confirmed by reference to estimates made by Virapat *et al*. (2000) of 122 314 to 318 909 (reservoirs only)
(b) National total (2005) All inland areas	198 800	–	Available but localized survey data for Thailand and comparisons with similar areas. These figures include the full range of estimated production for reservoirs and between 350 000 and 800 000 tonnes (Coates, 2002) or fisheries outside reservoirs including capture production from rice-fields and brackishwater inland fisheries (currently reported as coastal production).

POTENTIAL SOURCES OF ERROR IN THE GPP PROCESS

In the GPP survey, information on household production, expenditures and income earned from capture fisheries is collected by means of interviewing a sample of households selected using a statistical sampling technique. The whole process of sampling fishing households and conducting the survey is carried out by the Provincial Fisheries Office. Since some of the provincial fisheries officers do not have basic knowledge of statistical processes, this might cause sampling errors. Preferably, random samples of households should be selected throughout the country by FITC and thereafter the provincial offices should conduct the field surveys.

Besides sampling errors, the ability of households to recall the actual production figure could be another possible source of error. The usual method of collecting fishing statistics is to conduct an interview with the household head and to ask him/her to recall monthly production and the fishing effort spent. It has been demonstrated in scientific surveys that the ability to accurately recall information decays within 48 hours (Coates, 2002). This problem is more prominent in the small-scale production fishing households since the respondents probably get only a small production per day and do not conduct fishing activities throughout the year.

MARINE FISHERIES

Since 1945, marine capture fisheries have developed significantly and have expanded rapidly in many developing states of the South China Sea region, including Thailand. This development is mainly because of the following factors:

- the introduction of modern technologies and techniques for fishing such as the widely used monofilament nylon gill net in the SSF and the trawl net in the LSF subsector;
- the increased motorization of fisheries boats;
- technical assistance rendered by donors and multilateral agencies such as FAO;
- inflow of capital investment for the required infrastructure;
- the discovery of new fishing grounds in offshore waters; and
- the recognition of the fisheries contributions by governments and their common policy of strengthening the fisheries sector (Menasveta, 1994).

Marine capture fisheries has been the main subsector of capture fisheries in Thailand for the past two decades (Figure 1). Its proportion in total fisheries production has decreased though because coastal aquaculture production has increased, and both of the capture fisheries subsectors have not been growing (Figure 1). In 2004, the marine production from the Gulf of Thailand (GoT) contributed 68.5 percent of the total marine production, whereas the Andaman Sea accounted for the remaining 31.5 percent (DoF, 2006a).

Marine capture fisheries can be characterized as SSF and LSF. The definition of SSF and LSF used in this context is as same definition being used by the National Statistical Office and DoF, Thailand. The fishing boats, which are non-powered, outboard powered and inboard powered boats less than 10 gross tonnage (GT), as well as the fishing gears generally operating inshore, are considered as SSF. Also, coastal fishing operations without boats are included in SSF. The fishing boats of more than 10 GT and the fishing operations conducted offshore are LSF.

REPORTED DATA

Types of fishing gear used by small-scale and large-scale fishers can be seen in Table 7. The reported productions of marine capture fisheries by type of fishing gear are summarized in Figure 13 (DoF, 2006f). Otter board trawl contributed the highest production about 1.38 million metric tonnes or about 52.2 percent of total production, which is about 2.64 million tonnes. Among SSF, collecting shellfish contributed the highest production, followed by various types of gill nets. However, there have been some unreported productions obtained from marine capture fisheries, particularly from SSF that are not usually registered and therefore do not appear in official statistics. Species composition of marine capture fisheries production is summarized in Table 9 and Figure 14. In LSF, pelagic fish is the dominant production (34 percent), followed by trash fish (31 percent) and demersal fish (19 percent). The important groups of species are anchovy, Indo-Pacific mackerel, big-eye sardines, threadfin beam, round scads and small tunas (Figure 15). For SSF, shellfish is the dominant production (24 percent), followed by pelagic fish (19 percent), crabs (19 percent) and squids (13 percent). The important species are short necked clams, blue swimming crabs and Indo-Pacific mackerels (Figure 17).

Table 7 Gear-based division between large-scale and small-scale fisheries

Large-scale fisheries (LSF)	Small-scale fisheries (SSF)
1. Otter board trawl	1. Mackerel gill net
2. Pair trawl	2. Pomfret gill net
3. Beam trawl	3. Mullet gill net
4. Purse seine	4. Shrimp trammel net
5. Anchovy purse seine	5. Crab gill net
6. King mackerel drifting gill net	6. Squid trammel net
7. Mackerel encircling gill net	7. Other gill nets
8. Push net	8. Squid falling net
9. Deep water set net	9. Other cast nets
	10. Hand push net
	11. Long line
	12. Hand line and pole & line
	13. Set bag net
	14. Fish trap
	15. Crab trap
	16. Squid trap
	17. Shallow water set net
	18. Other stationary gears

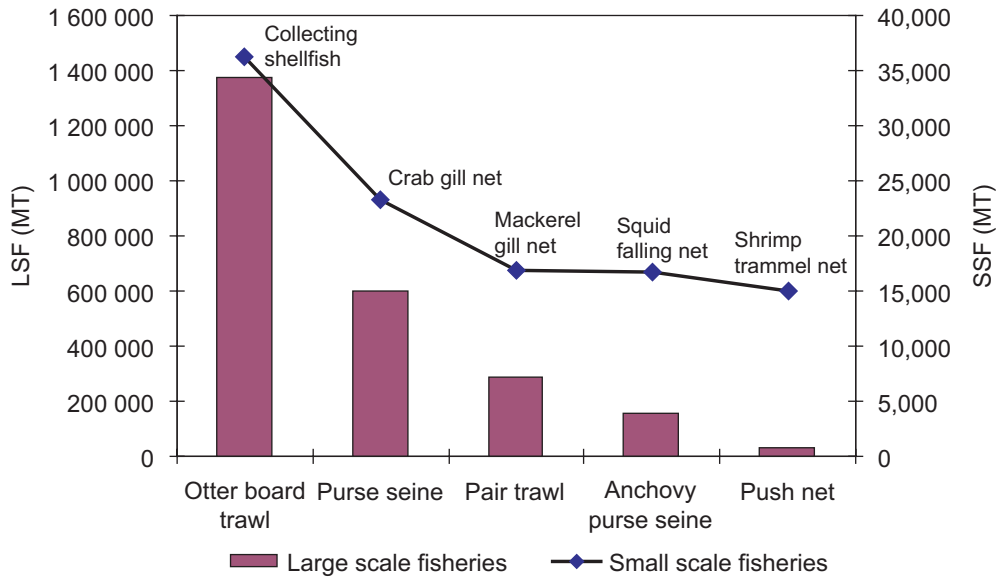


Figure 13 Production of top five fishing gears of marine capture fisheries by subsector, 2004[9]

[9] DoF (2006f).

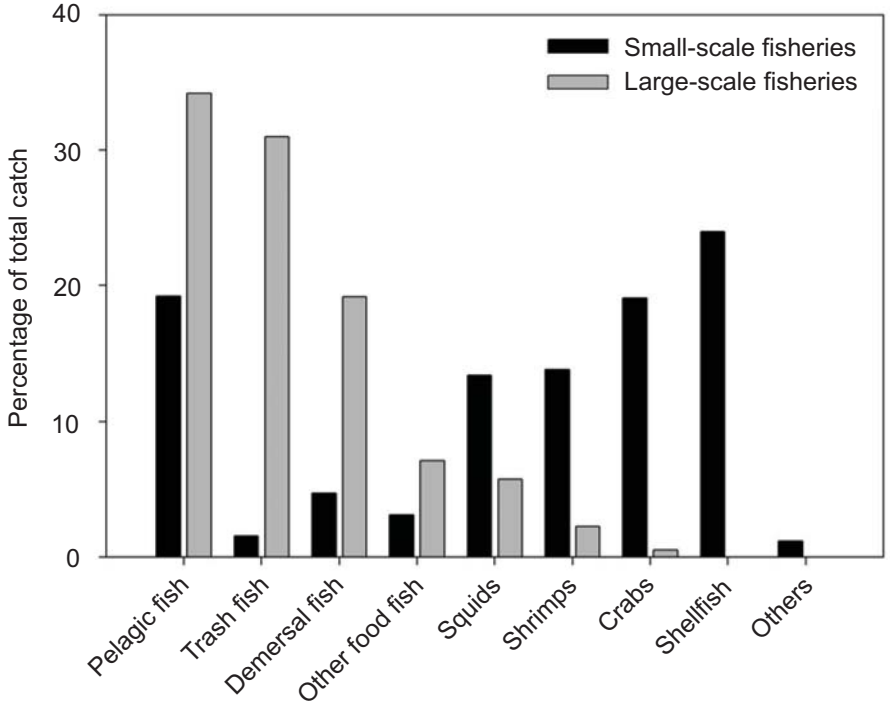


Figure 14 Composition of marine capture production by subsector, 2004[10]

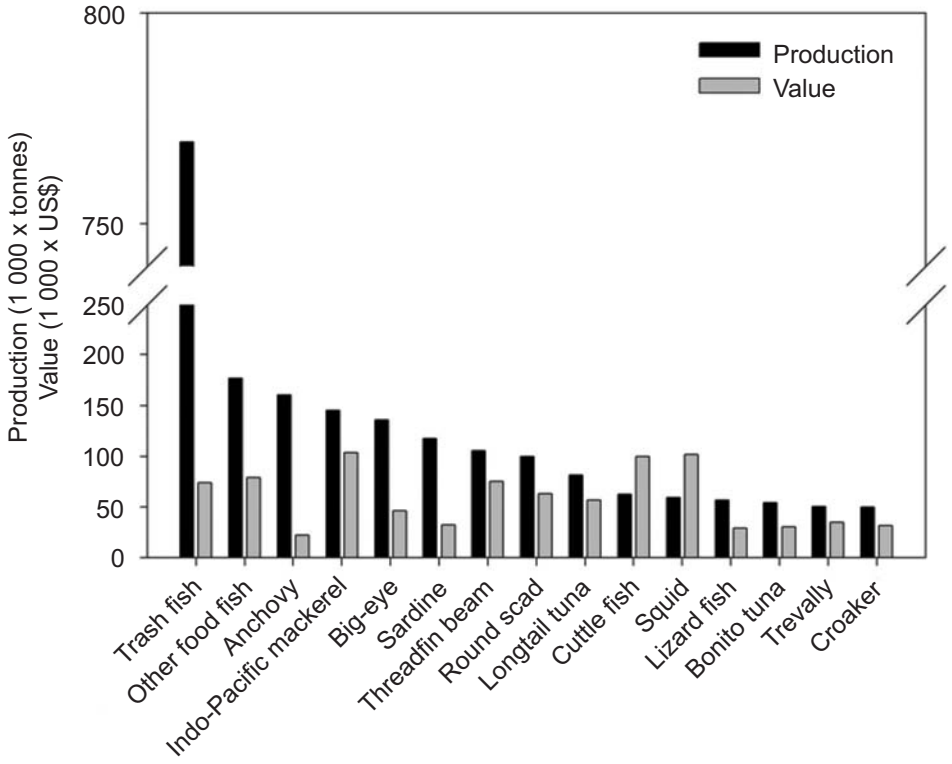


Figure 15 Production and value of top 15 species group (by production) of marine capture fisheries for the LSF subsector, 2004[11]

[10] DoF (2006f).
[11] DoF (2006f).

Table 8 Landed production of marine capture fisheries by fishing gears in Thailand 2004

Fishing methods	Grand total (tonnes)	Pelagic fish	Subtotal fish		Trash fish	Shrimps	Crabs	Squids	Shellfish	Others
			Demersal fish	Other food fish						
Otter board trawl	1 376 785	130 510	440 262	103 701	538 256	42 058	11 104	110 761	133	0
Purse seine	599 480	497 944	1 018	44 881	51 116	0	0	4 521	0	0
Pair trawl	288 700	42 736	32 921	23 809	162 131	2 591	1 401	23 088	23	0
Anchovy purse seine	157 151	151 375	0	1 120	3 237	0	0	1 419	0	0
Push net	30 124	195	1 107	1 766	12 474	10 965	667	2 950	0	0
King mackerel drifting gill net	19 550	16 306	359	1 427	1 124	0	0	334	0	0
Mackerel encircling gill net	9 785	9 328	0	139	256	0	0	62	0	0
Deep water set nets	1 688	681	43	108	778	0	0	78	0	0
Beam trawl	1 007	1	62	21	14	767	79	18	45	0
LSF Subtotal	**2 484 270**	**849 076**	**475 772**	**176 972**	**769 386**	**56 381**	**13 251**	**143 231**	**201**	**0**
Collecting shellfish	36 317	0	0	0	0	0	0	0	36 317	0
Crab gill net	23 343	53	205	357	0	95	22 587	46	0	0
Mackerel gill net	16 891	16 189	106	562	0	0	34	0	0	0
Squid falling net	16 747	326	0	207	93	0	10	16 111	0	0
Shrimp trammel net	14 934	203	312	852	3	12 686	510	368	0	0
Other gill nets	8 805	3 884	3 549	1 147	0	13	199	13	0	0
Set bag net	8 315	6	526	329	2 238	5 116	100	0	0	0
Crab trap	4 621	0	0	0	0	15	4 606	0	0	0
Other moving gears	4 310	3 080	38	118	3	216	855	0	0	0
Mullet gill net	4 226	3 847	58	312	0	5	4	0	0	0
Squid trap	2 752	0	0	0	0	0	0	2 752	0	0
Hand line and pole & line	2 496	1 255	572	172	0	0	0	497	0	0
Other stationary gears	2 068	0	0	373	0	1 677	0	0	18	0
Fish trap	1 660	65	1 496	99	0	0	0	0	0	0
Hand push net	1 002	0	0	0	0	1 002	0	0	0	0
Squid trammel net	613	0	0	107	0	0	26	480	0	0
Long line	382	78	290	11	0	0	0	3	0	0
Pomfret gill net	246	189	0	42	0	0	15	0	0	0
Other cast nets	58	0	5	5	0	48	0	0	0	0
Shallow water set nets	23	3	0	9	0	3	4	4	0	0
Other fishing	1 890	0	20	0	0	47	21	0	0	1 802
SSF Subtotal	**151 699**	**29 178**	**7 177**	**4 702**	**2 337**	**20 923**	**28 971**	**20 274**	**36 335**	**1 802**
Grand total (tonnes)	**2 635 969**	**878 254**	**482 949**	**181 674**	**771 723**	**77 304**	**42 222**	**163 505**	**36 536**	**1 802**

Note: Methodology for preparing marine capture fisheries statistics is described in Appendix I; DoF (2006f).

Table 9 Landed production[12] and value of marine capture fisheries by species in Thailand, 2004 (values in 1 000 Baht)

Species	Production (tonnes)			Value (1 000 Baht)		
	Total	LSF[13]	SSF[14]	Total	LSF[1]	SSF[2]
Indo-Pacific mackerel	160 398	145 648	14 750	4 414 624	4 076 072	338 552
Round scad	100 355	100 355	0	2 508 875	2 485 557	23 318
Longtail tuna	81 531	81 525	6	2 242 138	2 241 973	165
King mackerel	26 238	24 567	1 671	2 175 826	2 037 212	138 614
Trevally	50 867	50 596	271	1 362 404	1 361 762	642
Sardine	119 901	117 799	2 102	1 290 702	1 269 797	20 905
Bonito tuna	54 887	54 702	185	1 197 967	1 189 220	8 747
Indian mackerel	34 889	33 609	1 280	897 464	845 961	51 503
Anchovy	163 237	159 976	3 261	896 808	871 862	24 946
Big-eye scad	40 741	40 741	0	715 316	715 316	0
Black-banned trevally	5 322	5 314	8	507 234	507 234	0
Wolf herring	12 910	12 813	97	411 014	406 618	4 396
Hardtail scad	17 077	16 501	576	349 219	339 345	9 874
Black pomfret	4 138	4 054	84	315 253	304 428	10 825
Mullet	4 148	0	4 148	195 591	0	195 591
Silver pomfret	1 005	808	197	152 190	129 312	22 878
Threadfin	610	68	542	54 262	6 120	48 142
Pelagic fish	**878 254**	**849 076**	**29 178**	**19 686 887**	**18 787 789**	**899 098**
Threadfin beam	105 895	105 653	242	2 956 806	2 947 644	9 162
Big-eye	136 572	136 556	16	1 800 633	1 800 504	129
Red snapper	18 130	17 760	370	1 639 016	1 610 739	28 277
Croaker	50 851	50 264	587	1 255 367	1 240 854	14 513
Lizard fish	57 017	57 017	0	1 139 980	1 139 980	0
Grouper	7 509	6 041	1 468	772 171	545 444	226 727
Sand whiting	14 706	12 256	2 450	609 974	490 000	119 974
Hair tail	17 396	17 396	0	608 265	608 265	0
Marine catfish	16 029	15 241	788	559 861	533 365	26 496
Barracuda	14 311	14 013	298	545 225	532 456	12 769
Shark	10 155	10 147	8	355 575	355 075	500
Flatfish	10 565	10 296	269	345 064	339 886	5 178
Ray	17 491	17 240	251	284 604	280 718	3 886
Indian halibut	3 062	3 062	0	131 365	131 365	0
Conger eel	2 801	2 801	0	92 520	92 520	0
Giant sea perch	186	0	186	18 208	0	18 208
Barbel eel	257	29	228	16 672	1 364	15 308
Monocle bream	16	0	16	796	0	796
Demersal fish	**482 949**	**475 772**	**7 177**	**13 132 102**	**12 650 179**	**481 923**
Other food fish	**181 674**	**176 972**	**4 702**	**3 190 470**	**3 083 720**	**106 750**
Trash fish	**771 723**	**769 386**	**2 337**	**2 911 767**	**2 907 030**	**4 737**
Banana prawn	15 420	5 766	9 654	3 380 685	1 618 866	1 761 819
School prawn	11 551	9 295	2 256	1 462 088	1 176 431	285 657
Tiger prawn	2 556	2 544	12	778 988	775 920	3 068
King prawn	3 434	2 828	606	684 507	658 924	25 583
Jumbo tiger prawn	2 236	1 985	251	679 035	636 844	42 191
Flathead lobster	2 767	2 663	104	422 593	389 534	33 059
Mantis lobster	2 648	2 640	8	155 954	155 454	500
Acetes	5 734	1 558	4 176	71 698	19 481	52 217
Other shrimps	30 958	27 102	3 856	1 962 538	1 596 530	366 008
Shrimps & prawns	**77 304**	**56 381**	**20 923**	**9 598 086**	**7 027 984**	**2 570 102**

[12] DoF (2006f).
[13] DoF (2006a).
[14] DoF (2006b).

Table 9 (Cont.)

Species	Production (tonnes)			Value (1 000 Baht)		
	Total	LSF[13]	SSF[14]	Total	LSF[1]	SSF[2]
Blue swimming crab	29 524	5 204	24 320	2 563 598	508 626	2 054 972
Mud crab	2 859	14	2 845	254 234	2 184	252 050
Other crabs	9 839	8 033	1 806	503 621	394 511	109 110
Crabs	**42 222**	**13 251**	**28 971**	**3 321 453**	**905 321**	**2 416 132**
Squid	73 594	59 596	13 998	4 642 560	4 002 455	640 105
Cuttle fish	68 655	62 752	5 903	4 333 320	3 915 832	417 488
Octopus	21 256	20 883	373	725 948	716 002	9 946
Squids	**163 505**	**143 231**	**20 274**	**9 701 828**	**8 634 289**	**1 067 539**
Short necked clam	28 876	0	28 876	141 667	0	141 667
Bloody cockle	2 567	0	2 567	46 226	0	46 226
Scallop	156	156	0	13 572	13 572	0
Horse mussel	44	0	44	348	0	348
Other shellfish	4 893	45	4 848	48 326	847	47 479
Shellfish	**36 536**	**201**	**36 335**	**250 139**	**14 419**	**235 720**
Jelly fish	1 528	0	1 528	2 527	0	2 527
Others	274	0	274	5 238	0	5 238
Others	**1 802**	**0**	**1 802**	**7 765**	**0**	**7 765**
Grand total	**2 635 969**	**2 484 270**	**151 699**	**61 800 497**	**54 010 731**	**7 789 766**

Considering the value of marine capture fisheries production, pelagic fish contributed the highest percentage in both LSF and SSF, which is 38 percent and 50 percent, respectively (Table 9, Figure 16). Indo-Pacific mackerel, squids and cuttlefish contributed high value for LSF (Figure 15), whereas blue swimming crabs, banana prawns and squids are important for the production value of SSF (Figure 17).

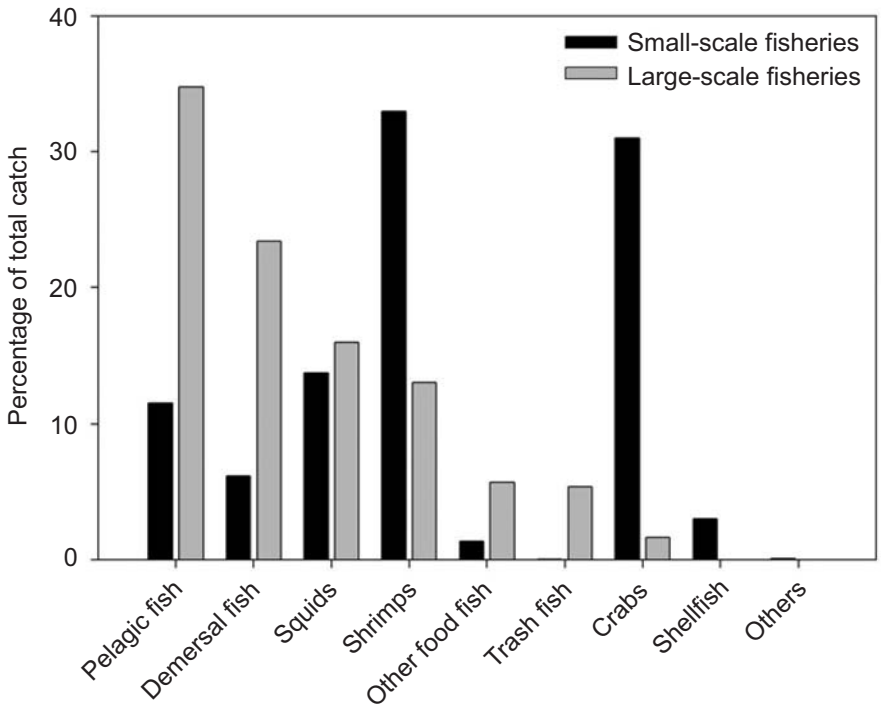


Figure 16 Composition of marine capture value by subsector, 2004[15]

[15] DoF (2006a, 2006b).

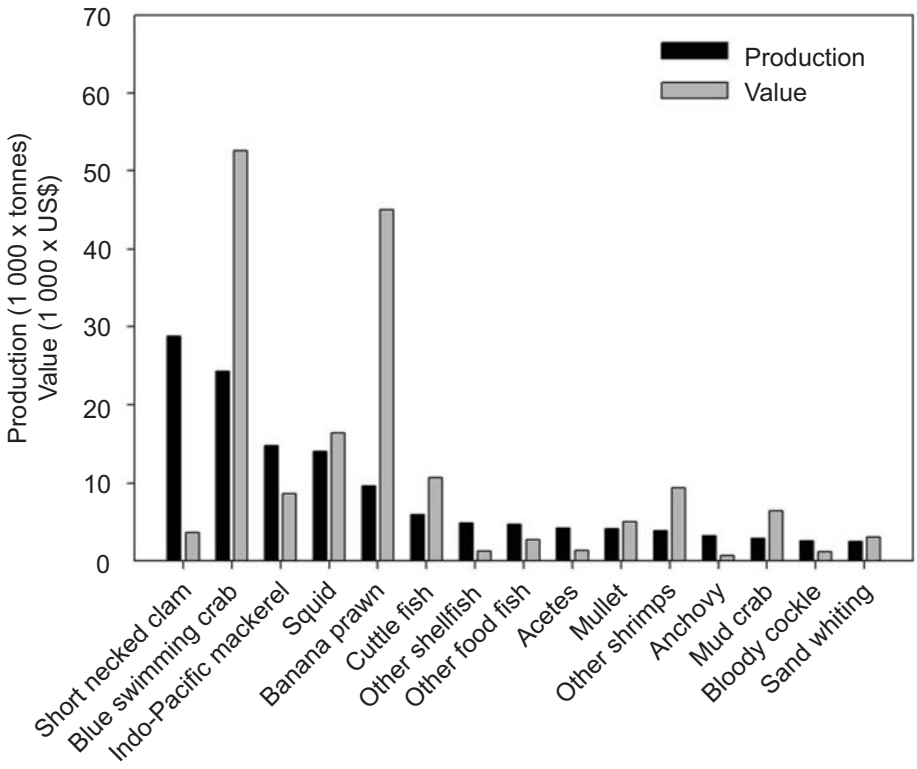


Figure 17 Production and value of the top 15 species group (by production) of marine capture fisheries for the SSF subsector, 2004[16]

Table 10 Disposition of marine production by type of fish and type of fish processing plant, 2004[17] (tonnes)

Type of plant	Total	Other food fish	Trash fish & fish left over from processing	Shrimp	Crabs	Squids	Shellfish	Lobsters
Freezing	1 084 553	605 589	–	287 551	10 227	134 630	45 208	1 348
Canning	1 237 017	1 036 615	–	123 405	24 127	12 699	40 171	–
Fish sauce	110 531	110 531	–	–	–	–	–	–
'Budu' sauce	2 226	2 226	–	–	–	–	–	–
Streaming	12 960	12 960	–	–	–	–	–	–
Smoking	6 209	6 209	–	–	–	–	–	–
Dried salted fish	65 349	65 349	–	–	–	–	–	–
Dried shrimps	12 543	–	–	12 543	–	–	–	
Dried squids	16 559	–	–	–	–	16 559	–	–
Dried shellfish	47 279	–	–	–	–	–	47 279	–
Fish balls	10 354	10 354	–	–	–	–	–	–
Fish-shrimp chips	8 057	7 681	–	376	–	–	–	–
Fish meal	1 555 950	112 586	1 443 364	–	–	–	–	–
Total	**4 169 587**	**1 970 100**	**1 443 364**	**423 875**	**34 354**	**163 888**	**132 658**	**1 348**

Note: Some amount of fish used for canned fish and frozen fish are imported from other states.

[16] DoF (2006a, 2006b).
[17] DoF (2006c).

DISPOSITION OF PRODUCTION

Marine production is generally sent for processing with most of the fish and shrimp production sent to canning and freezing processing plants and squids mainly sent to freezing processing plants. Fish meal, however, comprises the highest amount disposed from marine production (Table 10). Most of it is produced from trash fish and the fish left over from other processing activities. In 2004, 423 866 tonnes of fish meal were produced by using 771 723 tonnes of trash fish, 112 586 tonnes of other food fish and 671 641 tonnes of the fish left over from other processing activities. The production of fish meal has been continually increasing since 1987, after an apparent drop in production in the late 1990s (Table 11).

Table 11 Quantity of trash fish used for fish meal production, 1987 to 2004[18] (tonnes)

Year	Quantity used in fish meal production			Total	Total fish meal production	No. of plants
	Trash fish	Other food fish	Fish left over from processing			
1987	838 184	56 332	–	894 516	212 980	95
1988	888 774	55 006	–	943 780	236 892	96
1989	1 012 708	58 317	–	1 071 025	268 524	98
1990	1 022 106	64 919	–	1 087 025	285 042	104
1991	1 029 852	85 446	–	1 115 298	279 949	98
1992	1 295 104	94 417	–	1 389 521	348 624	106
1993	1 304 249	70 434	–	1 374 683	344 599	115
1994	1 473 138	82 083	–	1 555 221	389 885	118
1995	1 749 608	47 065	–	1 796 673	449 788	122
1996	1 652 688	45 230	–	1 697 918	425 075	118
1997	799 814	45 756	670 187	1 515 757	378 940	111
1998	758 465	53 841	511 581	1 323 887	342 438	97
1999	755 382	57 464	388 987	1 201 833	309 248	98
2000	725 489	62 675	358 927	1 147 091	299 073	96
2001	722 109	56 363	659 259	1 437 731	378 352	93
2002	679 640	59 908	768 096	1 507 644	391 583	93
2003	695 999	63 668	769 361	1 529 028	392 312	100
2004	771 723	112 586	671 641	1 555 950	423 866	95

Note: The quantity of trash fish before year 1997 included the fish left over from processing.

FISHING UNITS (BOATS AND CREW)

Fishing units employed in marine capture fisheries are categorized by size and shown in Table 13. Most of them are small-scale fishing units (60 141 units), of which 79 percent are outboard powered boats or long-tail boats. The majority (41 percent) comprises 11 343 large-scale fishing boats (20 to 50 GT). The average size of crew per fishing unit is obviously related to the size of the boat, as is the net profit per fishing unit. The average size of crew per SSF fishing unit is 1 to 3 persons, whereas it is 7 to more than 26 persons per LSF fishing unit (Table 13).

The net profit per fishing household of SSF is 5 955 Baht/month, whereas it is about 3 400 to 464 000 Baht/month/boat for LSF (Table 12). The total number of marine fisheries households is 57 801 households, of which 92 percent and 8 percent are SSF and LSF households, respectively.

[18] DoF (2006c).

Table 12 Cost and income of marine capture fisheries sectors in Thailand

Type of fishing units	Cash cost	Non-cash cost	Total cost	Total income	Net profit
SSF[19] (Baht/month/household)	3 528	490	4 018	9 973	5 955
LSF[20] (Baht/month/boat)					
10 to 20 GT	85 136	7 617	92 753	96 116	3 363
20 to 50 GT	233 865	11 152	245 017	281 982	36 965
50 to 100 GT	340 081	15 020	355 101	400 133	45 032
100 to 200 GT 200 to 500 GT	353 352	13 415	366 767	830 800	464 033

Note: SSF, surveyed from shrimp trammel net, crab gill net and mullet gill net.
LSF, surveyed from otter board trawl, pair trawl, beam trawl and push net.

Among SSF households, the main fishing gears are shrimp trammel net, crab gill net and mullet gill net, which comprise 20 percent, 14 percent and 7 percent of total SSF households, respectively (National Statistical Office, 2001b). In the peak season, there are approximately 168 000 fishers, of which 56 percent are in SSF and 44 percent are in LSF. In SSF, most of the fishers (81 percent) are family members, but most of the fishers in LSF (94 percent) are employees (Table 13).

Table 13 Number of fishing units, households and fishers of marine capture fisheries in Thailand

Type of fishing units	Fishing vessels statistics 2004[23]	Number of fishing units		Best estimated number	Average crew per fishing unit[21]	Number of fishing house-holds[22]	Number of fishers (peak season)[12]		
		Inter-censal marine survey 2000[12]	SS marine household income survey 2000[24]				Family member	Employees	Total
No boat			3 763	3 763	1	3 550	4 962	0	4 962
Non-powered boat		2 639	3 112	2 876	1	2 559	3 011	271	3 282
Outboard powered boat		42 217	52 695	47 457	2	41 225	60 222	11 164	71 386
Inboard powered boat									
< 5 GT	2 751	3 324	3 933	3 336	2	3 249	4 573	1 597	6 170
5 to 10 GT	2 338	2 898	2 892	2 709	3	2 760	3 878	4 551	8 429
SSF Subtotal				**60 141**		**53 343**	**76 646**	**17 583**	**94 229**
10 to 20 GT	3 378	2 605		3 378	7	1 994	2 350	7 607	9 957
20 to 50 GT	4 667	2 459		4 667	10	1 340	1 256	11 341	12 597
50 to 100 GT	2 799	1 461		2 799	13	517	343	10 339	10 682
100 to 200 GT	438			438	22				
200 to 500 GT	59	516		59	26	607	262	40 413	40 675
> 500 GT	2			2	NA				
LSF Subtotal				**11 343**		**4 458**	**4 211**	**69 700**	**73 911**
Grand total				**71 484**		**57 801**	**80 857**	**87 283**	**168 140**

Note: Average crews per fishing unit of LSF are surveyed from otter board trawl, pair trawl, beam trawl and push net.

[19] National Statistical Office (2001b).
[20] DoF (2006g).
[21] DoF (2006g).
[22] National Statistical Office (2001a).
[23] DoF (2006e).
[24] National Statistical Office (2001b).

THAI CAPTURE FISHERIES OUTSIDE THE NATIONAL EEZ

The production of marine capture fisheries of Thailand has been steady for years, but this does not reflect the richness of marine resources in Thai waters. In fact about 1.15 million tonnes of total marine production (2.64 million tonnes) are obtained from overseas fisheries (Table 15). This production is from the EEZs of coastal states in Southeast Asia, South Asia, the Middle East and East Africa, such as Cambodia, Indonesia, Malaysia, Myanmar, Viet Nam, Bangladesh, India, Oman, Yemen, Madagascar and Somalia. Less than 1 000 tonnes of tuna production are obtained on the high seas (Jantrarotai, 2004b).

The move of Thai fishing boats out of Thai waters is a result of the overexploitation of the fisheries resources in Thai waters. This overexploitation can be seen clearly in the dramatic decline of production per unit effort (CPUE) from trawl surveys in the Gulf of Thailand from 298 kg/hr in 1961 to about 20 kg/hr in the early 1990s (DoF, 1990). Furthermore, the catch composition changed toward smaller and less-valuable species in later years (Kongprom *et al.,* 2003). There have been occasions when there has been a lack of raw materials for the fish processing industry. Hence, Thai fishers with support of the Thai government have sought new fishing grounds outside Thai waters to increase their catch and secure the national fisheries production base.

Table 14 Number of Thai boats fishing in the EEZs of other coastal states, 2006[25]

Coastal states	Number of fishing boats
Indonesia	349
Malaysia	140
Myanmar	133
Cambodia	100
India	20
Somalia	10
Bangladesh	7
Total	**759**

The fishing operations outside of Thailand are under various forms of arrangement (Jantrarotai, 2004a). Fishing contracts might be arranged between government and government, private sector and government, or private sector and private sector. However, there are generally two main forms of arrangement, i.e. licensing and joint venture. At present, there are 759 Thai fishing boats operating in the EEZs of seven coastal states that have made known their type of agreement to DoF (Table 14). This is, however, a gross underestimate of the number of Thai fishing boats operating outside Thai waters. In fact there are about 3 000 to 4 000 Thai boats fishing in the EEZs of other coastal states and two Thai boats fishing on the high seas (Jantrarotai, 2004b). Most of these boats are fishing under a private sector to private sector arrangement and are not obliged to report to DoF. The most accessed fishing grounds of these unreported fishing boats are the EEZs of Indonesia and Myanmar.[26]

EEZ OF INDONESIA

About 1 000 to 2 000 Thai boats flying the Thai flag and the Indonesian flag operate in the EEZ of Indonesia with fishing contracts between Thai companies and Indonesian companies (Kongpornprattana, 2006). The boats are 60 to 600 GT. They usually operate in three fishing grounds, namely north of Sumatra, in the South China Sea and in the Arafura Sea.

[25] Fisheries Foreign Affairs Division (2007), personal communication). These figures are only for Thai boats that operate in the EEZs of specified coastal states under fishing cooperation programmes and which provide information to DOF Thailand. The figures of Thai boats operating under deals between Thai and foreign private sectors are not included.

[26] It is unclear if the catch by these boats (~ 3 000 large-scale boats) is reported to DoF or caught in landing surveys or if it remains unreported.

North of Sumatra Island, in the Strait of Malacca area

There are about 200 Thai boats fishing in this area with permission to operate as Indonesian boats. Most of them come from Trang province and only 20 to 30 boats come from Satun province. These boats are mostly 50 to 60 GT trawlers. However, Thai boats fishing in this area have faced problems because it is deep water fishing grounds that present difficulties for smaller boats. The Thai fishing boats, thus, tend to move inshore where trawlers are prohibited and they are at risk of being arrested by Indonesian patrols. Moreover, the Thai fishing boats also have conflicts with local small-scale fishers because of the damage their gear and boats make to small-scale fishing gears in coastal areas.

The South China Sea, in Natuna Islands area

There are many Thai boats fishing in this area (600 to 800), depending on the season. The fisher applies for permission to operate as a Thai boat and/or Indonesian boat. Most of them are trawlers from Samut Prakan, Samut Sakhon, Samut Songkhram, Petchaburi, Nakhon Si Thammarat, Songkhla and Pattani provinces. Only some of them (50 boats) are small tuna purse seines from Rayong and Pattani provinces. Since this area does not have an abundance of marine resources, the fishers sometimes come to fish in the coastal area and are at risk of being arrested by Indonesian patrols.

The marine production obtained from this area is transferred back to Thailand by carrier boats, which land fish at fishing ports every day. At Songkhla fishing port for instance, the carrier boats officially land approximately 75 000 tonnes of fish per year and the main part of this production consists of demersal fish (Songkhla Fishing Port Division, 2007, personal communication).

The Arafura Sea

This area can be considered as the most important fishing ground for Thai boats because of its rich marine resources. But the boats fishing in this area should be more than 100 GT and equipped with high technology. The fishers must have a generator onboard in order to freeze fish during long fishing trips. Carrier boats are also needed for carrying fish back to Thailand. In this area, there are about 50 Thai boats flying the Indonesian flag, 300 Thai boats flying the Thai flag and 55 large carrier boats (1 000 GT), which transfer and land fish every day at Samut Sakhon province.

EEZ of Myanmar

Thai boats fish in the EEZ of Myanmar under a Joint Venture Programme and a Fishing Right Programme (Boonkumjad, 2004).

Joint Venture Programme

The present fisheries cooperation between Thailand and Myanmar started in 2001 during discussions between DoF Thailand and DoF Myanmar. The result of discussions was that a Joint Venture Fisheries Programme in the EEZ of Myanmar would be based on two principles: 1) the fishing operation has to be carried out through a Joint Venture Company that will be regarded as a foreign company according to the Myanmar Company Act; and 2) the fishing vessels to be operated by the Joint Venture Company have to fly the flag of the owner's nationality or country of registration. At present there are seven Thai companies that have applied for permission to fish through Myanmar Investment Commission (MIC), but so far only two companies have been approved and these sent 19 boats to fish in the EEZ of Myanmar under this programme.

Fishing Access Programme

DoF Thailand held discussions with DoF Myanmar on fisheries cooperation during visits to Myanmar in 2004. After the discussions, Myanmar decided to grant fishing concessions to 500 Thai fishing boats under a Fishing Right Programme through a single Thai company and Thai fishing boats need to be recommended by DoF, Thailand. The Thai company that has been granted this fishing right is the Siam Jonathan Company. As of October 2004, 323 Thai boats have operated in the EEZ of Myanmar under this company (Thummachua, 2004) and landed fish in Ranong province. The amount landed is increasing — from 207 tonnes in April 2004 to 24 282 tonnes in September 2004. The average production of the 70 to 100 GT trawlers operating two trips a month is 67.9 tonnes/month/boat. The species composition is mainly economically valuable species such as round scads, lizard fish, threadfin breams, groupers etc. The average net profit is 465 260 Baht/month/boat.

Table 15 Production of marine capture fisheries outside of Thai waters, 2004[27]

Species	Grand total (tonnes)	Otter board trawl 14 to 18 m	Otter board trawl 19 to 25 m	Otter board trawl > 25 m	Pair trawl 14 to 18 m	Pair trawl > 18 m	Purse seine	King mackerel drifting gill net
Indo-Pacific mackerel	48 753	0	1 368	46 231	0	50	1 104	0
Indian mackerel	8 839	382	2 779	5 616	0	62	0	0
King mackerel	16 582	174	1 829	13 458	11	48	159	903
Wolf herring	7 228	395	5 073	1 715	0	45	0	0
Longtail tuna	69 892	0	0	32	0	0	68 906	954
Bonito tuna	41 189	0	0	0	0	0	39 777	1 412
Round scad	66 323	0	0	0	0	1 279	65 044	0
Hardtail scad	54	0	0	0	0	0	54	0
Trevally	12 679	508	2 782	8 969	19	99	302	0
Big eye scad	8 951	395	1 214	391	10	55	6 886	0
Black-banned trevally	3 798	474	3 085	200	12	27	0	0
Threadfin	59	0	59	0	0	0	0	0
Sardine	1 680	0	0	1 630	0	0	50	0
Anchovy	878	404	394	0	28	52	0	0
Mullet	0	0	0	0	0	0	0	0
Black pomfret	2 381	30	348	1 641	0	12	350	0
Silver pomfret	355	28	265	48	0	14	0	0
Pelagic fish	**289 641**	**2 790**	**19 196**	**79 931**	**80**	**1 743**	**182 632**	**3 269**
Barracuda	7 601	475	3 284	3 781	0	61	0	0
Croaker	32 287	637	4 598	26 920	1	131	0	0
Threadfin beam	81 868	2 777	35 715	43 042	78	256	0	0
Monocle beam	0	0	0	0	0	0	0	0
Lizard fish	49 507	2 627	18 977	27 519	94	290	0	0
Hair tail	12 842	482	5 002	7 215	0	88	55	0
Red snapper	16 197	400	2 830	12 933	12	22	0	0
Giant Seaperch	0	0	0	0	0	0	0	0
Big-eye	117 925	2 740	29 334	85 406	116	329	0	0
Sand whiting	10 698	233	595	9 855	3	12	0	0
Barbel eel	28	0	0	28	0	0	0	0
Marine catfish	12 827	268	1 355	11 164	13	27	0	0
Ray	12 569	823	4 725	6 792	47	182	0	0
Shark	6 816	605	4 418	1 626	39	128	0	0
Flatfish	5 243	298	4 088	827	0	30	0	0
Indian halibut	2 159	133	487	1 477	1	61	0	0

[27] DoF (2006f).

Table 15 (Cont.)

Species	Grand total (tonnes)	Otter board trawl 14 to 18 m	Otter board trawl 19 to 25 m	Otter board trawl > 25 m	Pair trawl 14 to 18 m	Pair trawl > 18 m	Purse seine	King mackerel drifting gill net
Conger eel	1 352	74	499	779	0	0	0	0
Grouper	4 412	353	3 059	965	11	24	0	0
Demersal fish	**374 331**	**12 925**	**118 966**	**240 329**	**415**	**1 641**	**55**	**0**
Other food fish	**71 943**	**4 716**	**56 136**	**10 170**	**96**	**825**	**0**	**0**
Trash fish	**311 040**	**110 248**	**191 118**	**0**	**758**	**8 916**	**0**	**0**
Banana prawn	1 257	169	1 048	18	1	21	0	0
Jumbo tiger prawn	400	27	319	45	0	9	0	0
Tiger prawn	710	140	434	125	1	10	0	0
King prawn	1 622	181	359	1 070	0	12	0	0
School prawn	3 544	401	1 461	1 662	3	17	0	0
Other shrimps	3 472	515	2 061	879	0	17	0	0
Acetes	0	0	0	0	0	0	0	0
Flathead lobster	1 912	218	604	996	28	66	0	0
Mantis lobster	1 262	4	21	1 234	3	0	0	0
Shrimps & prawns	**14 179**	**1 655**	**6 307**	**6 029**	**36**	**152**	**0**	**0**
Blue swimming crab	1 725	230	851	554	9	81	0	0
Mud crab	0	0	0	0	0	0	0	0
Other crabs	4 861	125	1 977	2 690	0	69	0	0
Crabs	**6 586**	**355**	**2 828**	**3 244**	**9**	**150**	**0**	**0**
Squid	25 989	2 351	15 264	7 375	275	683	41	0
Cuttle fish	41 024	2 542	16 929	20 652	275	626	0	0
Octopus	10 266	479	4 221	5 464	9	93	0	0
Big fin reef squid	1 826	155	1 299	280	24	68	0	0
Squids	**79 105**	**5 527**	**37 713**	**33 771**	**583**	**1 470**	**41**	**0**
Scallop	4	0	0	4	0	0	0	0
Other shellfish	0	0	0	0	0	0	0	0
Shellfish	**4**	**0**	**0**	**4**	**0**	**0**	**0**	**0**
Grand Total	**1 146 811**	**138 216**	**432 264**	**373 478**	**1 977**	**14 897**	**182 710**	**3 269**

SUMMARY AND SYNTHESIS

CAPTURE FISHERIES – REPORTED DATA

In 2004, the capture fisheries sector contributed 69.3 percent of total fisheries production, whereas the aquaculture sector contributed 30.7 percent. Each sector, however, contributed about 50 percent of the total production value (Figure 1). Capture fisheries refers to all types of harvesting of naturally occurring living resources in both marine and freshwater environments. For Thailand, capture fisheries continuously plays a much more significant role quantitatively than the aquaculture sector (Figure 1).

CAPTURE FISHERIES – ESTIMATED DATA

INLAND CAPTURE FISHERIES

In Thailand, the rate of utilization of freshwater fish is high as almost all kinds of fish are eaten. Inland capture fisheries in Thailand are considered to comprise mostly SSF. Inland capture fisheries are reported (DoF, 2007) to contribute approximately 200 000 tonnes per year and fishing is normally carried out in natural and human-made freshwater bodies of various types. Fish caught from inland habitats are multispecies and vary in abundance.

It has been estimated that an additional 300 000 tonnes should be attributed to inland fisheries in Thailand.[28] Reports based on back calculating consumption figures estimate the inland production in one part of Thailand (the Mekong River Basin) to be as large as 945 782 tonnes.[29] Furthermore, Hortle (2007) estimated an annual area-based yield, ranging from 162 626 to 602 505 tonnes, for the same area. This part of Thailand is probably relatively productive in terms of inland fisheries but doubling that amount for the whole of Thailand seems reasonable. So the estimated production for Thailand would then be 325 252 to 1 205 010 tonnes.

In addition, the reported production of about 200 000 tonnes does not seem likely when compared to the estimated production calculated by taking estimates of the production per unit area for different

[28] Coates, D. (2002).
[29] Hortle, K.H. (2007).

types of area and then multiplying each figure by the total area for each type (Table 16). Indeed, the potential output is higher than the reported production by as much as five times. In a relatively poor country such as Thailand where fish is a dietary staple, a resource like this is unlikely to be unexploited and unused. Therefore, a conservative estimate of Thailand's yearly production could be 75 percent of the estimated "high" biomass output (~1 100 000 tonnes), similar to the estimate figure in Table 5. Thus, using a combination of agricultural census data and provincial production estimates, it is estimated that inland fisheries produce 1 060 320 tonnes per year (Table 16 and 5).

Table 16 Sensitivity analysis of estimated inland capture figure using biomass **estimates by habitat**

Environment	Output/Area (kg/ha)		Total area (ha)	Potential Output (tonnes)	
	Low	High		Low	High
Rice paddy[30]	25	100	10 224 969 [31]	255 624	1 022 497
Water area[32]					
Rivers and floodplains[33]	35	100	4 100 000	143 000	410 000
Reservoirs, lakes and swamps	35	100	400 000	14 000	40 800
Total[34]				**412 617**	**1 473 297**
Estimated inland capture[35]					**1 060 320**

Silver barb, Nile tilapia, striped snake-head fish, Jullien's mud carp, walking catfish and common climbing perch are, generally, the dominant species in the production from freshwater bodies in Thailand. The production and value of inland capture fisheries, particularly obtained from natural reservoirs, have been increasing in recent years. Freshwater fish contributed more than 99 percent of total freshwater production with most of the remainder being accounted for by shrimps. As this figure is based on the reported data only, the "real" species composition of the production in Thailand could be very different.

The number of fishers and fisher households participating in inland capture fisheries is approximately 3.13 million and 2.72 million, respectively. The number of fishing boats used in inland capture fisheries is not systematically recorded and hence has to be estimated. The major constraints in collecting inland fisheries information are lack of basic up-to-date data, lack of accuracy of data collection, inadequate knowledge of scientific data collection methods, and the fact that information is found scattered throughout the country.

MARINE CAPTURE FISHERIES

Marine capture fisheries in Thailand have developed significantly since 1945, mainly as a result of the introduction of modern fishing technologies and techniques. Marine capture fisheries in this context can be divided into two groups, LSF and SSF according to the definitions of the Thai Department of Fisheries (DoF).

Among all fishing gears, the otter board trawl contributed the highest production of about 1.4 million tonnes in 2004. For SSF, collecting shellfish contributed the highest production,[36] followed by various types of gill nets. In LSF, pelagic fish is the dominant production category (34 percent) with anchovy

[30] An aquatic animal production of 25-100 kg/ha/year is estimated from a number of sources and can be considered as a relatively conservative estimate.
[31] http://www.faorap-apcas.org/thailand/busdirectory/doc/B01TotalRice_web2007-new.xls
[32] Royal Irrigation Department 2004
[33] An aquatic animal production of 35-100 kg/ha/year for rivers and floodplains and also swamps lakes and reservoirs is also estimated from a number of sources. This is considered a relatively conservative estimate.
[34] Range of production base don typical production levels of different aquatic habitats/environments, assuming high utilization by rural people.
[35] Estimated mean production – See chapter "Inland capture fisheries" Table 5.
[36] It should be noted that shell weight is included.

and Indo-Pacific mackerel as dominant species, whereas shellfish (24 percent), particularly short necked clam, is the dominant production species of SSF. However, pelagic fish contributed the highest value in both LSF and SSF.

Much of the fish and shrimp produced is canned or frozen. Fish meal, however, accounts for the highest single amount from marine production. In 2004, approximately 424 000 tonnes of fish meal were produced by using 1 556 000 tonnes or 55 percent of the marine production.

Most of the fishing units employed in marine capture fisheries are small-scale fishing boats and 83 percent of these boats are outboard powered boats. The dominant large-scale fishing unit is the 20 to 50 gross tonnage (GT) boats, which make up 33 percent of the total large-scale fishing boats. The size of crew and the net profit per fishing unit is related to the size of the boat. The total number of households involved in marine fisheries is about 58 000 with approximately 168 000 fishers during the peak fishing seasons.

Capture fisheries outside the national EEZ

Approximately 1.2 million tonnes of the total marine production (2.6 million tonnes) is obtained from non-Thai fisheries, particularly from the EEZs of other coastal states in Southeast Asia, South Asia and East Africa, and also less than 1 000 tonnes of tuna production is obtained from the high seas.

Thai fishers, with the support of the Thai government, have sought new fishing grounds outside the waters of Thailand because the marine resources in Thai waters have been overexploited. Thailand's Department of Fisheries (DoF) has information on 759 Thai boats operating in the EEZs of seven other coastal states in 2006, but in fact there are about 3 000 to 4 000 Thai boats fishing in the EEZs of the other coastal states and two Thai boats fishing on the high seas. Most of these fishing boats are operating under contracts arranged by private sector actors who are not obliged to report their dealings to the DoF in Thailand. The most important fishing grounds for Thai fishing boats outside of Thailand are the EEZs of Indonesia and Myanmar. About 1 000 to 2 000 Thai boats are flying the Thai flag and the Indonesian flag and operate in the EEZ of Indonesia. As of October 2004, 323 Thai boats operated in the EEZ of Myanmar under the "Fishing Access programme" and most of these boats landed their catches in Ranong province. The catches landed, mostly of demersal fish, have been increasing rapidly providing a good monthly net profit for fishers.

SYNTHESIS

The data presented in the summary table below (Table 17) are derived from official statistics along with the supporting documentation (see chapters inland capture fisheries and marine capture fisheries) and additional calculations as explained in the footnotes accompanying the table.

The capture fisheries of Thailand produced an estimated total of 3 910 865 tonnes of aquatic products in 2004 compared to the reported 2 991 368. Of this production 32 percent is produced by small-scale fisheries and the remaining 68 percent is produced by large-scale fisheries; however a large fraction of this produce is either turned into fish meal (29 percent) or exported (30 percent). Hence, for domestic consumption the small-scale fisheries contribute more than half (53 percent) of the production. The participation in these fisheries is high, with a total of 3 299 495 fishers. Of these, 98 percent are small-scale fishers. The higher fraction of fishers in small-scale fisheries is also reflected in the number of boats within each category. Out of a total of 74 606 boats, almost 85 percent is used in small-scale fisheries.

Table 17 Summary of Thailand's capture fisheries divided into large- and small-scale fisheries

	Inland	Marine	
	Small	Large[37]	Small
Production			
Reported production (tonnes)	203 700	2 635 969	151 699
of which caught outside EEZ (tonnes)	0	1 146 811	0
Estimated production (tonnes)	1 060 320	2 662 329[38]	188 216[39]
Trash/low produced (tonnes)[40]	0	769 386	2 337
Value			
Reported value (1 000 US$)[41]	199 226	1 381 348	199 226
Estimated value (1 000 US$)	1 060 320[42]	1 381 348	235 743[43]
Other			
Number of boats	3 122[44]	11 343	60 141
Domestic human consumption (tonnes)	1 060 320	1 070 239	185 879
Export (tonnes)	0	796 344[45]	0
Fishermen (peak season)	3 131 355	73 911	94 229
of which are Family members	3 107 696	4 211	76 646
Costs (capital, fuel and running)	0[46]	425 362	13 299
Income per unit (household/boat)[47]	609	74 808	1 825

The major finding of this analysis is that the marine small-scale fishery production in Thailand is a relatively small percentage of the total production (~10 percent) although there are ~ 60 000 small-scale boats (80 percent). Hence, for any future efforts to improve the fisheries data/statistics of Thailand it would be valuable to do sample surveys of marine small-scale fishing production to get a better estimate of its contribution to the total production. Additionally, the official reported figure for inland production is probably underestimated even by our estimate of ~1 100 000 tonnes production.

The production from outside of Thailand by Thai fishing boats and landed in Thailand will be reported in the new Southeast Asia Fisheries Development Center (SEAFDEC) forms as production from the area where it is caught (i.e. production transshipped to Thailand from Indonesia will be reported as production from Indonesia. It is still, however, unclear if the production of Thai boats operating outside of Thailand and not reported to DoF is reported as catch in Thailand or where it is actually caught or if it is reported at all. This could have major implications for the reported catch as the number of vessels in question is roughly 3 500 large-scale fishing boats. Also, species reporting is weak and should be improved. From marine fisheries, almost 1 000 000 tonnes is reported either as other food fish or as trash fish.

[37] Including production outside Thailand's EEZ.
[38] Including a 1 percent discard rate.
[39] Including a 1 kg/day/fisher fishing for own consumption.
[40] Based on percentage of fleet segment that falls into each category.
[41] Converted to US$ using the conversion rate for 15 December 2004, which was 39.1 Baht/US$ 1.
[42] Estimated as US$ 1 per kg of estimated production.
[43] Reported value + 1 US$ * (reported production (kg) – estimated production (kg))
[44] Estimated from 2.8 boats/km^2 of water and than applying a 50 percent reduction because of the high amount of fixed gear and hand nets used.
[45] All production for export estimated to come from large-scale fisheries.
[46] The running costs, fuel cost and investments in the inland sector are considered as negligible and hence all profit is considered to be net profit.
[47] The average income per year is calculated as net profit per boat divided by number of crew members or net profit per household multiplied by the ratio between households and the number of fishers.

Any census has weaknesses in capturing occasional or part time fishing and aquaculture activities. Definitions used or cut off points can also mean that households that are small-scale producers also may no be fully recorded (this is a common problem with small pond backyard aquaculture). Peri-urban or even urban activities may be ignored in rural censuses, just as landless households engaged in fisheries may not appear in agricultural censuses. A nice example of this are the owner/operators of the large fixed bag nets which can be found in urban areas (see picture below).

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APPENDIX I - INLAND FISHERIES PRODUCTION[48, 49]

Common name	Scientific name	At freshwater landing places[50]		From natural reservoirs[51]		From pond traps[52]	
		Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)
Jumbo tiger prawn	*Penaeus monodon*	83.53	19 147.65	0	0	0	0
Giant river prawn	*Macrobrachium rosenbergii*	76.85	22 406.23	53.20	7 521.53	0	0
Yellow shrimp	*Metapenaeus brevicornis*	46.93	5 265.84	0	0	0	0
Dwarf prawn	*Macrobrachium equidens*	45.64	3 846.95	0	0	0	0
Tiger prawn	*Penaeus semisulcatus*	26.83	7 566.02	0	0	0	0
Other shrimps		0	0	20.67	621.35	0	0
Shrimp Subtotal		*279.78*	*58 232.69*	*73.87*	*8 142.88*	*0*	*0*
Silver barb	*Puntius gonionotus*	409.27	13 280.83	11 894.96	398 083.43	121.97	2 786.21
Nile tilapia	*Tilapia nilotica*	245.32	7 273.24	10 205.92	345 718.80	3.39	92.07
Striped snake-head fish	*Channa striatus*	146.12	8 448.48	4 972.26	300 365.90	263.95	15 766.69
Common carp	*Cyprinus carpio*	0.06	2.80	2 393.77	78 971.35	0	0
Walking catfish	*Clarias batrachus*	52.04	3 580.90	2 276.37	102 711.14	60.04	2 207.88
Jullien's mud carp	*Cirrhina jullieni*	1 057.56	19 785.80	1 738.68	38 261.76	0	0
Rohu	*Labeo rohita*	19.45	597.95	1 663.12	54 409.32	0.19	2.85
Common climbing perch	*Anabas testudineus*	148.16	3 244.86	1 651.02	68 780.95	221.59	7 641.78
Small-scale mud carp	*Cirrhina microlepis*	9.47	285.14	1 556.99	51 201.17	0	0
Jullien's golden-price carp	*Probarbus jullieni*	0	0	1 482.10	46 872.46	0	0
Silver shark minnow	*Osteochilus hasseltii*	52.93	988.33	1 218.62	26 897.89	0	0
Grass carp silver carp Bighead carp	*Ctenopharyngodon idellus* *Hypophthalmichthys molitrix* *Aristichthys nobilis*	8.73	241.67	876.51	28 518.42	0	0
Yellow mystus	*Mystus nemurus*	172.44	13 085.62	534.81	26 776.71	0	0
Banded barb	*Hampala macrolepidota*	119.29	2 428.91	465.44	11 581.94	0	0
Striped dwarf catfish	*Mystus vittatus*	58.24	1 420.88	353.31	12 851.48	0	0

[48] Production and value by species of inland fisheries at freshwater landing places, from natural reservoirs and pond traps, 2003.
[49] *Note:* Methodology for preparing inland capture fisheries statistics is described in Appendix II.
[50] DoF 2005b.
[51] DoF 2005a.
[52] DoF 2005c.

Appendix I (Cont.)

Common name	Scientific name	At freshwater landing places[50]		From natural reservoirs[51]		From pond traps[52]	
		Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)
Striped catfish	*Pangasius hypothalamus*	127.56	2 981.09	303.40	7 607.03	0	0
Three-spot gourami	*Trichogaster trichopterus*	0	0	174.82	3 235.08	2.46	37.34
Whisker sheatfish	*Kryptopterus bleekeri*	205.77	30 273.72	152.60	10 944.97	0	0
Snakeskin gourami	*Trichogaster pectoralis*	34.66	1 197.35	120.12	5 587.36	53.46	1 846.85
Grey feather back	*Notopterus notopterus*	547.29	22 987.60	116.11	3 751.46	0	0
Blanc's striped featherback	*Notopterus blanci*	0	0	113.47	6 008.24	0	0
Giant snake-head fish	*Channa micropeltes*	73.04	2 181.45	108.80	4 821.18	0	0
Spotted featherback	*Notopterus chitala*	24.93	1 235.83	105.97	3 856.03	0	0
Black sheatfish	*Ompok miostoma*	0	0	82.77	4 961.76	0	0
Red-cheek barb	*Puntius orphoides*	0	0	75.59	2 283.11	0	0
Giant gourami	*Osphronemus goramy*	37.95	1 893.31	59.96	2 770.81	0	0
Spotted spiny eel	*Macrognathus siamensis*	0.93	37.61	55.87	2 413.50	0	0
Sand goby	*Oxyeleotris marmoratus*	80.59	9 238.92	35.23	2 588.11	0	0
Greater black shark	*Morulius chrysophekadion*	40.50	1 523.27	34.83	1 701.20	0	0
Swamp eel	*Fluta alba*	22.20	1 463.79	31.56	1 729.75	0	0
Java tilapia	*Tilapia mossambica*	0	0	28.68	509.51	0	0
Striped tiger nandid	*Pristolepis fasciatus*	646.07	12 600.48	23.88	744.20	0	0
Soldier river barb	*Cyclocheillichthys enoplos*	20.32	970.80	21.42	811.16	0	0
Bleeker's sheatfish	*Micronema bleekeri*	0.37	48.15	10.16	833.12	0	0
Great white sheatfish	*Wallagonia attu*	42.96	4 972.85	9.12	598.10	0	0
Silver rasbora	*Rasbora argyrotaenia*	0	0	5.84	114.21	0	0
One-spot glass catfish	*Ompok krattensis*	6.20	396.90	2.71	163.73	0	0
Snapper	*Lutjanus* spp.	0	0	1.79	94.24	0	0
Smith's barb	*Puntioplites proctozsron*	364.30	6 144.93	1.64	31.16	0	0
Black ear catfish	*Pangasius larnaudi*	3.86	151.54	0.68	31.14	0	0

Appendix I (Cont.)

Common name	Scientific name	At freshwater landing places[50]		From natural reservoirs[51]		From pond traps[52]	
		Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)
Fire spiny eel	*Mastacembelus erythrotaenia*	13.91	729.26	0.53	21.23	0	0
Seabass	*Lates calcarifer*	33.82	4 451.58	0.38	22.82	0	0
Soldier croaker	*Nibea soldado*	0	0	0.35	12.13	0	0
Temminck's kissing gourami	*Helostoma temmicki*	0	0	0.33	13.20	0	0
Botia	*Botia modesta*	0	0	0.32	12.80	0	0
Sangaward catfish	*Pangasius siamensis (P. macronema)*	215.02	3 755.70	0	0	0	0
Common sheatfish	*Kryptopterus apogon*	160.33	17 917.62	0	0	0	0
Mekong giant catfish	*Pangasianodon gigas*	32.77	2 797.91	0	0	0	0
Shieldheaded catfish	*Tachysurus* spp.	31.31	2 935.72	0	0	0	0
Mullet	*Mugil* spp.	28.72	3 510.37	0	0	0	0
Blotched snake-head fish	*Channa lucius*	15.13	525.13	0	0	0	0
Anchovy	*Encrasicholina* spp.	8.65	179.72	0	0	0	0
Other fish		1 764.57	44 055.05	5 227.11	124 455.58	32.29	444.74
Fish Subtotal		*7 082.81*	*255 823.06*	*50 189.92*	*1 784 730.64*	*759.34*	*30 826.41*
Others		0.36	16.26	0	0	0	0
Grand total		*7 362.95*	*314 072.01*	*50 263.79*	*1 792 873.52*	*759.34*	*30 826.41*

APPENDIX II - INLAND FISHERIES[53]

Common name	Scientific name	2000		2001		2002		2003		2004	
		Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)
Silver barb	*Puntius gonionotus*	13 007.02	406 628.41	12 944.39	392 807.35	11 395.17	341 636.53	11 894.96	398 083.43	12 288.03	382 293.32
Nile tilapia	*Tilapia nilotica*	12 675.78	428 931.68	12 321.52	364 518.62	9 755.44	313 927.79	10 205.92	345 718.80	11 985.72	420 564.16
Striped snake-head fish	*Channa striatus*	6 503.97	365 154.81	4 599.95	242 885.15	4 749.90	252 756.68	4 972.26	300 365.90	5 802.04	327 508.28
Jullien's mud carp	*Cirrhina jullieni*	2 905.44	56 586.83	1 436.51	29 085.43	1 318.45	26 040.49	1 738.68	38 261.76	4 509.71	102 584.71
Other fish		8 461.59	200 856.54	6 146.87	146 926.29	5 839.54	133 703.29	5 227.11	124 455.58	4 103.05	96 109.75
Common climbing perch	*Anabas testudineus*	2 118.01	58 304.15	1 199.76	33 913.24	1 079.82	30 125.24	1 651.02	68 780.95	2 894.43	92 748.94
Walking catfish	*Clarias batrachus*	6 228.39	287 974.36	2 304.42	103 441.95	2 069.31	93 390.73	2 276.37	102 711.14	2 841.34	131 166.55
Common carp	*Cyprinus carpio*	2 226.89	71 659.41	1 480.31	70 884.78	2 631.69	93 969.96	2 393.77	78 971.35	1 898.63	66 167.81
Jullien's golden-price carp	*Probarbus jullieni*	1 072.69	30 701.41	1 359.09	38 104.29	1 184.78	32 593.41	1 482.10	46 872.46	1 529.03	42 979.41
Small-scale mud carp	*Cirrhina microlepis*	1 533.26	46 869.84	1 261.66	39 121.05	1 199.17	36 668.05	1 556.99	51 201.17	1 499.71	48 718.41
Rohu	*Labeo rohita*	2 293.05	72 686.82	1 928.37	59 671.95	1 454.83	42 227.32	1 663.12	54 409.32	1 478.58	45 518.58
Banded barb	*Hampala macrolepidota*	827.92	24 162.62	365.36	9 060.67	252.10	7 204.91	465.44	11 581.94	838.11	22 421.34
Grey feather back	*Notopterus notopterus*	316.75	7 713.13	56.88	1 902.12	105.98	3 283.58	116.11	3 751.46	785.03	26 430.44
Yellow mystus	*Mystus nemurus*	639.74	30 231.54	326.46	16 522.03	282.79	13 566.91	534.81	26 776.71	718.81	34 653.02
Grass carp, silver carp, bighead carp	*Ctenopharyngodon idellus Hypophthalmichthys molitrix Aristichthys nobilis*	941.74	29 890.25	895.90	25 264.03	669.67	19 796.20	876.51	28 518.42	682.05	21 292.34
Snakeskin gourami	*Trichogaster pectoralis*	214.16	9 465.17	18.15	446.23	276.30	11 125.37	120.12	5 587.36	594.60	18 594.41
Striped dwarf catfish	*Mystus vittatus*	284.22	8 993.47	212.63	8 546.33	280.71	10 377.31	353.31	12 851.48	475.83	14 958.89
Striped catfish	*Pangasius sutchi*	331.31	8 710.02	283.71	7 548.03	340.24	8 530.17	303.40	7 607.03	326.77	8 798.15
Three-spot gourami	*Trichogaster trichopterus*	177.27	3 982.53	39.31	365.75	112.46	2 052.28	174.82	3 235.08	260.22	4 496.78
Striped tiger nandid	*Pristolepis fasciatus*	92.25	2 405.00	73.14	1 758.04	29.15	899.90	23.88	744.20	233.43	4 732.51
Blanc's striped featherback	*Notopterus blanci*	123.11	3 695.14	243.01	11 817.24	80.44	4 022.59	113.47	6 008.24	214.45	8 436.94
Smith's barb	*Puntioplites proctozsron*	6.95	202.29	3.13	78.44	0	0	1.64	31.16	208.51	2 624.25
Sand goby	*Oxyeleotris marmoratus*	64.44	3 915.17	9.69	396.89	15.38	763.54	35.23	2 588.11	207.20	10 353.90
Spotted featherback	*Notopterus chitala*	89.83	4 799.64	286.91	12 180.24	154.61	5 307.73	105.97	3 856.03	203.81	6 713.86
Silver shark minnow	*Osteochilus hasseltii*	105.32	2 606.73	1 195.15	28 936.77	755.68	22 206.52	1 218.62	26 897.89	185.87	4 725.47
Whiskered sheatfish	*Kryptopterus bleekeri*	137.59	10 997.69	337.64	23 654.89	163.94	11 637.83	152.60	10 944.97	174.26	12 931.46

[53] Production and value of inland capture fisheries from natural reservoirs by species in Thailand, 2000 to 2004.

Appendix II (Cont.)[54]

Common name	Scientific name	2000		2001		2002		2003		2004	
		Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)	Production (tonnes)	Value (1 000 Baht)
Greater black shark	*Morulius chrysophekadion*	12.66	446.13	4.10	147.56	39.90	824.78	34.83	1 701.20	122.98	3 325.58
Soldier river barb	*Cyclocheillichthys enoplos*	3.05	152.44	4.72	226.05	18.56	977.36	21.42	811.16	115.04	8 323.77
Giant snake-head fish	*Channa micropeltes*	17.30	735.47	72.63	2 629.73	126.78	6 594.97	108.80	4 821.18	87.79	3 698.49
Swamp eel	*Fluta alba*	49.82	2 175.73	13.20	743.55	45.54	3 289.74	31.56	1 729.75	81.03	3 423.93
Black sheatfish	*Ompok miostoma*	12.92	1 052.84	275.40	22 043.43	133.65	4 938.43	82.77	4 961.76	61.48	6 776.47
Giant river prawn	*Macrobrachium rosenbergii*	23.85	4 980.43	50.58	7 118.98	47.77	3 423.68	53.20	7 521.53	41.44	6 377.93
Java tilapia	*Tilapia mossambica*	19.04	725.16	53.24	804.45	17.93	268.91	28.68	509.51	21.80	446.77
Great white sheatfish	*Wallagonia attu*	1.57	94.63	8.16	326.64	1.36	54.76	9.12	598.10	13.99	631.99
Silver rasbora	*Rasbora argyrotaenia*	4.01	80.71	0	0	6.98	105.20	5.84	114.21	9.36	201.01
Other shrimps		32.28	1 454.13	33.42	1 193.11	35.72	741.11	20.67	621.35	9.02	696.29
Soldier croaker	*Nibea soldado*	0	0	14.51	580.31	0.42	19.89	0.35	12.13	8.07	320.41
Fire spiny eel	*Mastacembelus erythrotaenia*	16.21	529.48	1.00	36.08	0.49	19.21	0.53	21.23	7.85	476.05
One-spot glass catfish	*Ompok krattensis*	219.06	4 587.99	217.95	4 903.88	0.12	7.33	2.71	163.73	7.61	487.69
Red-cheek barb	*Puntius orphoides*	34.46	1 033.82	305.77	9 173.42	97.05	2 635.86	75.59	2 283.11	4.75	71.57
Seabass	*Lates calcarifer*	2.01	180.91	1.06	96.26	0	0	0.38	22.82	3.36	268.51
Spotted spiny eel	*Macrognathus siamensis*	2.01	119.80	0.23	9.52	0	0	55.87	2 413.50	3.24	112.13
Giant gourami	*Osphronemus goramy*	1.17	65.96	13.47	673.42	51.17	2 553.96	59.96	2 770.81	2.92	131.24
Black ear catfish	*Pangasius larnaudi*	86.71	4 335.11	0.09	3.96	0	0	0.68	31.14	1.78	62.39
Bleeker's sheatfish	*Micronema bleekeri*	0	0	0	0	34.97	4 145.48	10.16	833.12	1.71	34.27
Botia	*Botia modesta*	0	0	0	0	0.38	7.50	0.32	12.80	0.42	16.85
Temminck's kissing gourami	*Helostoma temmicki*	0	0	9.83	288.29	0.83	48.20	0.33	13.20	0.22	6.48
Snapper	*Lutjanus* spp.	0.44	35.76	0	0	2.82	265.30	1.79	94.24	0.16	15.91
Others		13.55	637.72	7.93	475.41	30.03	1 517.90	0	0	0	0
Total		63 930.81	2 201 548.87	52 417.21	1 721 311.85	46 890.02	1 550 253.9	50 263.79	1 792 873.52	57 545.24	1 994 429.41

[54] DoF (2006d).

APPENDIX III - CALCULATION – MARINE CAPTURE FISHERIES

MARINE PRODUCTION OF LSF[55]

The catch survey is conducted on nine target fishing gears in 22 provinces, which are located along the sea. The samplings cover all annually registered fishing units of nine fishing gears. One fishing unit means a fishing household with fishing gear and fishers. The sampling technique used is stratified random sampling with type of fishing gear as strata. This technique is also applied in fishing effort analysis. The proportion of samplings of each stratum is as follows:

Table 1. App. III Percentage of each stratum sampled for nine different fishing gears

Type of gear	Boat length	Percentage of total fishing units
Otter board trawl		
	boat length < 14 m	10
	boat length 14-18 m	10
	boat length 19-25 m	10
	boat length > 25 m	15
Pair trawl		
	boat length < 14 m	30
	boat length 14-18 m	10
	boat length > 18 m	15
Beam trawl	All	30
Purse sein	All	10
Anchovy purse seine	All	10
King mackerel drifting gill net	All	10
Mackerel encircling gill net	All	15
Push net	All	15
Deep water set net	All	15

The analysis is first monthly done by group of fishing gear, species, and province, after that each result is summed up to the annual total production. The equations for analysis are as follows:

For fishing gears that are not surveyed by length of boat

$$T_h = \frac{N}{n} \sum_{i=1}^{n} X_{hi}$$

When
T_h = total catch by type of fishing gear in month h
N = number of total fishing units
n = number of samples
x_{hi} = catch of sample i in month h
h = month 1, 2, 3,…, 12
i = sample 1, 2, 3,…, n

Then the total catch all year is $T = \sum_{h=1}^{12} T_h$

[55] (DoF, 2006f).

For fishing gears that are surveyed by length of boat (otter board trawl, pair trawl)

$$T_{hj} = \frac{N_j}{n_j} \sum_{allij} X_{hij}$$

When j = group by length of boat, 1, 2, 3, 4 for otter board trawl, and 1, 2, 3 for pair trawl

T_{hj} = total catch of fishing unit in month h of group j

N_j = number of total fishing units of group j

n_j = number of samples of group j

x_{hij} = catch of sample i of group j in month h

Then the total catch by month is $T_h = \sum_{j=1}^{n} T_{hj}$

And the total catch all year is $T_h = \sum_{h=1}^{12} T_h$

MARINE PRODUCTION OF SSF[56]

The catch survey is conducted on target fishing gears, which are all types of fishing gears except the nine fishing gears of LSF mentioned above, in 22 coastal provinces. Then the target fishing gears are as follows:

1. Mackerel gill net;
2. Pomfret gill net;
3. Mullet gill net;
4. Shrimp trammel net;
5. Crab gill net;
6. Squid trammel net;
7. Other gill nets;
8. Squid falling net;
9. Other cast nets;
10. Hand push net;
11. Long line; and
12. Hand line and Pole & line.

The sampling technique used is stratified stage sampling that the first stage is to divide marine fishing communities into five fishing zones by provinces as follows:

Zone 1: Trad, Chanthaburi, Rayong;

Zone 2: Chonburi, Chachoengsao, Samut Prakan, Samut Sakhon, Samut Songkhram, Petchaburi, Prachuap Khiri Khan;

Zone 3: Chumphon, Surat Thani, Nakhon Si Thammarat; and

Zone 4: Songkhla, Pattani, Narathiwat

Each zone is divided into 2 strata, A and B. The stratum A is fishing communities having boats more than 100 units, while having boats less than 100 units for stratum B. Fishing community samplings are conducted by using proportion of each stratum. The total samples will be 400 fishing communities.

[56] (DoF, 2006b).

For the second stage, the small-scale fishing gear survey is conducted by census in fishing community samples of each stratum. At least five fishing households of each fishing gear are sampled for catch data. The equations used for production and value analysis are as follows:

$$\hat{Q}_{hi} = \frac{N_{hj}}{n_{hj}} \cdot \sum_{i=1}^{n_{hj}} \frac{M_{hij}}{m_{hij}} \cdot \sum_{k=1}^{m_{hij}} X_{hijk}$$

$$\hat{V}_{hj} = \frac{N_{hj}}{n_{hj}} \cdot \sum_{i=1}^{n_{hj}} \frac{M_{hij}}{m_{hij}} \cdot \sum_{k=1}^{m_{hij}} Y_{hijk}$$

When X_{hijk} = catch of household k, fishing gear j, fishing community i of zone h

Y_{hijk} = value of household k, fishing gear j, fishing community i of zone h

h = fishing zone 1, 2,…, 5

i = fishing community 1, 2,…, n

j = fishing gear 1, 2,…, r

k = fishing household 1, 2,…, m

N = number of total fishing communities

n = number of fishing community samples

M = number of total fishing households in fishing community sample

m = number of total fishing household samples

And $\hat{Q}_{hj}$ = total catch of each fishing gear in each fishing zone

$\hat{V}_{hj}$ = value of each fishing gear in each fishing zone

So $$\hat{Q}_{h} = \sum_{j=1}^{r_h} \hat{Q}_{hj}$$

$$\hat{V}_{h} = \sum_{j=1}^{r_h} \hat{V}_{hj}$$

When $\hat{Q}_{h}$ = catch of all fishing gears in each zone

$\hat{V}_{h}$ = value of all fishing gears in each zone

And $$\hat{Q} = \sum_{h=1}^{5} \hat{Q}_{h}$$

$$\hat{V} = \sum_{h=1}^{5} \hat{V}_{h}$$

When $\hat{Q}$ = total catch of all fishing gears in all zones

$\hat{V}$ = total value of all fishing gears in all zones

APPENDIX IV - CALCULATION – INLAND CAPTURE FISHERIES

INLAND FISHERIES PRODUCTION AT FRESHWATER LANDING PLACES[57]

Monthly sampling technique is used to analyze catch and value of inland fisheries production from large human-made freshwater bodies, such as dams, and also large freshwater reservoirs. The sampling sites are freshwater landing places of the fishing boats that operate in those reservoirs. The survey is divided into two steps as follows:

1. Survey for number of fishing boats that daily land fish at fishing places; and
2. Analyze the species composition and value of catch from fishing boats that land fish at fishing places by using sampling method.

The equations for analysis are as follows:

$$\hat{Q}_h = \frac{N_h}{n_h} \sum_{j=1}^{n} \sum_{i=1}^{m} X_{hij}$$

$$\hat{V}_h = \frac{N_h}{n_h} \sum_{j=1}^{n} \sum_{i=1}^{m} X_{hij} \cdot P_{hij}$$

When
$\hat{Q}_h$ = production landed at fishing places in month h
$\hat{V}_h$ = value of production landed at fishing places in month h
N_h = number of total boats at fishing places in month h
n_h = number to sample boats at fishing places in month h
x_{hij} = catch of species i of sample boat j in month h
h = month 1, 2,…, 12
i = species 1, 2,…, m
j = sample boat 1, 2,…, n
p_{hij} = average price of species i of sample boat j in month h

So

$$\hat{Q} = \sum_{h=1}^{12} Q_h$$

$$\hat{V} = \sum_{h=1}^{12} V_h$$

When
$\hat{Q}$ = total catch of all year
$\hat{V}$ = value of total catch all year

[57] (DoF, 2005b).

INLAND FISHERIES PRODUCTION FROM FRESHWATER NATURAL RESERVOIRS[58]

The survey is yearly conducted to obtain the annual catch production of natural reservoirs, in all provinces by sampling technique. The natural reservoirs are divided into three groups as follows:

1. Reservoirs, which are divided into five sub-groups by area, i.e. smaller than 50 rai, 51-100 rai, 101-500 rai, 501-1 000 rai, and larger than 1 000 rai;
2. Natural swamps, which are divided into five sub-groups by area, i.e. smaller than 10 rai, 11-30 rai, 31-50 rai, 51-100 rai, and larger than 100 rai; and
3. Fish barrage, which are divided into five sub-groups by area, i.e. smaller than 10 rai, 11-30 rai, 31-50 rai, 51-100 rai, and larger than 100 rai.

The equations for catch analysis by province are as follows:

$$X_{hij} = \frac{A_{ij}}{\sum_{k=1}^{n_{ij}} a_{ijk}} \sum_{k=1}^{n_{ij}} X_{hijk}$$

When
X_{hijk} = catch of species h, natural reservoir group i, area j, sample reservoir k
X_{hij} = catch of species h, natural reservoir group i, and area j
A_{ij} = area of natural reservoir group i, area j
a_{ijk} = area of sample reservoir k, natural reservoir group i, area j
h = species type (1, 2,…, n)
i = group of natural reservoirs (1, 2, 3)
j = area (1, 2, 3, 4, 5)
k = sample reservoir (1, 2,…, n_{ij})

Then, the catch of all species in each group of natural reservoirs and areas by province is

$$X_{ji} = \sum_{h=1}^{n} X_{hij}$$

The catch of all species in all areas of each group of natural reservoirs by province is

$$X_{i} = \sum_{j=1}^{5} X_{ij}$$

The value of species h in natural reservoir group i, area j is

$$V_{hij} = P_{hij} \bullet X_{hij}$$

[58] (DoF, 2006d).

The value of species *h* in all areas of natural reservoir group *i* is

$$V_{hi} = \sum_{j=1}^{5} V_{hij}$$

The value of all species in natural reservoir group *i* is

$$V_{i} = \sum_{h=1}^{n} V_{hi}$$

When P_{hij} = average price of species *h* in natural reservoir group *i*, area *j*
V_{hij} = value of species *h* in natural reservoir group *i*, area *j*

INLAND FISHERIES PRODUCTION FROM POND TRAPS[59]

The survey is yearly conducted to obtain the annual catch production of pond traps, which are personal or public properties, in all provinces by sampling technique. Pond traps are made for capture fisheries purpose. The one, who wants to harvest the catch production in any pond traps, has to inform the local district office.

The equations for catch, value, and price analysis of each species by province are as follows:

$$\hat{Q}_{ij} = \frac{A_{ij}}{a_{ij}} \sum_{k=1}^{l} X_{ijk}$$

When $\hat{Q}_{ij}$ = catch of species *j* in province *i*
A_{ij} = total area of pond traps, which have production, in province *i*
a_{ij} = total area of sample pond traps for species *j* in province *i*
X_{ijk} = catch of sample pond trap *k*, species *j* in province *i*
i = province (*i* = 1, 2,…, *n*)
j = species (*j* = 1, 2,…, *m*)
k = sample pond trap (*k* = 1, 2,…, *l*)

$$\hat{V}_{ij} = \frac{A_{ij}}{a_{ij}} \sum_{k=1}^{l} V_{ijk}$$

When $\hat{V}_{ij}$ = value of species *j* in province *i*
A_{ij} = total area of pond traps, which have production, in province *i*
a_{ij} = total area of sample pond traps for species *j* in province *i*
V_{ijk} = value of sample pond trap *k*, species *j* in province *i*
i = province (*i* = 1, 2,…, *n*)
j = species (*j* = 1, 2,…, *m*)
k = sample pond trap (*k* = 1, 2,…, *l*)

[59] (DoF, 2005c).

$$P_{ij} = \frac{V_{ij}}{Q_{ij}}$$

When P_{ij} = average price of species *j* in province *i*

V_{ij} = value of species *j* in province *i*

Q_{ij} = catch of species *j* in province *i*

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