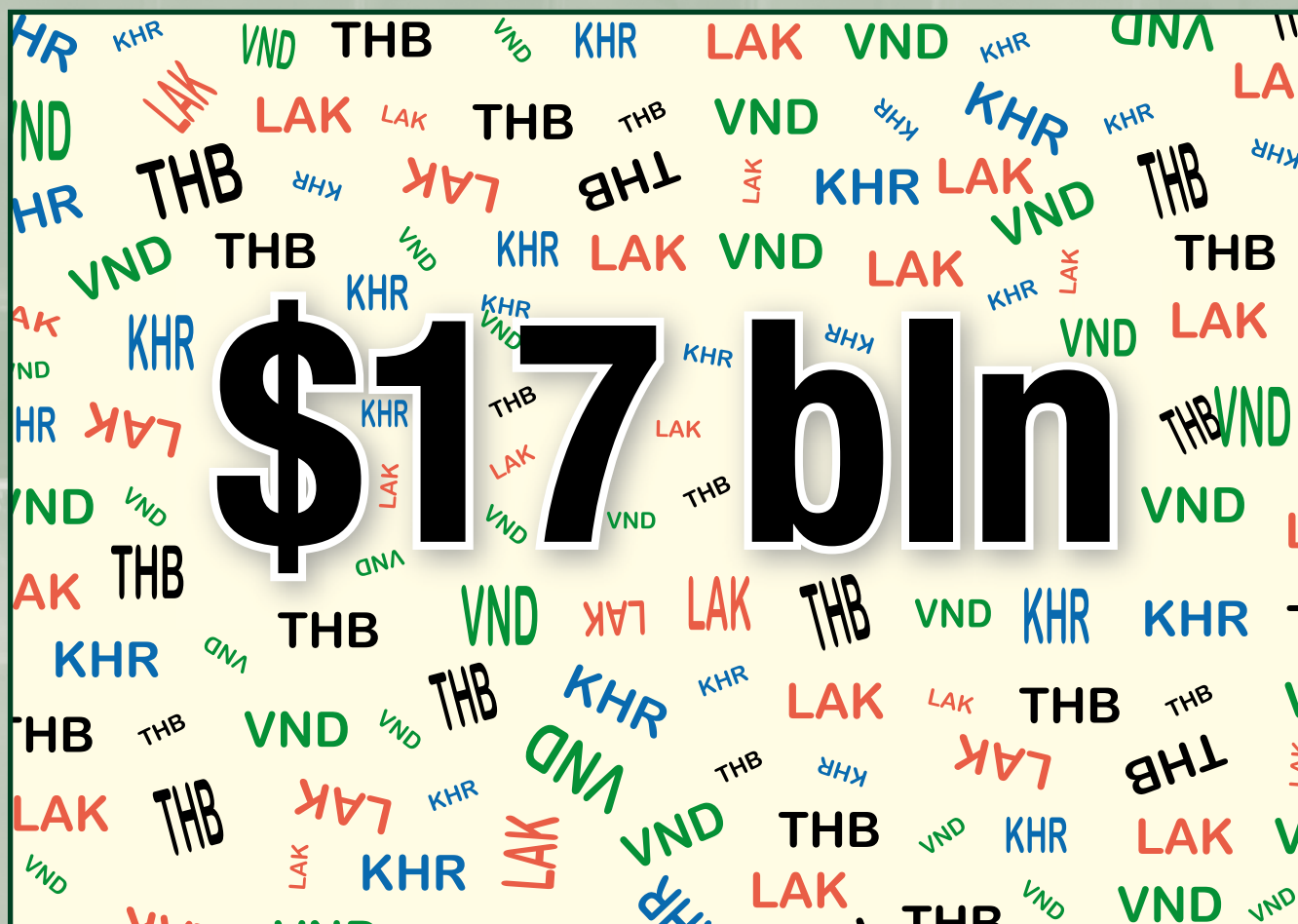


Fisheries Research and Development in the Mekong Region

Volume 21, No 3

ISSN 0859-290X

December 2015



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- World aquaculture set to overtake capture fisheries in 2023
- Thai ornamental fish centre eyes global market
- Catfish deal between Viet Nam and US
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- Genetic considerations in culture-based fisheries



Catch and Culture is published three times a year by the office of the Mekong River Commission Secretariat in Phnom Penh, Cambodia, and distributed to over 650 subscribers around the world. The preparation of the newsletter is facilitated by the MRC Fisheries Programme with funding from DANIDA, SIDA and USAID. Free email subscriptions are available through the MRC website, www.mrcmekong.org. For information on the cost of hard-copy subscriptions, contact the MRC's Documentation Centre at doc.centre@mrcmekong.org.

Contributions to *Catch and Culture* should be sent to peterstarr@mac.com and copied to mrccs@mrcmekong.org.

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Editorial panel:

So Nam, Fisheries Programme Coordinator

Peter Degen, International Technical Advisor

Souvanny Phommakone, Fisheries Programme Officer

Ly Vuthy, Fisheries Programme Officer

Theerawat Samphawamana, Fisheries Programme Officer

Nguyen Hai Son, Fisheries Programme Officer

Malasri Khumsri, Fisheries Management and Governance Specialist

Ngor Peng Bun, Capture Fisheries Specialist

Kong Sovanara, Aquaculture Specialist

Editor: Peter Starr

Designer: Chhut Chheana

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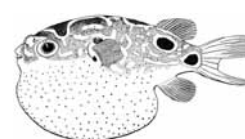
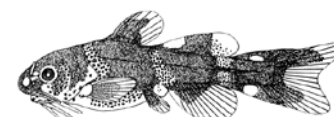
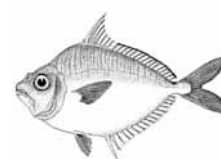


PHOTO: WITCHAMAI SOMCHARN

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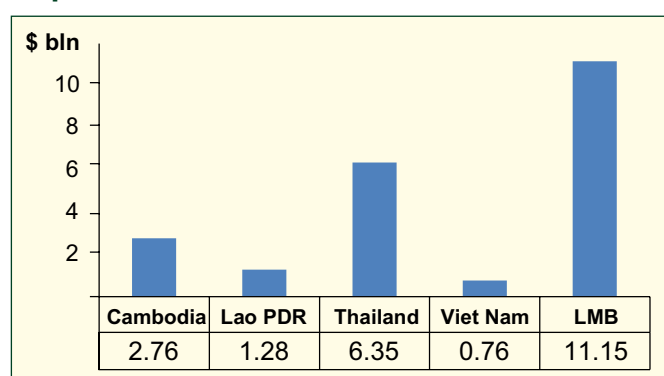
Lower Mekong fisheries estimated to be worth around \$17 billion a year

BY SO NAM, SOUVANNY PHOMMAKONE, LY VUTHY, THEERAWAT SAMPHAWAMANA, NGUYEN HAI SON, MALASRI KHUMSRI, NGOR PENG BUN, KONG SOVANARA, PETER DEGEN AND PETER STARR *

New estimate based on total production of 4.4 million tonnes for both capture fisheries and aquaculture within the basin

Revised yield estimates and recent first-sale prices indicate that fisheries in the Lower Mekong Basin are currently worth about \$17 billion a year. The value is equivalent to three percent of the combined gross domestic product (GDP) of the four countries and 13 percent of the international trade value of fish as measured by the latest export forecasts of \$130 billion for this year (FAO, 2015). The MRC Fisheries Programme estimated the economic values of Lower Mekong fisheries as part of its recent research for an upcoming *State of the Basin* report for 2015. Total fisheries production was calculated at about 4.4 million tonnes comprising an estimated 2.3 million tonnes from capture fisheries and about 2.1 million tonnes from aquaculture production in 2012, the most recent year for which production figures for all four countries are available.

Capture fisheries estimated value in basin

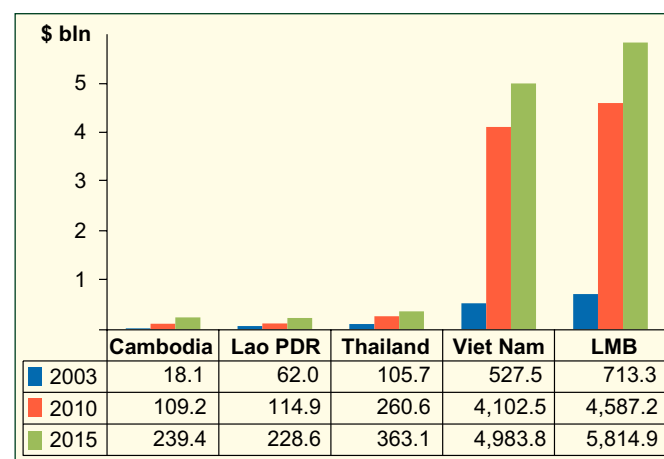


SOURCE: HORTLE AND BAMRUNGRACH (2015) AND MRC FISHERIES PROGRAMME ESTIMATES FROM NATIONAL FISHERIES STATISTICS AND NATIONAL SURVEY REPORTS

Based on first-sale prices, the wild catch would be worth about \$11 billion in 2015 (\$2.8 billion in Cambodia, \$1.3 billion in Lao PDR, \$6.4 billion in Thailand and \$0.8 billion in Viet Nam). Reservoir fisheries alone are estimated to be worth about

\$1.1 billion, with about two-thirds of the value generated in Thailand. The average price of \$4.8/kg reflected landing prices of small, medium and large-sized species in all four countries in 2015. In Cambodia, the average price was \$3.6/kg, based on prices for five key species at four locations which were cross-referenced with a national fish price database. In Lao PDR, the average price of 39 species at four locations was \$5.2/kg. In Thailand, the average price for 18 species caught at four locations was \$6.9/kg. In Viet Nam, the average price of six common species in two provinces in the Mekong Delta, Dong Thap and An Giang, was \$2.1/kg.

Aquaculture estimated value in basin



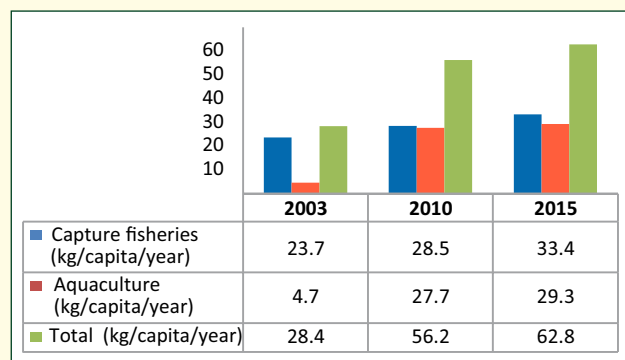
SOURCE: MRC FISHERIES PROGRAMME ESTIMATES FROM NATIONAL FISHERIES STATISTICS AND NATIONAL SURVEY REPORTS

According to recent farm-gate prices in the four countries, aquaculture in the Lower Mekong is estimated to be worth about \$5.8 billion in 2015, up from about \$4.8 billion in 2010 and less than \$1 billion in 2003. Aquaculture has been growing rapidly in the Lower Mekong Basin with total production reaching 2.1 million tonnes in 2012, up from 1.8 million tonnes in 2010 and less than 0.7 million tonnes in 2003. The average annual growth rate has been around 17 percent, which is three times faster than the world average of 5.6

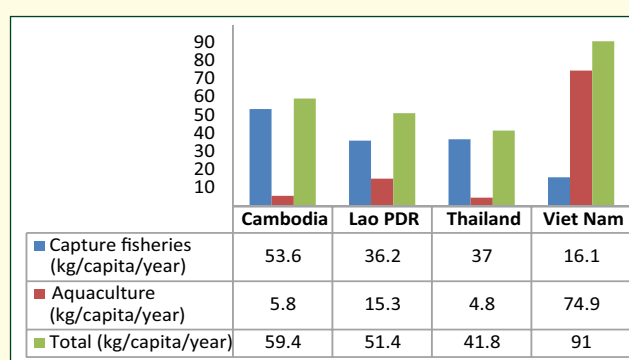
Most animal protein consumed in basin is from inland fish and other aquatic animals

Inland fish and other aquatic animals account for more than half the animal protein consumed by people in the Lower Mekong Basin, ranging from almost 50 percent in Lao PDR and Thailand to almost 60 percent in Viet Nam and 80 percent in Cambodia (Hortle, 2007). The proportion of animal protein derived from fish and other aquatic animals is significantly higher than the world average of 17 percent with consumption rates particularly high in the provinces around the Tonle Sap Lake (So, 2015). Average fish consumption in the basin is estimated at 63 kg per year in 2015. Vietnamese appear to be the biggest consumers, eating more than twice as much fish as Thai inhabitants of the basin. However, the Vietnamese figure is somewhat misleading because it includes fish produced in the LMB that are consumed outside the basin. Other inland aquatic animals such as frogs, insects, clams, shrimps, snails and snakes account for about 6 percent of total animal protein consumption (Hortle, 2007).

Fish consumption in basin (2003-2015)



Country fish consumption in basin (2015)



SOURCE: CONSUMPTION BASED ON MEMBER COUNTRY ESTIMATES OF BASIN POPULATION (63.2 MILLION IN 2003, 66.6 MILLION IN 2010 AND 68.9 MILLION IN 2015)

percent in the decade to 2014 (OECD/Food and Agriculture Organization of the United Nations, 2015). Viet Nam is by far the largest aquaculture producer, accounting for almost 90 percent of the basin's production value which mainly reflects the farming of black tiger shrimp (*Penaeus monodon*) and catfish (*Pangasianodon hypophthalmus*) in the Mekong Delta.

The average farm-gate price for fishes and other aquatic animals in the Lower Mekong Basin was estimated at \$2.8/kg. In Cambodia, the average price of \$2.9/kg is based on a market survey of aquaculture by a research institute under the Fisheries Administration. In Lao PDR, the average price was \$2.2/kg and was based on farm-gate prices for 10 fish species being raised on two farms near Vientiane. Seven of these species were exotic and the remaining three were native species including the Mekong giant catfish (*Pangasianodon gigas*). The average price of \$3/kg in Thailand is based on Department of Fisheries statistics on prices for nine fish species (seven native and two exotic) as well as

indigenous river prawns (*Macrobrachium* spp.) and exotic white-leg shrimp (*Litopenaeus vannamei*), a marine species which has since been banned from inland aquaculture. In Viet Nam, the average price of \$2.9/kg is based on farm-gate prices in the Mekong Delta for five fish species (four indigenous and one exotic) and black tiger shrimp.

LMB fisheries as proportion of national GDP

	Value (\$ mln, 2015)	GDP (\$ mln, 2014)	% of national GDP
Cambodia	3,001	16,709	18.0
Lao PDR	1,508	11,772	12.8
Thailand	6,718	373,804	1.8
Viet Nam	5,740	186,205	3.1
LMB	16,967	588,490	2.9

SOURCE: WORLD BANK (2015) AND MRC FISHERIES PROGRAMME ESTIMATES FROM NATIONAL FISHERIES STATISTICS AND NATIONAL SURVEY REPORTS

Fisheries are relatively more important to the smaller and less developed economies of

Cambodia and Lao PDR, both located almost entirely within the basin. For Cambodia, the value of LMB fisheries is equivalent to 18 percent of the country's total GDP, which is in line with a World Bank estimate of 16 percent excluding aquaculture (World Bank, 2012). In Lao PDR, the LMB fisheries value represents almost 13 percent of national GDP. Although LMB fisheries values are higher in Thailand and Viet Nam, they represent smaller shares of overall activity in these economies, which are bigger and more developed than the Cambodian and Lao economies with considerable economic activity outside the basin.

The annual capture fisheries yield estimate of 2.3 million tonnes, up from the previous estimate of 1.9 million tonnes (MRC, 2010) comes from a recent study classifying aquatic Lower Mekong habitats into broad zones (Hortle and Bamrungrach, 2015). The higher figure reflects better estimation methods and does not necessarily reflect increased production of capture fisheries. Estimates of the basin's inland fishery resources have gradually become more accurate over the past two decades. In 1996, *Catch and Culture* estimated annual fisheries production from the basin at 1.0 million tonnes including a small contribution from aquaculture (Jensen, 1996). That was almost three times higher than an earlier estimate of only 357,000 tonnes (Mekong River Commission Secretariat, 1992). The revised estimate was later raised to 1.5 million tonnes (MRC, 2003) and then 1.9 million tonnes before the latest estimate based on habitats.

Government figures and estimates based on World



Lao fish monger. According to government estimates, Viet Nam alone has more than 70,000 fish traders in the Mekong Delta. Figures for fish traders are not available for other countries in the Lower Mekong Basin.

PHOTO: KENT G. HORTLE

Bank data indicate that more than five million people are actively engaged in fisheries in the Lower Mekong Basin. Almost two thirds of these people are involved in fishing and more than a quarter are engaged in farming of fish and other aquatic animals such as freshwater prawns, shrimp and frogs. The rest are processors or traders.

Separate studies have indicated that two thirds of LMB households, more than 40 million people, are either dependent or engaged in fisheries (MRC 2003, World Bank, 2012). It is noted that catching fish and other aquatic animals is a very important part of livelihoods and food generation portfolios of most rural villagers, especially in Cambodia and Lao PDR (Arthur et al. 2011, Swift *et al.*, 2005). Large parts of the population do not appear in censuses and surveys as “fishers” as they may engage in fishing only part time or seasonally and may consider themselves as “farmers”. Yet they do depend on fishing yields for complementary or seasonal income and for home consumption. In this context, it should also be mentioned that fishing is an integral part of the livelihoods, culture and food security coping strategies of upland

People engaged in LMB fisheries (number)

	Cambodia	Lao PDR	Thailand	Viet Nam	LMB
Fishers	1,009,190	526,300	1,065,900	689,910	3,291,300
Fish farmers	80,976	782,800	315,948	279,552	1,459,276
Processors	220,464	NA	NA	133,705	354,169
Traders	NA	NA	NA	72,786	72,786
Total	1,310,630	1,309,100	1,381,848	1,175,953	5,177,531

SOURCE: NATIONAL STATISTICS (CAMBODIA, LAO PDR AND VIET NAM) AND ESTIMATES BASED ON WORLD BANK DATA (THAILAND)

peoples who are mostly indigenous or ethnic minority groups showing the highest poverty incidences in the region (Xu and Daniel, 2011, Ministry of Agriculture and Forestry, 2014, Swift *et al.*, 2005, Degen *et al.*, 2005, Hap N. and M. Bhattarai, 2005, Choulamany, 2004). Thus, the actual number of people engaging in fisheries and associated industries in the Lower Mekong Basin is estimated at about 40-50 million.

** Dr So Nam is coordinator of the MRC Fisheries Programme, Ms Souvanny, Mr Ly Vuthy, Mr Theerawat and Mr Son are programme officers. Dr Malasri is the programme's fisheries management and governance specialist, Mr Peng Bun is its capture fisheries specialist, Mr Sovanara is its aquaculture specialist, Mr Degen is the programme's international technical advisor and Mr Starr is editor of Catch and Culture.*

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World aquaculture production forecast to overtake capture fisheries in 2023

OECD and FAO see 'new era' for aquaculture but note that capture fisheries will still be vital for food security

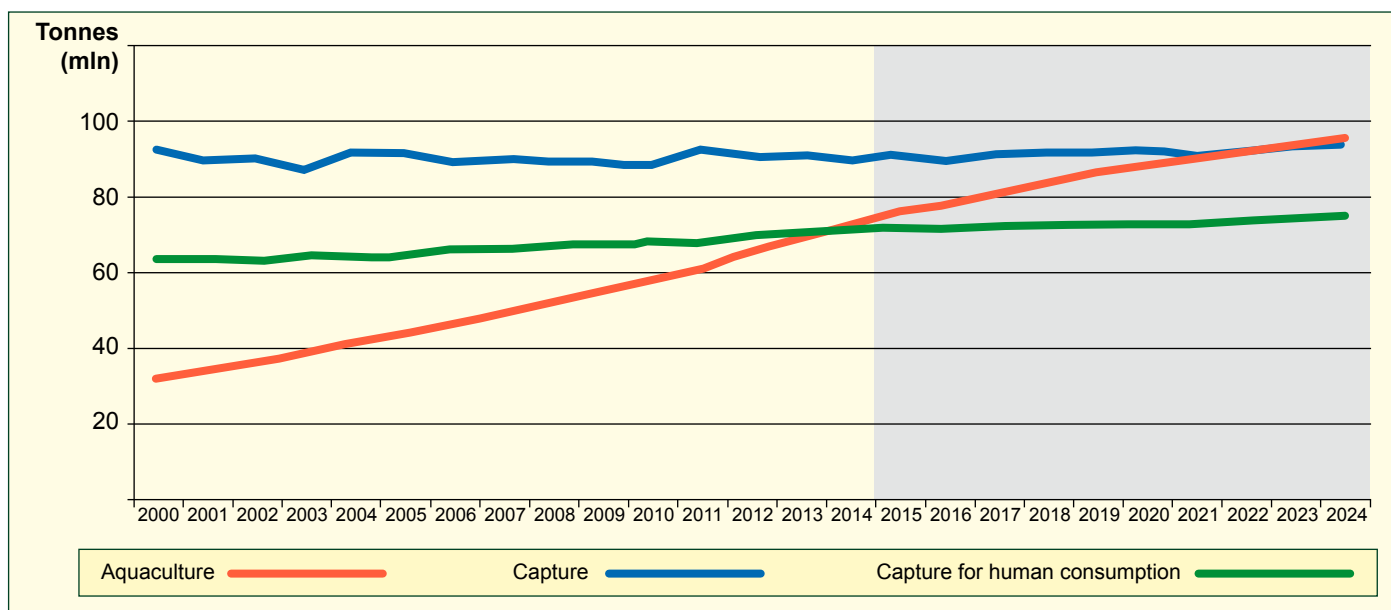
World aquaculture production is forecast to surpass global production of capture fisheries in 2023, according to the latest outlook by the Organisation for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO). "This development heralds a new era, indicating that aquaculture will increasingly be the main driver of changes in the fisheries and aquaculture sector," the *OECD-FAO Agricultural Outlook 2015-2024* concluded.

But the report also warned that productivity gains in aquaculture might be affected by several factors such as availability and accessibility to land, water and financial resources as well as improvements in technology and feeds. "In addition, animal disease outbreaks have shown ... the potential to affect aquaculture production and subsequently domestic and international markets depending on

the size and the species involved," it said. Released in July, the latest forecasts follow last year's development in which aquaculture overtook capture fisheries for human consumption (excluding ornamental fish and fish destined for the production of fishmeal, fish oil and other non-food uses). The report said aquaculture was expected to remain "one of the fastest growing food sectors" notwithstanding a slowdown in its average annual growth rate from 5.6 percent in the previous decade to 2.5 percent in the projection period to 2024. By then, aquaculture production is expected to reach 96 million tonnes, up 38 percent from the base period (average for 2012-14).

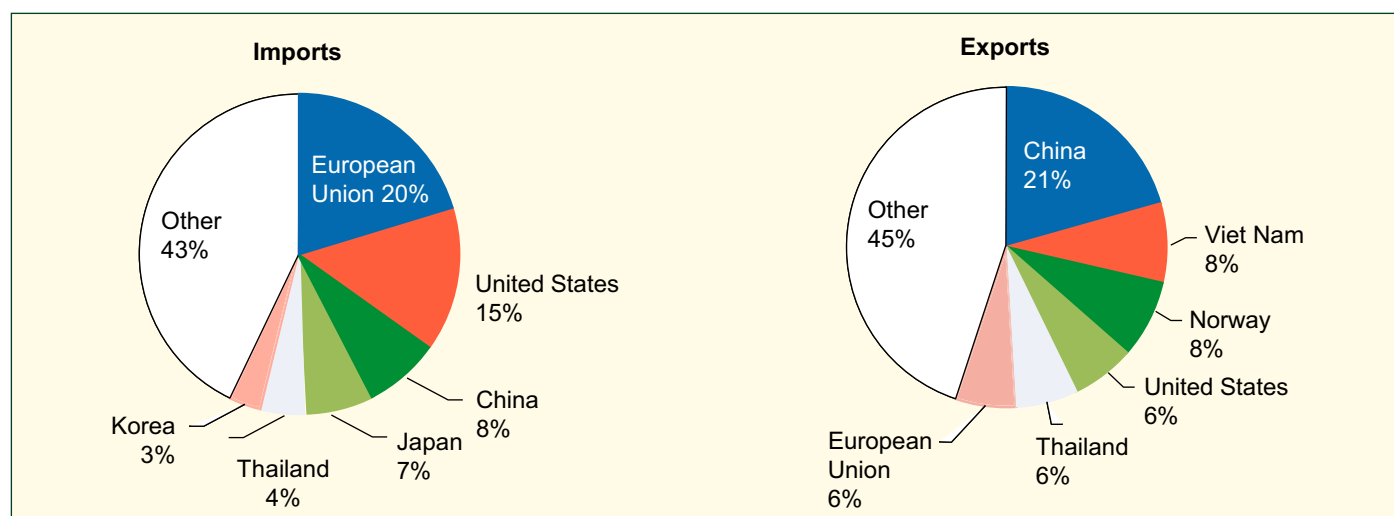
Total production of aquaculture and capture fisheries is forecast to reach 191 million tonnes in 2024, up 19 percent from the base period. World output of fishmeal is expected to rise to about five million tonnes at the end of the forecast period and fish oil production is expected to hover around one million tonnes. In both cases, the share of fishmeal and fish oil obtained from whole fish is expected to fall compared to the previous decade. The report

Production projections for aquaculture and capture fisheries (2015-2024)



SOURCE: OECD-FAO AGRICULTURAL OUTLOOK 2015-2024

Top importers and exports (projections for 2024)



SOURCE: OECD/FAO (2015), "OECD-FAO AGRICULTURAL OUTLOOK", OECD AGRICULTURE STATISTICS (DATABASE). DOI: [HTTP://DX.DOI.ORG/10.1787/AGR-OUTL-DATA-EN](http://dx.doi.org/10.1787/AGR-OUTL-DATA-EN)

identified the key uncertainties surrounding these forecasts as the natural productivity of fish stocks and ecosystems as well as the impact of El Niño weather phenomenon over the Pacific Ocean which results in drier conditions in Southeast Asia.

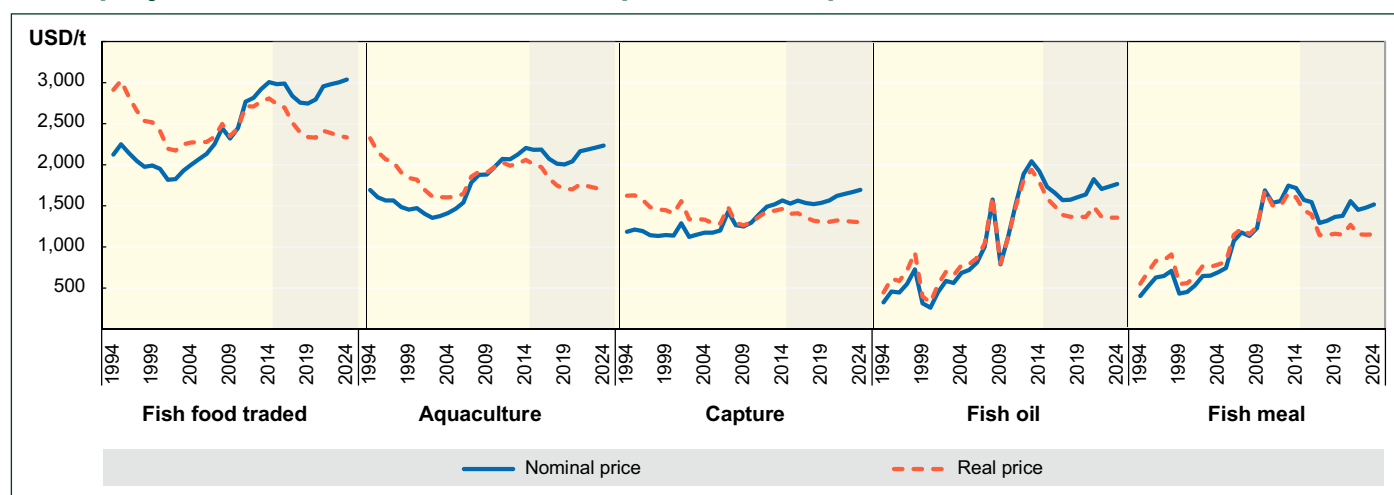
Despite the growing importance of aquaculture, "the capture sector will remain dominant for a number of species and vital for domestic and international food security," the report said. At the same time, it noted the long-term trend of South American and Asian countries steadily increasing their share of trade in fishery products.

"Developing countries, in particular in Asia, will continue to drive major changes and expansion in

global fishery production, trade and consumption, being the main producers, exporters and growing consumers," the report said. Indeed, Viet Nam is forecast to be the world's second largest exporter of fisheries products in 2024, accounting for eight percent of total exports, and Thailand is forecast to rank fifth with a six percent share of the global market (see chart above). The report said trade policies, especially bilateral trade agreements, would remain "an important factor influencing the dynamics of the world fish markets."

Fish prices are expected to decline in real terms after reaching record heights in 2014. The report said prices would be affected by income and population growth, a limited increase in capture

Price projections for fish food traded, aquaculture, capture fisheries, fish oil and fish meal



SOURCE: OECD/FAO (2015), "OECD-FAO AGRICULTURAL OUTLOOK", OECD AGRICULTURE STATISTICS (DATABASE). DOI: [HTTP://DX.DOI.ORG/10.1787/AGR-OUTL-DATA-EN](http://dx.doi.org/10.1787/AGR-OUTL-DATA-EN)

World fish and seafood projections by OECD and FAO (2015-2024)

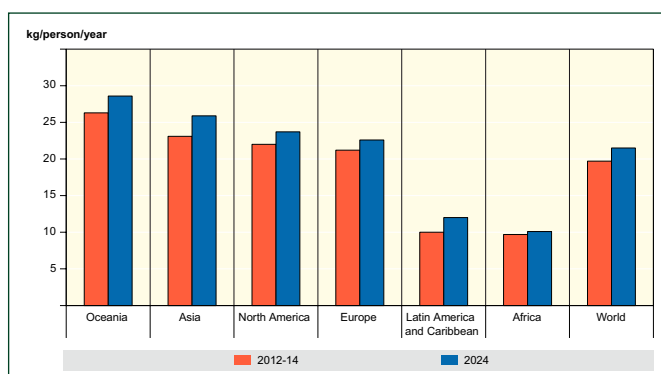
		Average 2012-14	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
FISH (World)												
Production	kt	161,180	168,792	169,486	174,471	177,582	180,775	182,833	182,831	186,256	189,130	191,348
of which aquaculture	kt	69,942	76,945	79,113	82,124	84,843	87,544	89,352	90,869	92,648	94,618	96,395
Consumption	kt	160,982	168,779	169,473	174,458	177,569	180,762	182,820	182,818	186,243	189,117	191,335
of which for food	kt	140,807	149,520	151,142	155,028	158,031	161,124	163,298	164,577	167,327	169,905	172,199
of which for reduction	kt	14,998	14,774	13,911	15,075	15,248	15,413	15,362	14,147	14,886	15,247	15,236
Price												
Aquaculture ¹	\$/t	2,132.1	2,183.9	2,187.2	2,075.6	2,015.4	2,007.4	2,041.0	2,158.4	2,174.5	2,188.3	2,215.3
Capture ²	\$/t	1,525.2	1,528.7	1,564.4	1,535.5	1,521.2	1,537.2	1,566.2	1,621.5	1,644.4	1,666.9	1,693.5
Product traded ³	\$/t	2,913.9	2,983.5	2,992.1	2,843.3	2,760.9	2,749.9	2,795.9	2,956.7	2,978.7	2,997.6	3,034.6
Developed countries												
Production	kt	28,472	28,780	28,884	29,095	29,202	29,367	29,492	29,552	29,641	29,729	29,821
of which aquaculture	kt	4,310	4,439	4,574	4,762	4,968	5,175	5,333	5,440	5,560	5,659	5,762
Consumption	kt	36,665	36,921	36,372	36,770	36,855	37,010	37,093	37,073	37,247	37,519	37,696
of which for food	kt	31,634	32,231	31,692	32,140	32,276	32,494	32,636	32,635	32,894	33,203	33,417
of which for reduction	kt	4,221	4,073	4,062	4,013	3,960	3,898	3,839	3,820	3,735	3,698	3,660
Developing countries												
Production	kt	132,707	140,012	140,601	145,376	148,380	151,408	153,341	153,279	156,615	159,01	161,527
of which aquaculture	kt	65,632	72,505	74,540	77,362	79,875	82,369	84,019	85,429	87,088	88,958	90,632
Consumption	kt	124,317	131,858	133,101	137,688	140,715	143,753	145,728	145,745	148,996	151,599	153,639
of which for food	kt	109,173	117,290	119,450	122,888	125,755	128,630	130,662	131,942	134,433	136,702	138,782
of which for reduction	kt	10,777	10,701	9,849	11,062	11,288	11,515	11,524	10,326	11,151	11,550	11,576
FISHMEAL (World)												
Production	kt	4,666.3	4,701.3	4,518.7	4,840.2	4,913.2	4,986.3	5,009.3	4,728.6	4,950.5	5,072.2	5,100.4
from whole fish	kt	3,446.2	3,433.0	3,239.1	3,535.8	3,592.0	3,646.3	3,647.7	3,359.1	3,556.9	3,661.9	3,673.0
Consumption	kt	4,872.8	4,782.4	4,573.8	4,600.9	4,863.0	4,936.0	5,067.8	4,971.4	4,693.7	5,045.9	5,074.1
Variation in stocks	kt	-206.5	-81.1	-55.1	239.3	50.2	50.3	-58.6	-242.8	256.8	26.4	26.3
Price ⁴	\$/t	1,674.3	1,574.5	1,547.9	1,296.7	1,323.1	1,370.7	1,387.1	1,565.4	1,459.2	1,487.5	1,520.3
Developed countries												
Production	kt	1,316.5	1,377.3	1,394.5	1,397.0	1,395.9	1,398.2	1,398.7	1,405.2	1,399.0	1,402.7	1,406.5
from whole fish	kt	977.3	978.0	979.3	971.5	962.5	951.0	940.1	939.3	921.9	916.2	910.3
Consumption	kt	1,689.2	1,502.1	1,411.8	1,422.3	1,474.6	1,453.7	1,457.7	1,385.6	1,288.0	1,377.8	1,381.1
Variation in stocks	kt	11.7	-42.4	-6.1	24.3	0.2	0.3	-28.6	19.2	14.8	1.4	1.3
Developing countries												
Production	kt	3,349.8	3,324.0	3,124.2	3,443.2	3,517.3	3,588.1	3,610.6	3,323.5	3,551.5	3,669.5	3,693.9
from whole fish	kt	2,469.0	2,455.0	2,259.9	2,564.3	2,629.4	2,695.3	2,707.5	2,419.8	2,635.1	2,745.7	2,762.7
Consumption	kt	3,183.6	3,280.3	3,162.0	3,178.6	3,388.5	3,482.3	3,610.1	3,585.8	3,405.7	3,668.0	3,693.0
Variation in stocks	kt	-218.2	-38.7	-49.0	215.0	50.0	50.0	-30.0	-262.0	242.0	25.0	25.0
FISH OIL (World)												
Production	kt	951.7	1,021.3	974.2	1,036.3	1,048.3	1,063.2	1,065.3	1,006.7	1,049.0	1,071.1	1,074.3
from whole fish	kt	575.3	600.4	552.3	610.5	618.4	625.9	622.5	559.7	597.2	614.4	612.7
Consumption	kt	996.3	1,039.9	1,029.9	942.0	1,049.2	1,064.0	1,066.0	1,102.5	954.2	1,071.6	1,074.8
Variation in stocks	kt	-44.6	-18.7	-55.6	94.3	-0.9	-0.8	-0.7	-95.8	94.8	-0.5	-0.5
Price ⁵	\$/t	1,951.3	1,731.1	1,661.1	1,571.5	1,575.9	1,608.8	1,639.0	1,823.1	1,700.1	1,727.0	1,754.5
Developed countries												
Production	kt	418.7	460.0	459.0	458.9	461.0	465.8	468.4	471.6	472.1	474.9	477.8
from whole fish	kt	173.8	181.1	179.3	175.6	173.7	171.4	168.8	168.1	164.1	162.3	160.5
Consumption	kt	596.4	661.9	654.5	565.6	630.6	631.1	624.6	660.2	535.1	604.5	599.5
Variation in stocks	kt	11.1	-9.7	-23.6	22.3	-0.9	-0.8	-0.7	-23.8	22.8	-0.5	-0.5
Developing countries												
Production	kt	533.0	561.3	515.3	577.4	587.4	597.5	596.9	535.1	576.9	596.1	596.5
from whole fish	kt	401.5	419.3	373.0	434.9	444.7	454.5	453.6	391.6	433.2	452.1	452.2
Consumption	kt	399.9	378.0	375.3	376.4	418.6	432.9	441.3	442.4	419.1	467.1	475.2
Variation in stocks	kt	-55.7	-9.0	-32.0	2.0	0.0	0.0	0.0	-72.0	72.0	0.0	0.0

¹ World unit value of aquaculture fisheries production (live weight basis).² FAO estimated value of world ex-vessel value of capture fisheries production excluding for reduction.³ World unit value of trade (sum of exports and imports).⁴ Fishmeal, 64-65% protein, Hamburg, Germany.⁵ Fish oil, any origin, N.W. Europe.SOURCE: OECD/FAO (2015), "OECD-FAO AGRICULTURAL OUTLOOK", OECD AGRICULTURE STATISTICS (DATABASE). DOI: [HTTP://DX.DOI.ORG/10.1787/AGR-OUTL-DATA-EN](http://dx.doi.org/10.1787/AGR-OUTL-DATA-EN)

fisheries production, high meat prices in the short term and feed prices. "All these factors will contribute to high fish prices in the near future followed by a decline in the remaining years of this decade and an increase in the 2020s," it said.

The ratio between aquaculture and fishmeal prices is expected to remain "relatively stable" during the forecast period. But the ratio between prices of fishmeal and oilseed is expected to increase since demand for fishmeal from the aquaculture and livestock sectors is growing faster than supply. "The popularity of the Omega-3 fatty acids in human diets and the growth in aquaculture production have both contributed to a rise in the fish oil to oilseed price ratio since 2012, which is expected to be maintained over the medium term. However, since fish oil and oilseed oil prices are starting from very high levels, a decline is expected in nominal terms for the rest of this decade."

Projections for fish consumption (2024)



SOURCE: OECD/FAO (2015), "OECD-FAO AGRICULTURAL OUTLOOK", OECD AGRICULTURE STATISTICS (DATABASE). DOI: [HTTP://DX.DOI.ORG/10.1787/AGR-OUTL-DATA-EN](http://dx.doi.org/10.1787/AGR-OUTL-DATA-EN)

Global fish consumption is meanwhile projected to reach 21.5 kg per capita in live weight equivalent in 2024, up from 19.7 kg in the base period. "The average annual growth rate will be lower in the second half of the outlook period, due to more competitive meat prices. Per capita fish consumption is expected to increase in all continents, with Asia showing the fastest growth," the report said.

Further reading

OECD/Food and Agriculture Organization of the United Nations (2015), OECD-FAO Agricultural Outlook 2015-2024, OECD Publishing, Paris. http://dx.doi.org/10.1787/agr_outlook-2015-en

Catfish demand mostly steady in first half

US imports of frozen fillets of pangasius catfish (*Pangasianodon hypophthalmus*) rose 17 percent from a year earlier to 58,000 tonnes in the six months to June, according to the Food and Agriculture Organization of the United Nations (FAO). The agency's latest *Food Outlook* published in October said pangasius, which is mostly produced by farms in the Mekong Delta, would continue to be a "top choice" of affordable fish protein. "Demand remains steady in most markets," it said.

The biannual outlook said demand for pangasius remained "reasonably firm" in EU markets even though the region's imports fell substantially to 54,000 tonnes in the first half under pressure from the weakening euro. "Following the recent round of negotiations on the EU-Viet Nam Free Trade Agreement (FTA), it was agreed to cut the tax on pangasius significantly, which could promote future export volume growth," the UN agency said.

Viet Nam accounted for 71 percent of global pangasius production of 1.67 million tonnes in 2013. "Indonesia has significantly increased its production over the years, and now ranks as the second largest producer, making up 25 percent of the global pangasius supply," the FAO said. "Other production trends include increases from Cambodia and Myanmar, with the latter beginning exports to the US market."

The report noted that many Vietnamese pangasius farmers forced out of business were starting to farm tilapia (*Oreochromis* spp.) With supply also increasing in Latin America and India, global tilapia production is expected to rise six percent from a year earlier to five million tonnes in 2015. In China, however, "volumes are slowing, as the nation's exporters are looking to diversify and enlarge their markets," the FAO said. "Balancing high production, quality and sustainability is challenging for the tilapia industry in China."

Trans-Pacific Partnership accord has catfish deal between Viet Nam, US

BY PETER STARR *

Bilateral agreement to come into effect with signing of TPP expected during second quarter of 2016

Viet Nam and the United States have tentatively reached agreement over a lingering trade dispute involving catfish, according to draft letters exchanged between U.S. Trade Representative Michael Froman and Vietnamese Industry and Trade Minister Vu Vuy Hoang. The draft letters are among multiple "side instruments" to the Trans-Pacific Partnership (TPP), an ambitious regional trade agreement between Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, the United States and Viet Nam.

In line with other parties to the agreement, the Vietnamese Ministry of Industry and Trade published the chapters and associated annexes of the TPP agreement on its website on November 5, a month after trade ministers concluded a final round of negotiations in Atlanta. The ministry also published market-access offers and country-specific annexes as well as Viet Nam's side instruments with other TPP countries including 11 with the United States.

One of the instruments with the United States is an undated letter from Froman to the Vietnamese minister which refers to U.S. inspections of ray-finned fishes under the Food, Conservation and Energy Act of 2008 and the Agricultural Act of 2014 (see *Catch and Culture*, Vol 21, No 2). The letter says the two sides recognise the "importance" of pangasius, namely *tra* (*Pangasiandon hypophthalmus*) and *basa* (*Pangasius bocourti*), and agree to consult with each other in implementing a "final rule" for the inspection programme.

Inspections 'not inconsistent' with WTO

"The United States intends to implement the final rule in a manner not inconsistent with its obligations under the WTO Agreement," the letter says. "With a view to fostering trade of Siluriformes, the United States is considering a transitional period for the implementation of the final rule, during which the United States would continue to allow imports from foreign countries, including Viet Nam, of Siluriformes if they comply with U.S. laws and regulations."

Froman adds that the United States plans to work with Viet Nam and other interested parties



SOURCE: OFFICE OF THE US TRADE REPRESENTATIVE



Vietnamese Industry and Trade Minister Vu Vuy Hoang

PHOTO: GOVERNMENT OF VIET NAM

to "identify and provide technical assistance, as appropriate, regarding the requirements of the final rule, including workshops to promote understanding of the new requirements." In his reply to Froman, which is also undated, Minister Hoang says the Government of Viet Nam "shares this understanding" and that the exchange of letters "constitutes an agreement between our two Governments" that will take effect on an unspecified date.

The Vietnam Association of Seafood Exporters and Producers (VASEP) did not immediately comment on the exchange of draft letters. But it posted a link to the full text of the agreement on its website a day after it was published by the Ministry of Industry and Trade. "Now you can read the Trans-Pacific Partnership trade deal before judgement passing," the association said. VASEP noted that Vietnam's bilateral agreements with other countries would take effect at the same time as the TPP agreement is signed, probably in the second quarter of 2016, at which point each state would ratify the agreement according to domestic laws. VASEP also noted that the legal review process was continuing and that the final text may include amendments. "However, they will not affect commitments," it said.

Anti-Vietnamese catfish lobbyists in the United States have long opposed the TPP, accusing Vietnamese farmers of using "illegal" farming practices, notwithstanding the industry's recent adoption of global standards. Food & Water Watch, a Washington-based group, warned in April



US Trade Representative Michael Froman

PHOTO: OFFICE OF THE US TRADE REPRESENTATIVE

last year that "the TPP will likely increase imports of potentially unsafe and minimally inspected fish and seafood products." The activists referred to an "imported catfish catastrophe" in the United States. "America's catfish farmers have been slammed by low-priced catfish imports, potentially tainted with illegal chemicals and drugs, especially from TPP nation Vietnam," the group said, urging Americans to oppose President Barack Obama's fast-track approval of the agreement. Such comments by American protectionist groups date back more than a decade to when the United States initially imposed anti-dumping duties against pangasius from Viet Nam (see *Catch and Culture*, Vol 9, No 2).

The TPP partly overlaps with a proposed Regional Comprehensive Economic Partnership (RCEP) between 16 countries including all 10 ASEAN members and not just Brunei, Malaysia, Singapore and Viet Nam. This partnership would also include TPP members Australia, Japan and New Zealand along with non-members China, India and South Korea.

* Mr Starr is the editor of *Catch and Culture*

Further reading:

<http://tpp.moit.gov.vn>

http://seafood.vasep.com.vn/document-library/74_10909/full-text-of-trans-pacific-partnership-trade-deal-tpp.htm

<http://www.citizen.org/documents/fww-tpp-fish-imports-april-2014.pdf>

Is Indonesia challenging Vietnamese dominance of global catfish market?

Mekong Delta farmers face growing competition from rivals in Sumatra

Is Indonesia on the way to dethroning Viet Nam as the world's largest producer of pangasius catfish (*Pangasianodon hypophthalmus*)? Recent estimates show that the Vietnamese share of the global pangasius market has fallen to 71 percent while Indonesia's share has grown to 25 percent (see box on page 11). According to Antara, the official Indonesian government news agency, the country has the potential to "match" or even "exceed" Viet Nam's production of the fish which is native to the Mekong Basin as well as the Chao Phraya and MaeKlong basins in Thailand. Slamet Soebjakto, director general of capture fisheries at the Indonesian Ministry of Marine Affairs and Fisheries, told Antara in May this year that further development of the country's pangasius farming was "promising" given the abundance of natural and artificial water bodies along with both international and domestic demand for the fish, known locally as *ikan patin*.

The Antara report said "one of the biggest pangasius culture centers in Indonesia" in terms of potential was the Batang Hari River in Jambi Province in the eastern part of central Sumatra, where fish cage culture has been practised

since 1955 with an early focus on Hoven's carp (*Leptobarbus hoevenii*), a species native to both Sumatra and the Mekong. In Jambi, the report said, the ministry was planning to work with provincial and district governments to develop two pilot tidal ponds over a one-hectare area in the coastal district of Tanjung Jabung Timur.

Slamet reportedly said that the goal of the pilot ponds was to "implement a new aquaculture system" for pangasius by leveraging technology and Jambi's natural resources. These include tidal waters that can flush ponds twice a day, helping to maintain water quality and promoting faster fish growth. Antara noted that the Indonesian government has already chosen pangasius as a "key" species for aquaculture development (according to *Fishbase*, the species was introduced to Indonesia from Thailand in 1972).

Supporting factors

In addition to tidal waters, other supporting factors for farming pangasius on the Batanghari River are said to be the availability of feed, superior broodstock (apparently from Thailand) and good quality seed. Antara said the national and local governments were already planning to build a feed factory in collaboration with local farmers, other private investors and banks. The report



Frozen pangasius filets produced in Indonesia

said the provincial government was also planning to expand the establishment of fish-processing facilities when the existing provincial unit reaches its daily capacity of five tonnes.

'Catfish will no longer be an exclusive product of Viet Nam'

Other counties challenging Vietnamese pangasius producers include Bangladesh, India, and the Philippines. In February this year, *VietNamNet* reported that Jamaica had also started to develop pangasius farming while Puerto Rico was considering it. The FAO has meanwhile noted increased production by Cambodia and Myanmar (see box on page 11).

Pangasius processors in the Mekong Delta in Viet Nam have had mixed reactions to the increased competition. Le Thanh Tuan, chairman of Long Xuyen-based Sao Mai Seafood, reportedly told *VietNamNet* that the country needed to develop an effective catfish strategy or risk losing its position as the world's top exporter. But Duong Ngoc Minh, director general of leading catfish processor Hung Vuong Corporation in My Tho, seemed to be resigned to rising production in other countries. "Catfish will no longer be an exclusive product of Viet Nam," Minh reportedly said.

'As long as this is healthy rivalry, it's okay. One should not see this as a threat'

A source close to the Vietnamese catfish industry said Viet Nam was likely to benefit from increased competition from Indonesia. "As long as this is healthy rivalry, it's okay. One should not see this as a threat," he said. "The Vietnamese catfish industry must refine itself to be competitive. A good example is the rise of Chile and how Norway stays as the top producing country of safe, premium quality salmon." At the same time, he questioned Indonesia's confidence in maintaining the quality of its broodstock. "One must have a sufficiently large amount of unrelated broodstock and thereafter conduct a selective breeding or broodstock management programme to ensure high quality seed at an acceptable inbreeding rate," the source said.



Dried pangasius is a popular cooking ingredient in Indonesia which has almost three times as many consumers as Viet Nam

Further reading

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Southeast Asia's biggest ornamental fish centre sets sights on global market

By THEERAWAT SAMPHAWAMANA *

Fish Village in Thailand aims to boost export earnings from ornamental fish species to more than \$100 million

Located in Ratchaburi Province about 70 kilometres south of Bangkok, Banpong Fish Village is the largest ornamental fish market in Southeast Asia. With the plains of the MaeKlong River crisscrossed by many canals flowing through the town of Banpong and nearby rural areas, Ratchaburi and the neighbouring provinces of Nakhon Pathom and Kanchanaburi are the most important aquaculture area in Thailand. According to the Department of Fisheries, the three provinces had about 1,700 farms raising ornamental fish in 2013. These were among 2,725 fish farms (covering 3,620 hectares) in Ratchaburi, 6,910 farms (covering 12,200 hectares) in Nakhon Pathom and 3,827 farms (covering 1,028 hectares) in Kanchanaburi.

The local market for ornamental fish was established on a three-hectare site in 2000, eliminating the need for farmers to transport their fish to Chatuchak Market in Bangkok. By avoiding high transport costs and middlemen, local farmers were able to boost their earnings by as much as 40 percent. To support the growing ornamental fish trade, the market expanded to almost 20 hectares in 2014 to include a new building and parking area. With 28,000 square metres of floor space, the new Fish Village building has about 300 ornamental fish shops and about 100 other outlets selling aquatic plants, accessories and other pets such as dogs, cats and birds. Retailers operate seven days a week between 10:00 a.m. and 5:00 p.m. while the wholesale market is held from midnight on Sunday to 7:00 a.m. on Monday.

According to Fish Village assistant manager Phasoubpron Pewsavasdi, the market has more than 200 ornamental fish species and an annual turnover of more than \$20 million. About 80 percent of the fish are sold to domestic consumers with the rest exported to Singapore, Canada, the United States and Japan as well as other countries in the Middle East and Europe. With rapid growth

in international demand and efforts to encourage wholesale buyers, especially from Japan, Europe and the United States, chief executive Naphinthorn Srisanphang says export sales alone could soon reach \$140 million a year.

To help strengthen the business, the Thai Department of Fisheries has staff working at a laboratory in the Fish Village area. They regularly monitor diseases and provide farm management advice to improve quality and safety to ensure that the fish being produced follow acceptable global standards. About 400 ornamental fish farms are GAP-certified for adhering to good agricultural practices. The Department of Fisheries plans to

Native and exotic species

Indigenous fish species sold at Fish Village are both farmed and collected from the wild. Farmed species include Siamese fighting fish (*Betta splendens*), striped catfish (*Pangasiandonon hypophthalmus*), giant pangasius (*Pangasius sanitwongsei*), Mekong giant catfish (*P. gigas*), red-tailed tinfoil (*Barbonymus altus*), tinfoil barb (*B. schwanenfeldii*), red-cheek barb (*Puntius orphoides*), Hoeven's carp (*Leptobarbus hoevenii*), clown featherback (*Chitala ornata*), giant gourami (*Osphronemus goramy*), kissing gourami (*Helostoma temminckii*), Asian bony tongue (*Scleropages formosus*), fine-scale tiger fish (*Danioides microlepis*), Jullien's gold carp (*Probarbus jullienii*) and giant carp (*Catlocarpio siamensis*). Native fishes from the wild include stingrays, spiny eels, *Botia* loaches, Indochina featherback (*Chitala blanci*), *Wallago* sheatfish, spotted archerfish (*Toxotes chatareus*), large-scale tongue sole (*Cynoglossus macrolepidotus*) and Boeseman's croaker (*Boesmania microlepis*). Exotic fish species are all farmed. They include goldfish, koi, guppies, cichlids (including pompadour and oscar fishes), swordfishes and other aquatic animals such as crayfishes and turtles.



Fish Village in Ratchaburi Province

PHOTO: WITCHAMAI SOMCHARN

improve the quality of the other 1,300 farms to be certified at a higher level over the next few years.

Siamese fighting fish culture

Chotikarn Farm, located in Nakhon Pathom Province about 30 kilometres east of Fish Village, is the largest producer of Siamese fighting fish (*Betta splendens*) in Thailand. It was established in 2004. Annual production has since risen from 80,000 to about 300,000 fish. The owner, Chotirose Sae-Lee, manages her business by contacting buyers directly in importing countries, notably Iran and China. She has a big wholesale and retail outlet at Fish Village and also sells fish online.

Males and females are raised in separate bottles. From the age of six months, couples are selected and released into a circular tank. The male forms a floating nest from bubbles and releases its sperm immediately when the female lays its floating eggs, usually between 200 and 300. The female is then removed (it likes to eat the eggs) and the eggs hatch within 24 hours, depending on the temperature. The male is kept in the tank to take care of the fry for six days.

Moina is provided as the main feed. After two months, the fish can be distinguished by sex. Only males are cultured in individual bottles (the females are sold as prey). The water is changed every two to three days. At six months, the males are ready to be sold at prices ranging from THB 3.5 to THB 30.0 (\$0.10 to \$0.85).

Koi culture

Sakkarin Sinthasut was the Outstanding National Ornamental Fish Farmer in 2014. He also owns JR Farm, a fish farm that specialises in koi, ornamental varieties of the common carp (*Cyprinus carpio*) that were originally bred in Japan. Spread across two and a half hectares in Ratchaburi Province, the farm has about 1,000 pairs of broodstock which can be used for breeding for about five years. Normally, 20 females can produce about 70,000 - 100,000 fingerlings. To avoid natural spawning, males and females are raised separately. Pairs are selected and injected with a synthetic hormone and domperidone. After being mixed with sperm, the fertilised eggs are incubated in a plankton net in a cement tank. Aeration and water flow are provided.

One-day-old fry are moved to nurse in earthen ponds to which lime and fertiliser have been added and from which mud has been removed (to fertilise surrounding lemon, coconut and banana trees and bamboo). The fry are fed twice a day with rice bran and fishmeal (2:1). After 45 days, about half of the one-inch fingerlings are selected for colour and sold to other farmers for about THB 1 (\$0.03) each. When they reach 2.5 inches, they are ready for the wholesale market at Fish Village where they usually sell for THB 4 (\$0.11) each. Unselected fish are sold to people to make merit by releasing into ponds at Buddhist temples. Mr Sakkarin says his average monthly sales are about THB 100,000 (\$2,900).

* Mr Theerawat is a programme officer at the MRC Fisheries Programme.

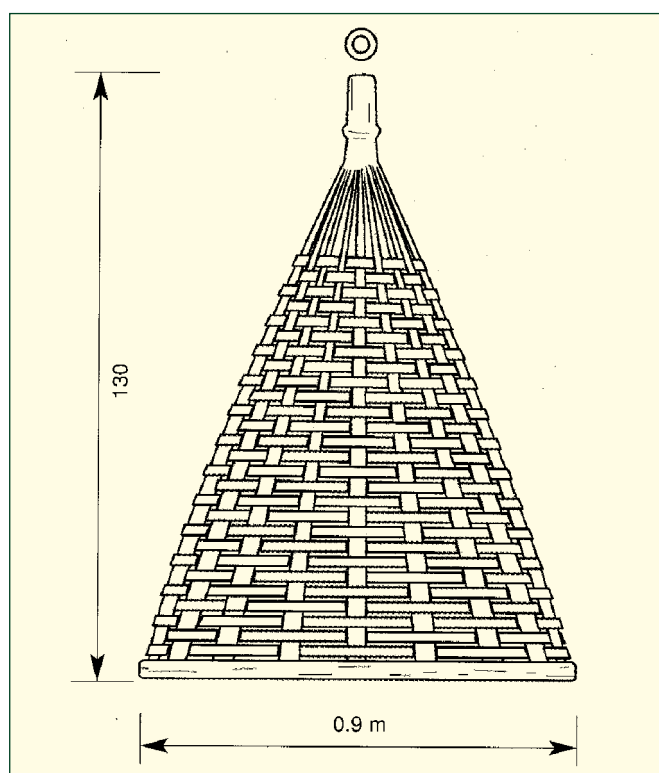
Harvesting small shrimps (*Caradina* spp.)

Fishing techniques for small shrimps have been well documented in Cambodia, particularly on the Tonle Sap Lake. Yet knowledge is patchy about which species are being caught.

Fishing for small shrimps is an important economic activity on the Tonle Sap Lake and other parts of Cambodia. To catch the shrimps, known locally as *kampeh*, people traditionally use bundles of brush, a technique described in detail in a comprehensive book on fishing gear in the Cambodian part of the Mekong Basin published by the country's Inland Fisheries Research and Development Institute in 2003 (Deap *et al.*, 2003).

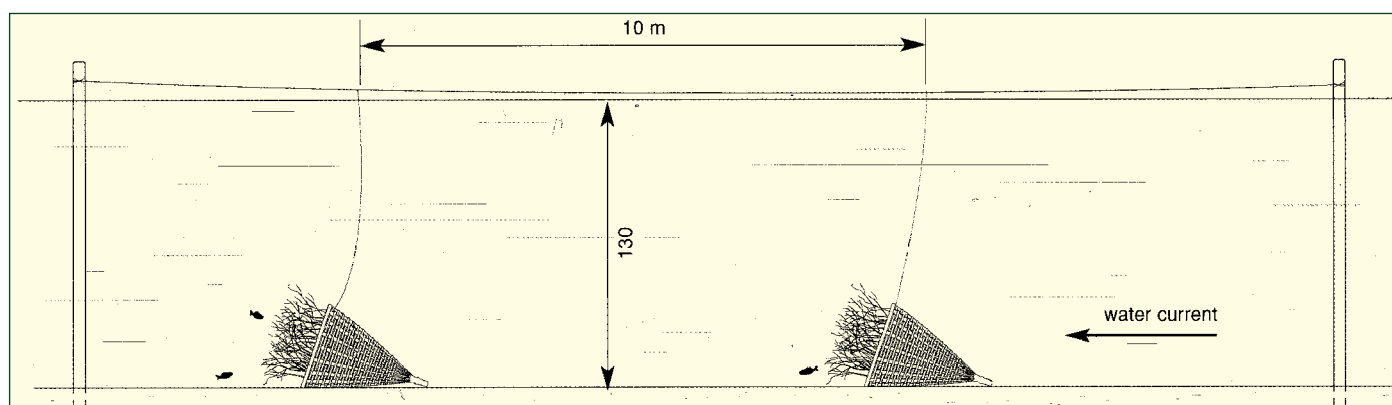
In Takeo Province in southeast Cambodia, for example, bush-bundle traps (*kansom*) are used. These are conical baskets typically made from a 5 cm bamboo stem split into 16 slats which are interwoven to form a cone (see illustrations right and below). In addition to small shrimps, the traps are used to target bagrid catfishes and swamp eels. Filled with brush and stone sinkers, the baskets are placed in rivers and streams as the annual flood recedes, usually starting in October. A small line attaches each trap to a main line which may be as long as 200 m with as many as 20 traps (see illustration below). At harvest, fishermen lift the traps out of the water as quickly as possible on to boats to prevent fish or shrimp from escaping. They then shake the traps until all of the catch falls into the boat.

A variation of the regular brush-bundle trap specifically targets caridina shrimps in the Tonle Sap Lake, typically in open waters between February and June when the small shrimps are abundant. These brush bundles for shrimp (*kansom kampeh*) are made of small branches and twigs tied with nylon rope into a bundle



Bamboo slats interwoven to form the cone of a bush-bundle trap (*kansom*)

ILLUSTRATION: ARIJAN ANSONIUS (DEAP *ET AL.*, 2003)



With the distance between each trap usually 10 m, a line may be as long as 200 m with as many as 20 traps.

ILLUSTRATION: ARIJAN ANSONIUS (DEAP *ET AL.*, 2003)



A line of brush-bundle traps (*kansom*) used to catch small shrimps on the Tonle Sap Lake in Pursat Province

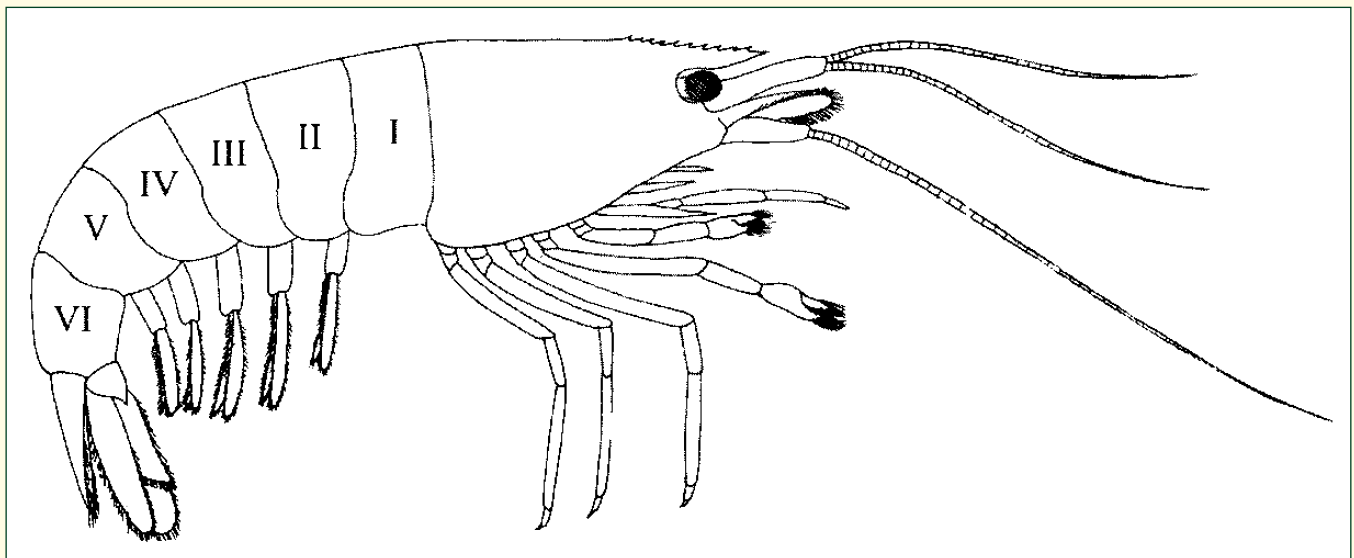
PHOTO: PHEM SEA

Caridina shrimps from the Atyidae family

Crustaceans and insects are the most important freshwater representatives of the phylum Arthropoda which classifies joint-legged animals. In tropical Asian rivers like the Mekong, the most conspicuous crustaceans are members of the order Decapoda which represents about 1,000 species of shrimps, crabs and crayfishes. Shrimps are almost entirely from the Atyidae or Paleomonidae families, the latter including species that require brackish water for part of their lives such as the giant freshwater prawn (*Macrobrachium rosenbergii*) which is widely farmed in the Lower Mekong Basin. Both families have elongated bodies and appendages, although atyids are much smaller than paleomonids, feeding mainly on detritus. The largest and most widespread atyid genus is *Caridina*, which are mostly 3 cm or less in length. These small shrimps are important consumers of fine organic materials in small and large rivers. They use their pincer-like claws, known as chelae, to brush the substratum or sift the passing water current. (MRC, undated, and Sangpradub *et al.*, 2006.)

Lipke Holthuis, the late curator of crustaceans at the National Museum of Natural History in the Netherlands, identified seven caridina shrimps of commercial value that were indigenous to the Indo-West Pacific region, an area spanning the entire Indian Ocean and its associated seas along with the Western Pacific and the Central Pacific. Writing in his catalogue of crustaceans of interest to fisheries published by the FAO in 1980, the Indonesian-born carcinologist noted that caridina species were, however, difficult to distinguish from each other. In scientific literature, economic importance had been therefore given to the family or genus in several instances but not to a separate species.

Dr Holthuis found that the small shrimps were of varying economic importance. The common caridina (*Caridina nilotica*) was eaten in Bangladesh, China, India and Indonesia, where it was highly prized by both local people and Dutch colonists alike. The common caridina has been identified in biomonitoring surveys of the Lower Mekong Basin (Davidson *et al.*, 2006



Side view of *Caridina* sp. In crustaceans, the first five abdominal segments have swimmerets, known as pleopods, that generate respiratory currents. In females, the pleopods are also used for holding eggs and developing the young. The flat and wide appendages in the sixth abdominal segment are known as uropods and are used as a rudder for swift backward movement. The thorax has eight pairs of appendages — three pairs of maxillipeds to manipulate food and five pairs of walking legs, also known as pereopods. The first three pairs of pereopods may have pincer-like claws, known as chelae, for feeding or defence. The head has two pairs of antennae, a pair of stalked eyes and three pairs of appendages around the mouth that are used for feeding or creating water currents for respiration.

ILLUSTRATION: SANGPRADUB AND BOONSONG (2006)

and Vongsombath *et al.*, 2009). According to Dr Holthuis, however, it was a complex of numerous species and sub-species. "The taxonomic status of the various forms assigned to this complex have not yet been satisfactorily straightened out," he wrote. "But the complex as a whole occupies the entire eastern part of Africa (Cairo to Natal) and goes eastward as far as southern Japan, Australia and Polynesia."

Among other species, Dr Holthuis found that the sawtooth caridina (*Caridina denticulata*), for example, was used as a food flavouring in China and as bait for fishing in Japan. But in Taiwan, this species was considered a pest by farmers of black tiger shrimp (*Penaeus monodon*) as they acted as predators on juveniles and competed with the larger species for food. The needlenose caridina (*Caridina gracilirostris*) was considered economically important in India, Indonesia and the Philippines, and as a potential basis for aquaculture in Malaysia. The Bengal caridina (*Caridina propinqua*) was found in markets in Bangladesh but said to be never eaten in Malaysia. It was nevertheless considered as having good farming potential in Malaysia, as was the Tonkin caridina (*Caridina tonkinensis*). The only country where the pugnose caridina (*Caridina weberi*) was recorded as economically

important was Indonesia (Holthuis, 1980).

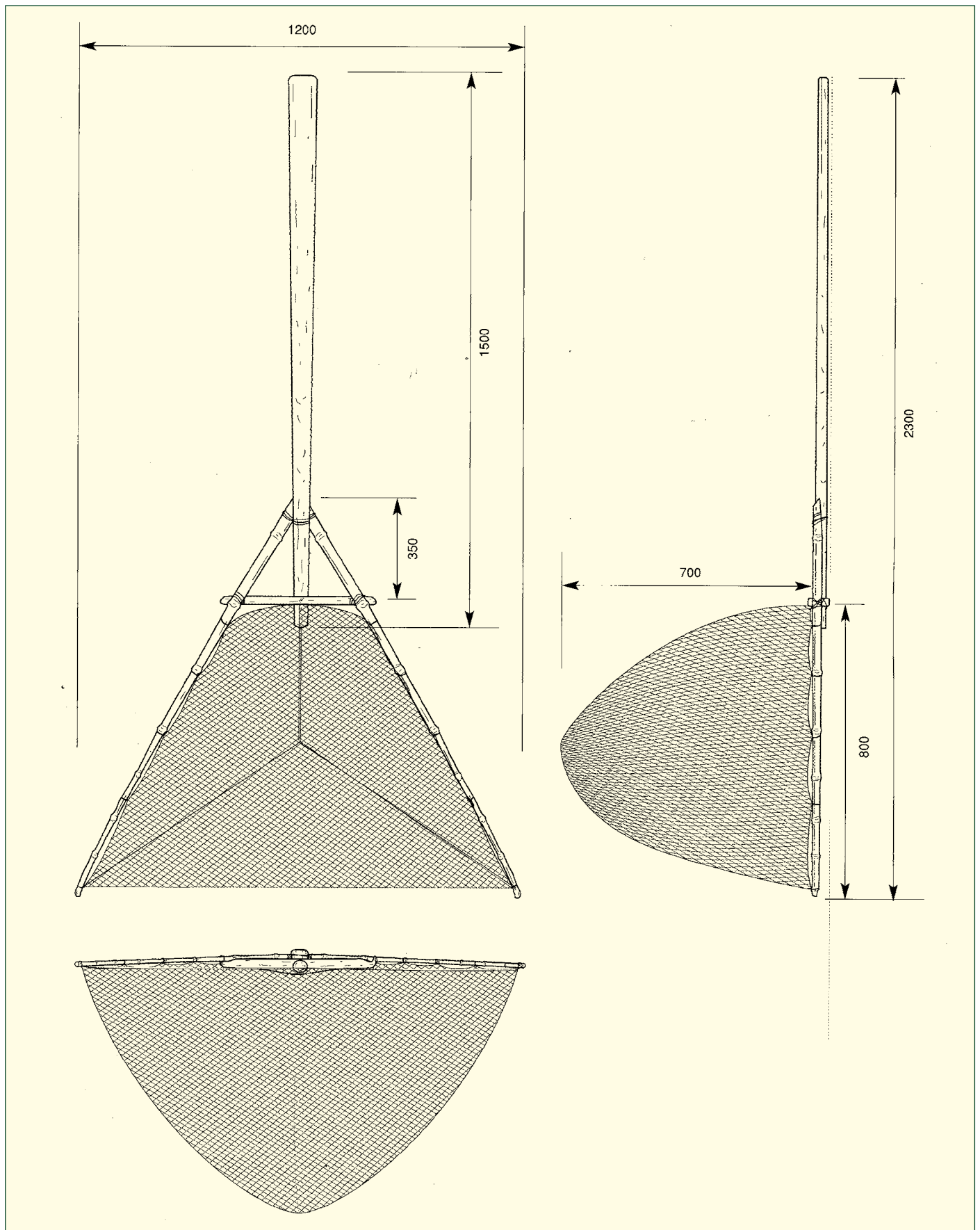
An assessment of freshwater ecosystems in Viet Nam in 2002 identified the subspecies *Caridina weberi sumatrensis* as being present in the Lower Mekong Basin in both central and southern Viet Nam (Pham, 2002). It's not clear whether this subspecies is economically important in Viet Nam. Taxonomists from the National University of Singapore and the Queensland Department of Natural Resources, Mines and Water in Australia have meanwhile described 12 species of caridina shrimps, including two new ones, as being present in Peninsular Malaysia and Singapore.

Published in the *Raffles Bulletin of Zoology* in 2007, their descriptions include two of the seven commercially valuable species documented by Dr Holthuis—the Bengal caridina and the needlenose caridina. According to these scientists, the distribution of the second species extends to both Cambodia and Thailand (Cai *et al.*, 2007). At the same time, the International Union for the Conservation of Nature (IUCN) notes that the needlenose caridina is of "significant importance" in the ornamental aquarium trade, where it is also known as the red-nosed shrimp (De Grave *et al.*, 2013).

Caridina shrimp species native to the Indo-West Pacific region

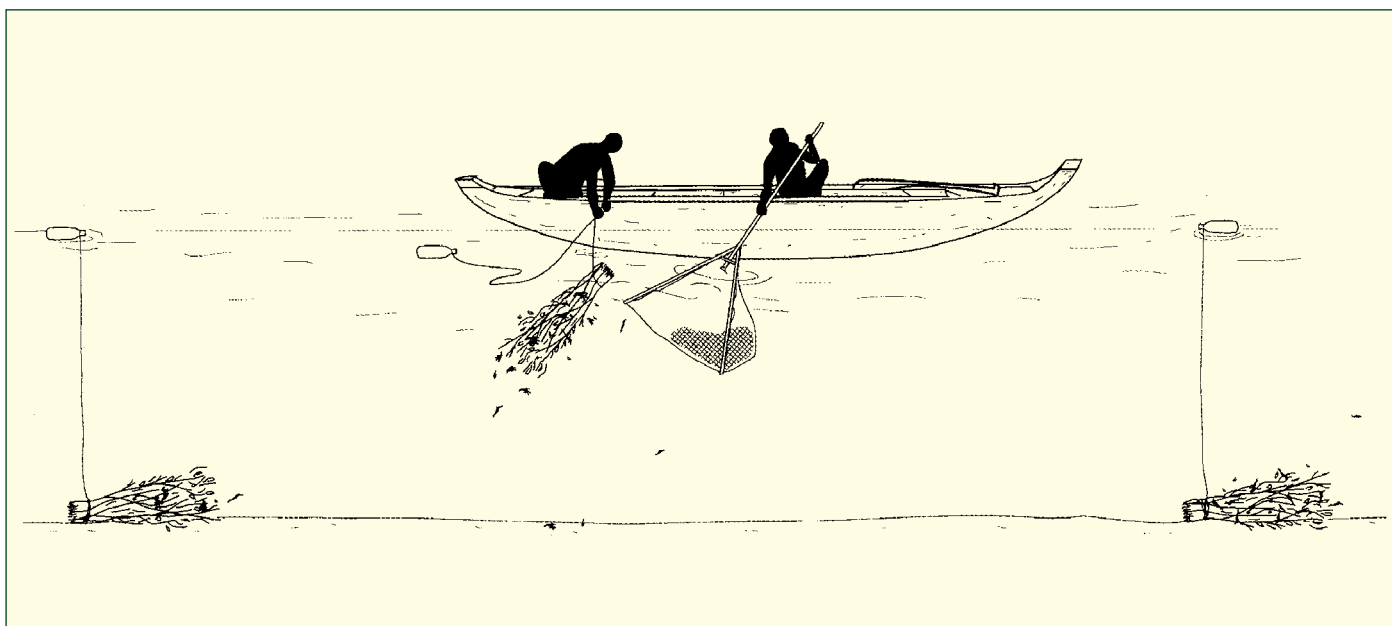
Scientific name	FAO Name	Distribution	Habitat	Total Length
<i>Caridina denticulata</i>	Sawtooth caridina	Korea; China; Japan; Taiwan	Fresh water from near the sea coast to an altitude of 400 to 500 m	20 mm (female), 30 mm (male)
<i>Caridina gracilirostris</i>	Needlenose caridina	Madagascar and India to Indonesia, Australia and Palau including Cambodia and Thailand	Fresh or slightly brackish water	37 mm
<i>Caridina laevis</i>	Smooth caridina	India to Thailand, Philippines and Indonesia	Fresh water	26 mm
<i>Caridina nilotica</i>	Common caridina	Eastern Africa to southern Japan, Australia and Polynesia	Fresh, sometimes slightly brackish, water	35 mm
<i>Caridina propinqua</i>	Bengal caridina	Bay of Bengal, Malay Peninsula, Thailand	Fresh and brackish water	20 mm
<i>Caridina tonkinensis</i>	Tonkin caridina	Viet Nam and Malaysia	Fresh water	19 mm
<i>Caridina weberi</i>	Pugnose caridina	India to Viet Nam, Palau and Polynesia	Fresh water	30 mm

Source: Holthuis (1980) and Cai *et al* (2007)



Long-handle scoop net for shrimp (*thnoring kampeh*)

ILLUSTRATION: ARIJAN ANSONIUS (DEAP ET AL., 2003)



A brush-bundle for shrimp (*kansom kampeh*) being operated with a long-handled scoop for shrimp (*thnorng kampeh*)

ILLUSTRATION: ARIJAN ANSONIUS (DEAP ET AL., 2003)

about 25 cm wide at the base and about 90 cm in length. The bundles are usually placed between 10 and 15 m apart with floating sticks to show their location. As a bundle is being lifted out of the water, a scoop net is attached. Once out of the water, the bundle is shaken and the shrimp drop into the net. A single *kansom kampeh* operation may comprise a few people or even a family in a boat operating as many as 80 brush bundles at a time.

The scoop nets used in such operations are long-handled scoop nets for shrimp (*thnorng kampeh*). These are made from a couple of bamboo forks, typically between 1.2 m and 2.1 m in length, and a wooden handle of about 1.5 m (see illustration on opposite page). The forks are attached to bag nets made from three pieces of triangular netting with a mesh size of 8 mm to 10 mm. The handles are often carved into paddles to allow individuals to navigate alone without a pilot. Operating the net independently from a bundle of brush simply involves scooping around waters with floating and flooded vegetation or waters near brush parks and floating houses.

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New survey indicates slowdown in decline of Mekong dolphin population

Slower decline and increasing rate of recruitment offer scientists hope that sub-population can survive if mortality rates can be reversed

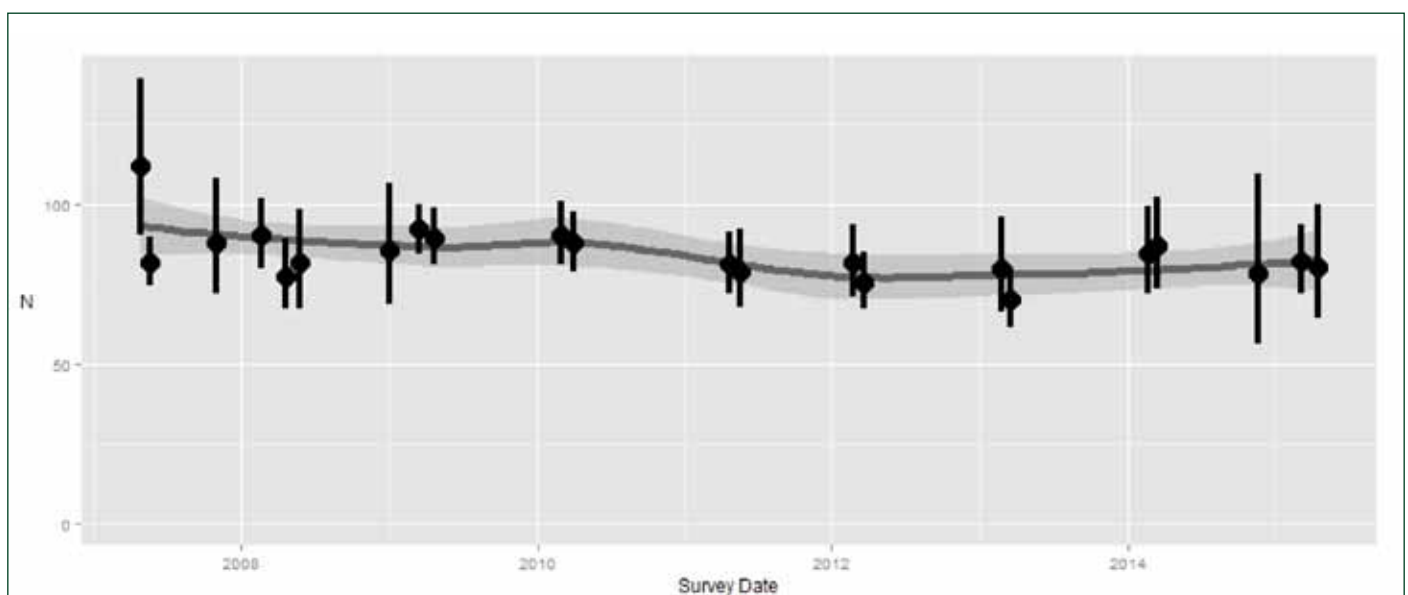
A survey by the World Wide Fund for Nature (WWF) and the Cambodian Fisheries Administration indicates that the decline in the Mekong population of the critically endangered Irrawaddy dolphin (*Orcaella brevirostris*) slowed to 1.6 percent in 2015, down from about 7 percent in 2007. Released in Phnom Penh on November 10, the survey results show a population of 80 individuals in the Mekong River between the eastern Cambodian province of Kratie and the southern Lao province of Champassak. The latest estimate is down from 85 individuals in 2010. But the results also indicate that the recruitment of new individuals – juveniles which survive to adulthood – is now 0.8 percent, up from zero before 2013.

"The result of the survey gives us a clear number of the endangered Mekong Irrawaddy dolphin, which is considered our country's living national

treasure, and it reflects our many years of continuous efforts put into protecting this species," Cambodian Fisheries Administration Director General Eng Cheasan said. "We will continue our conservation efforts to recover its population by eliminating all threats to the survival of Irrawaddy dolphins."

'It reflects our many years of continuous efforts put into protecting this species'

In a statement, WWF described the slower decline in the Mekong dolphin population as a "rare piece of good news" that came despite "serious threats" from gillnet fishing. "This is thanks to years of work by the Fisheries Administration and WWF in protecting their habitat and removing gill nets, a major cause of dolphin mortality," it said. The statement said the limited recruitment of 0.8 percent offered a "ray of hope" for a recovery in the sub-population but noted that it was still less than the mortality rate. Still, the slower rate of decline coupled with the increasing rate of



Estimated population size and 95% Confidence Interval (points), with smoothed population mean and confidence interval (ribbon) between 2007 and 2015

SOURCE: CAMBODIAN FISHERIES ADMINISTRATION AND WWF



Irrawaddy dolphins

PHOTO: ROLAND SEITRE / WWF

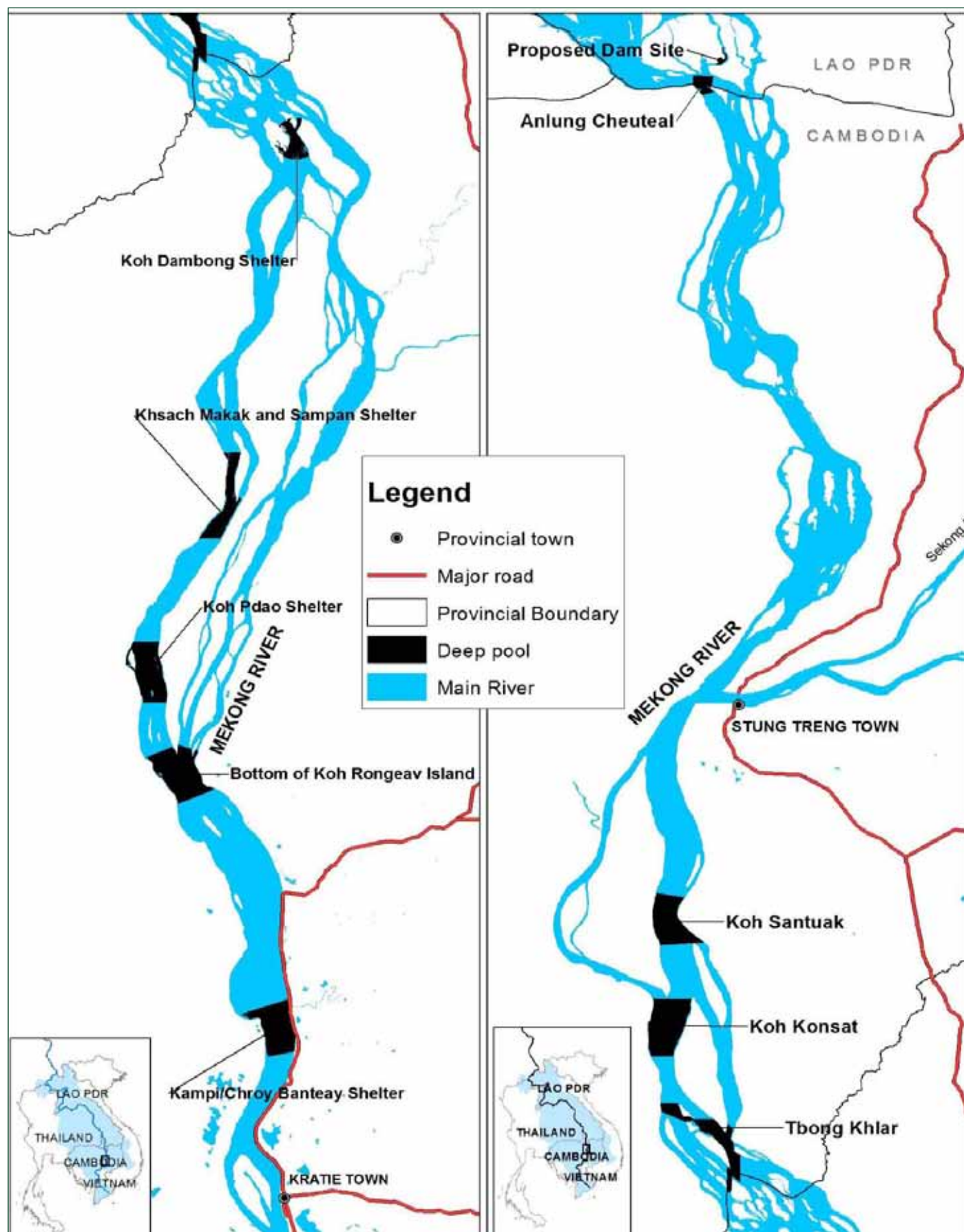
recruitment "gives scientists hope that the species can survive if mortality rates can be reversed."

**'We have reason to hope
that the Mekong's majestic
dolphins are on the way back'**

WWF said the survey was conducted along the Mekong mainstream from the Cambodian town of Kratie to the Khone Falls on the Cambodia-Lao border and back again, a total distance of 380 kilometres "It's not time to celebrate quite yet,

but we have reason to hope that the Mekong's majestic dolphins are on the way back," said Sam Ath Chhith, country director of WWF in Cambodia. "Now is not the time for complacency. We need to re-double our efforts to protect the dolphins." The latest estimate of 80 dolphins in the Mekong includes four individuals in Lao waters, WWF said. The Mekong population of the dolphin was estimated at no more than 200 individuals in 1997. Numbers fell to 127 in 2005, to 93 in 2007 and to 85 in 2010.

According to the International Union for the

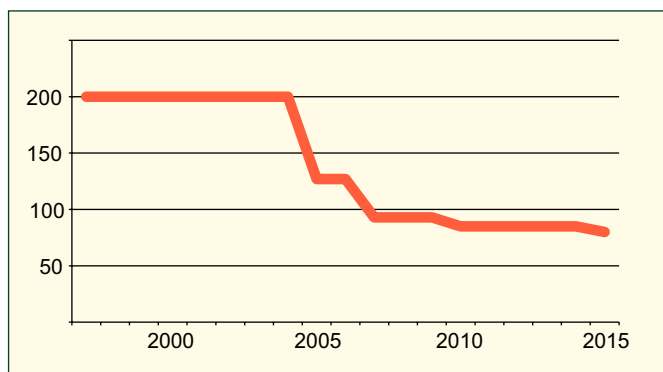


Study area in northeast Cambodia showing the Mekong River upstream from the town of Kratie (left) and further upstream to the town of Stung Treng and the Lao border (right)

SOURCE: CAMBODIAN FISHERIES ADMINISTRATION AND WWF

Irrawaddy dolphin population in Mekong

Estimates of individuals



SOURCE: WWF

Conservation of Nature (IUCN), the Irrawaddy dolphin is a "vulnerable" species distributed from Borneo and the central islands of Indonesia north to Palawan in the Philippines and west to the Bay of Bengal, including the Gulf of Thailand. Freshwater sub-populations are distributed in the Mekong as well as the Ayeyarwady River in

Myanmar and the Mahakam River in Indonesia. The IUCN Red List of Threatened Species has classified the three sub-populations as "critically endangered" since 2004, citing "dramatic" range declines in the three rivers.

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Distribution of Irrawaddy dolphin

Map highlighting freshwater sub-populations in Cambodia and Lao PDR as well as Indonesia and Myanmar



SOURCE: IUCN

Cambodia's fisheries: a decade of changes and evolution

BY ERIC BARAN AND GLORIA GALLEGOS *

How have capture fisheries in Cambodia changed over the past decade? This article compares fish diversity, catches, consumption as well as livelihood strategies and fisheries arrangements as documented by two studies published in 2004 and 2014.

The Mekong is home to the biggest inland fishery in the world, yielding more than two million tonnes of fish each year (Hortle, 2009). The system is highly productive due to an extensive floodplain system nurtured by annual monsoons. Cambodia contributes about a third of the inland catch, the world's fifth largest after China, India, Bangladesh and Myanmar since 2004, according to FAO data.

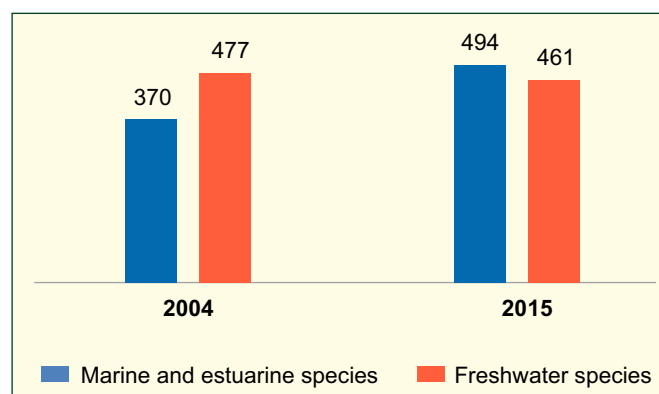
In Cambodia, fish plays an important nutritional and socio-economic role. The sector contributes significantly to gross domestic product (GDP) and provides full-time, part-time or seasonal employment to about 50% of the population (FAO, 2011; Un *et al.*, 2015). Capture fisheries also provide a dominant share of protein intake (Hortle, 2007) and combat micronutrient deficiencies in malnourished populations (Kawarazuka and Béné, 2010).

Given Cambodia's dependency on inland fish resources, it is important to monitor and document changes in the sector. The present review provides a comparison of two time periods a decade apart. It is derived from two main sources (Baran, 2005, and Baran *et al.*, 2014).

In 2004, Cambodia had 847 recorded fish species (758 taxonomically valid ones) of which 477 were freshwater fishes. Currently, Cambodia features 955 fish species of which 461 are freshwater species (see chart). The evolution of the overall number of fish species reflects the development of research in Cambodia over the past decade and subsequent integration of many new site-

specific species lists into reference databases (in particular, *FishBase* at www.fishbase.org), leading to a better listing of all species present. It also reflects the discovery of new species at a remarkably high rate (Thompson, 2008). The slight variation (3%) in the number of species between 2004 and 2014, however, is not significant and corresponds to taxonomic or ecological adjustments (classification as estuarine or freshwater species, for instance). It is unclear whether any species has vanished during the past decade, even though the abundance of some species has decreased a lot, particularly in some areas (Baran *et al.*, 2013).

Changes in counts of fish species



In 2005, ten freshwater species found in Cambodia were classified as either endangered or critically endangered. Following a recent revision by the International Union for the Conservation of Nature (www.iucnredlist.org), 13 freshwater species of Cambodia are listed as endangered. This includes five critically endangered species — the Mekong giant catfish (*Pangasianodon gigas*), giant pangasius (*Pangasius sanitwongsei*), Mekong giant salmon carp (*Aptosyax grypus*), giant barb (*Catlocarpio siamensis*) and Siamese tiger perch (*Datnioides pulcher*) as well as eight endangered species (golden dragon fish, Jullien's golden carp, thicklipped barb, flying minnow, striped catfish, Baird's schistura and two stingrays).

Loss of connectivity due to dams or infrastructure development and habitat loss in the basin are the biggest threats to endangered fish species in Cambodia. Intensive fishing is also a major threat to the “giants” among these endangered species.

According to Cambodian statistics, 324,000 tonnes of river fish were caught in 2005 (in addition to 60,000 tonnes of marine fish and 25,915 tonnes of fish from aquaculture). The catch was generated by large-scale fisheries (1/5), middle-scale fisheries (1/5) and small-scale or subsistence fisheries (3/5). Thus, the bulk of the catch came from fishers using small types of fishing gear such as hooks, traps or small-sized gillnets. The yearly value of catches at landing sites was estimated at \$150–\$225 million, increasing up to fivefold through the marketing chain. Fisheries contributed to between 8 and 12 percent of the country's GDP in the years 2000–2004 (Kurien *et al.*, 2006) and 6.9% of GDP in 2007 for a value of around \$600 million at that time (IMF, 2009).

In 2014, the overall fisheries sector produced 735,310 tonnes of which 69% came from freshwater fish (505,000 tonnes), 16% from marine fish (120,250 tonnes) and 15% from aquaculture (110,055 tonnes). The Inland Fisheries Research and Development Institute (IFReDI) (2013) estimated that at \$1.60/kg, the total economic value of freshwater fish and aquatic products was \$1 billion per year (\$800 million for inland fish alone). However, there is still no systematic assessment countrywide of the price of fish per kilogram to date. This probably results in an undervaluation of fisheries in the GDP of Cambodia. The total value of the fish production after processing and transport remains unknown.

Between 2001 and 2011, the trend has been steady growth in the inland fisheries sector with an increase of 29% (linearised). The modest growth of large inland fisheries (60,000 tonnes) compared with a substantial expansion of aquaculture (58,000 tonnes). Aquaculture is growing fast but is small and inland capture fisheries are expanding much more slowly but contribute by far the largest share of fish supply in Cambodia.

On the basis of rough estimates, average fish consumption in Cambodia was believed to amount to 38.4 kg/person/year in 2005. In contrast, a detailed study (Ahmed *et al.*, 1995) showed that

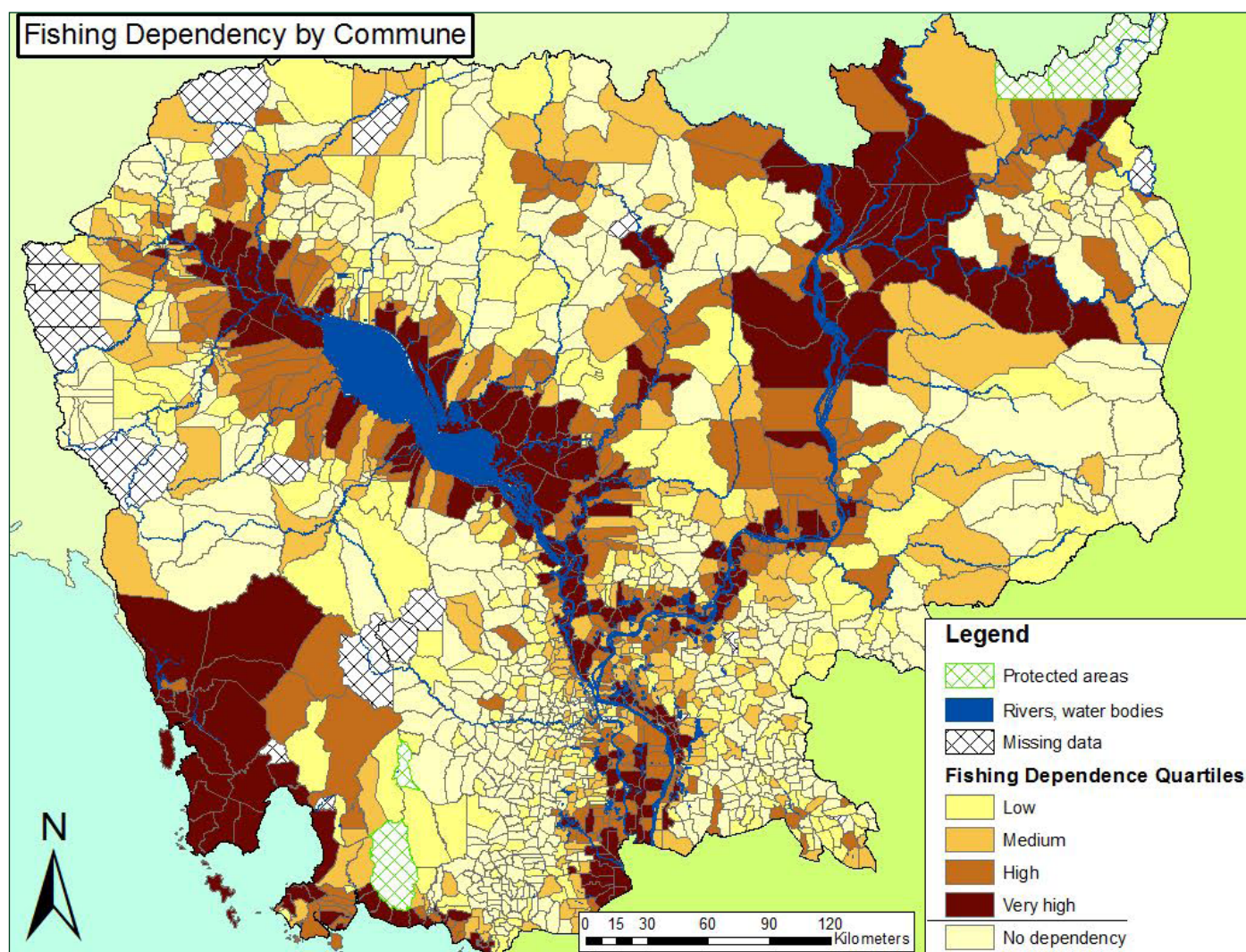
fish consumption of people living around the Tonle Sap Lake was 75.6 kg/person/year. A subsequent detailed data re-analysis (Hortle, 2007) concluded that average consumption of inland fish meat in Cambodia was 32.3 kg/person/year (plus 4.5 kg/person/year of other aquatic animals) with total consumption estimated at 52.4 kg/person/year based on fresh whole animal equivalent (FWAE) weight.

In 2013, an extensive study (IFReDI, 2013) showed that annual fish consumption amounted to 57.8 kg per person on average. Annual consumption of other aquatic products was 5.2 kg per person. The same study showed that fish protein provided 37% of total protein intake and 76% of the intake of animal protein. It is unclear whether this shows increased reliance on fish for nutrition or improved assessments of the role of fish in the diet. What is clear is that no other food sources represent an alternative at present (Kawarazuka, 2010; So Nam and Touch Bunthang, 2011).

Fishing is part of all rural livelihoods, although only a minority of people consider themselves professional fishers. Based on the 1998 population census, only 5.7% of people living around the Tonle Sap Lake were involved in fishing in 2005, although this figure was much disputed. The 2008 national census revised the assessment and concluded that 64% of all rural households (over 7 million people) were engaged in fishing (FAO, 2010). However, only 0.6% of the population declared fishing as their full-time occupation.

Cambodia's income and Human Development Index significantly progressed over a decade. But 85% of the rural population is largely dependent on natural resources and at least half of the population is employed on a part-time basis in fisheries (Un *et al.*, 2015). Fishing dependency (a combination of fisher density and poverty index) is very high in provinces where water resources are abundant and where economic and agricultural alternatives are limited (in particular Stung Treng, Kratie, Kampong Thom, Battambang and Banteay Meanchey provinces (see map).

Despite the difficulty of monitoring fish catch trends since the abolition of fishing lots, it is believed that fishing activity has intensified in recent years with increases in the number of fishers



SOURCE: NASIELSKI *ET AL.*, 2013

and people engaged in fishing-related activities such as trade and processing. Fish resources represent a source of income with a high profit-to-capital investment ratio. Amid climate change and increasingly unpredictable rainfall patterns, fisheries are seen as a factor of improved security among poor households.

In Cambodia, the catch used to be generated in part by large-scale fisheries. These consisted of fishing lots privatised and auctioned by the government. In 2005, there were 162 lots comprising 81 barrage lots partly fenced in the lake and rivers, covering an area of 852,900 ha. The length of fences reached 409 km, or 34% of the periphery of the Tonle Sap Lake (Baran *et al.*, 2007). Successive fishing lots reforms in 2000 and 2012 resulted in the cancellation of all private fishing lots, marking a shift from large-scale commercial management to decentralised

community-based management, together with a change in user rights (more than 1 million hectares were transferred from private concessions to community fisheries).

As of 2015, all fishing lots have been abolished in Cambodia's most significant contemporary policy addressing natural resource management and rural development. It is noted that the catch keeps increasing, regardless of this management reform.

Conclusions

Over the past decade, fish biodiversity in Cambodia "increased" from 847 to 955 species due to descriptions and recordings of new species. The number of endangered species meanwhile increased from 10 to 13. According to national statistics, inland catches increased from 324,000 to 505,000 tonnes, an average increase of 29% increment per year. This substantial growth in

fish yield contradicts the usual claim of resource rarefaction. Population growth (13.1 million in 2005 to 15.7 million in 2015) does not suffice to justify the claim, which highlights either an overestimate of the catch in national statistics or reduced catch per fisher following a substantial — but undocumented — increase in the number of fishers.

Fish consumption figures were not well established in 2005 but annual consumption averaged 57.8 kg of fish per person in 2013, making it the second most consumed food item after rice contributing 37% of the total protein supply. Despite growth and poverty alleviation over the past 10 years, fish remains absolutely central to livelihoods. More than half of the population is engaged in fishing, and fish dependency is very high in some provinces. The abolition of fishing lots and community fishery-based management are a radical change in the management approach, and the consequences remain to be fully assessed.

** Dr Baran is a senior scientist at the Greater Mekong Regional Office of WorldFish in Phnom Penh and Ms Gallego is an independent natural resources consultant*

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Environmental DNA testing helps unlock mysteries of giant catfish

A French biotechnology company and WWF carry out the first e-DNA-based assessment of fish diversity in Mekong

In 2013, French biotechnology company Spygen began collaborating with the Lao office of the World Wide Fund for Nature (WWF) to evaluate the potential of using environmental DNA to strengthen biodiversity conservation and management in the Mekong River. Two types of e-DNA were tested — a specific approach, used to track endangered species such as the Mekong giant catfish (*Pangasianodon gigas*), and a multi-specific approach enabling the monitoring of total aquatic biodiversity in the Mekong.

Initial results of the programme were presented to a meeting of the Association of Tropical Biodiversity and Conservation in April this year. In September, WWF announced that the study, the first e-DNA-based assessment of fish biodiversity in the Mekong, identified the Mekong giant catfish at a single location in northern Thailand, locally recognised as a spawning ground for the critically endangered species which can grow to more than 300 kg. Overall, the study sampled 12 locations along the Mekong in Cambodia, Lao PDR and

Thailand, detecting 176 fish species and other animals such as the Irrawaddy dolphin, frogs and salamanders.

"If we don't know where the Mekong giant catfish is, we can't save it. Good data leads to good conservation," said Dr Thomas Gray of WWF-Greater Mekong. "Sampling environmental DNA is a pioneering research technique that helps us help species like the Mekong giant catfish survive the immense threats they face."

Dr Eva Bellemain, senior project manager at Spygen, said the results of the study "help us understand fish presence and migration in the Mekong River in a new way, and offer important perspectives in the monitoring of fish and more generally biodiversity in the Mekong." She said e-DNA could "reveal all species present in an area, including the rarest and hardest to detect. It also washes away within days, so these samples only represent the species present at a given time, giving a clearer picture of which fish are in a specific location at a specific time."

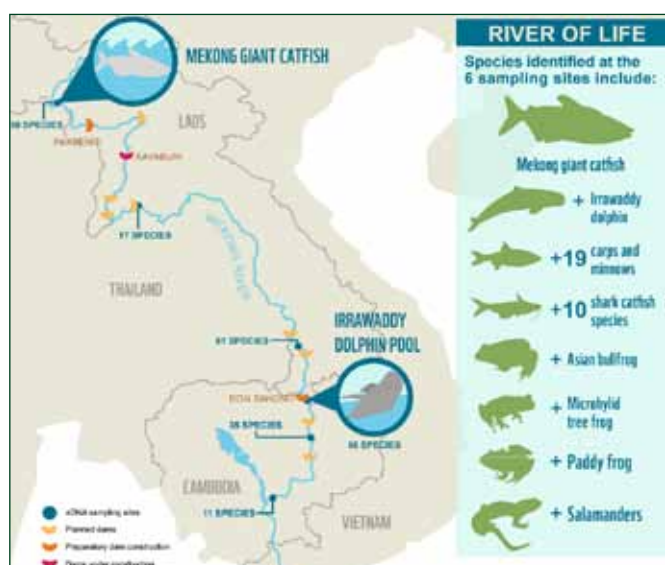
E-DNA detects species — regardless of their size, ecology, life stage or gender — through traces of DNA released into their environments (faeces, urine, gametes and mucus, for example). It can also result from the decomposition of dead organisms. In aquatic environments, the DNA released can be detected for only a few days.

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Location of e-DNA sampling sites showing number of species detected

SOURCE: WWF

Giant catfish caught in Phnom Penh

This 90-kilogram Mekong giant catfish became trapped in a bag net operated by the *dai* fishery on the Tonle Sap River in Phnom Penh on November 9. The fishery, which operates between October and March, targets small cyprinids migrating down the river from the Tonle Sap Lake at the end of the wet season and is the largest commercial fishery in the Lower Mekong Basin. The incident occurred at Kilometre No 6 in Russei Keo District in Phnom Penh. Cambodian Fisheries Administration Director-General Eng Cheasan led a group of fisheries officers to release the fish back into the river. He appealed to all fishers to help conserve the critically endangered species and release any individuals that are inadvertently caught. Catching the fish is illegal in Cambodia.



The Cambodian Fisheries Administration offers people a reward of 5,000 riel (\$1.25) for returning tags used to track the Mekong giant catfish

PHOTO: CHHUON KIMCHHEA



Preparing to release the Mekong giant catfish in Phnom Penh on November 9

PHOTO: CHHUON KIMCHHEA

Fish consumption among women and pre-school children in Cambodia

BY TOUCH BUNTHANG, SO NAM, CHHENG PHEN, POS CHHANTANA, EN NET AND ROBERT POMEROY *

In 2014, the Inland Fisheries Research and Development Institute of the Cambodian Ministry of Agriculture, Forestry and Fisheries undertook a study of the consumption of fish and other aquatic animals by women and pre-school children. The study, supported by Oregon State University through the University of Connecticut under the AquaFish Innovation Lab programme, covered 300 women and 343 children in three provinces – Stung Treng and Prey Veng on the Mekong River and Kampong Thom on the Tonle Sap Lake. Interviews over two weeks in June estimated food intake over the previous 24 hours. Evaluations of energy, macronutrients and micronutrients were made using the ASEAN Food Composition Table. To determine nutritional adequacy, nutrient intake was compared with the Recommended Dietary Allowances for Southeast Asia.

The women surveyed consumed 43 species of fish and other aquatic animals. The children, aged from 6 months to 5 years, consumed 38 species. The most popular was mud carp known as *trey riel* (*Henicorhynchus* sp.), accounting for more than a fifth of consumption by both women and children. Striped snakehead or *trey ros* (*Channa striata*) came next (13% of consumption by women and 18% by children). The third and fourth most commonly consumed species were Mekong silver barb or *trey chhpin* (*Barbonymus gonionotus*) and the bagrid catfish *trey kanhchus* (*Mystus* sp.).

Women's daily fish consumption averaged 145 grams, or 17% of total food intake. Among animal food sources (including meat, poultry and eggs), fish and other aquatic animals such as freshwater snails, prawns and crabs accounted for 80% of protein, 70% of energy and 54% of fat. For

micronutrients, the proportions were 88% for Vitamin A, 83% for calcium, 75% for iron and 45% for zinc from fish and other aquatic animals?

Children's fish consumption averaged 53 grams a day, or 11% of total food intake. Among animal foods, fish and other aquatic animals accounted for 78% of protein, 72% of energy and 60% of fat. For micronutrients, the proportions were 93% for calcium, 57% for iron, 56% for Vitamin A and 44% for zinc from fish and other aquatic animals. When compared to a Philippine survey in 2008, the study indicated that fish consumption among the Cambodian children was almost 50% higher than that for Philippine children (see table below).

Average daily calorific intake was 1,976 kcal for the Cambodian women (compared with 2,196 kcal in a Vietnamese study in 2013) with contributions of 71% from carbohydrates (65% in Viet Nam), 13% from protein (15% in Viet Nam) and 16% from fat (20% in Viet Nam). Calorific intake for children averaged 845 kcal a day with 68% from carbohydrates, 15% from protein and 17% from fat. For both women and children, the proportion of protein was desirable. But the proportion of fat in their diets was far lower than desirable.

'When compared to the Philippine survey of 2008, higher proportions of Cambodian women and children were meeting recommendations for energy and protein'

Only half the Cambodian women and less than a third of the children were meeting their recommended daily intake of energy. But almost

Food consumption by pre-schoolers

Average daily food consumption and selected main foods consumed by pre-school children in Cambodia and the Philippines

	All Foods	Cereals	Fish	Milk	Vegetables
Cambodia	489 grams	257 grams	53 grams	45 grams	21 grams
Philippines	492 grams	148 grams	36 grams	188 grams	16 grams

Daily energy and nutrient intake

Proportion of women and pre-school children in Cambodia and the Philippines who meet 100% of their recommended energy intake and 80% of their recommended intake of protein, iron and Vitamin A

	Women		Children	
	Cambodia	Philippines	Cambodia	Philippines
Energy (meeting 100% of intake)	50.0 %	17.9 %	29.6 %	17.8 %
Protein (meeting 80% of intake)	71.0 %	50.1 %	53.4 %	48.3 %
Iron (meeting 80% of intake)	10.7 %	12.3 %	24.1 %	25.2 %
Vitamin A (meeting 80% of intake)	28.0 %	16.0 %	18.6 %	26.0 %

three-quarters of the women and more than half of the children were meeting 80% of their daily protein needs. When compared to the Philippine survey of 2008, higher proportions of Cambodian women and children were meeting recommendations for energy and protein (see table above). For micronutrients, only 11% of women and 24% of the children in Cambodia met 80% of the recommended intake for iron, only 36% of women and 8% of children met 80% of their daily zinc needs, only 24% of both women and children met 80% of their calcium needs and only 28% of women and 19% of children met 80% of the recommended intake of Vitamin A.

As part of the study, the Industrial Laboratory Centre of Cambodia analysed fresh and processed fish and other aquatic animals commonly eaten by Cambodians. The analyses showed high levels of protein, calcium, iron and phosphorous (see table below), indicating that fish and other aquatic animals eaten by the rural poor are safe to consume.

The study concluded that low intakes of iron, zinc, calcium and Vitamin A put Cambodian women and children at risk of micronutrient deficiencies. It recommended:

(a) a programme using fish to combat micronutrient

deficiencies in women and children in rural areas, focussing on iron, zinc and Vitamin A;

- (b) research into improved processing of fish and other aquatic animals caught in open waters, lakes and rice fields including better methods of handling and preservation;
- (c) research into species, parts of fish and other aquatic animals (such as eyes, head, skin and meat) and processed fish products that are rich in micronutrients such as iron, zinc, calcium, Vitamin B complex and Vitamin A with the aim of incorporating these species into cultural practices
- (d) a nutritional education programme in partnership with partners such as the Cambodian Red Cross in consultation with the National Maternal and Child Health Centre and the National Nutrition Program on commonly consumed nutrient-dense species for women and mothers with additional focus on hygiene and sanitation.

This research was funded by AquaFishInnovation Lab under USAID CALWA No. EPP-A-00-06-00012-00. The AquaFishInnovation Lab accession number is 1438. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the AquaFish Innovation Lab or the US Agency for International Development

** Mr Touch Bunthang is deputy director of Cambodia's Inland Fisheries Research and Development Institute (IFReDI), Dr So Nam is coordinator of the MRC Fisheries Programme, Mr Chheng Phen is deputy director of IFReDI, Ms Pos Chhantana and Mr En Net are students at the Royal University of Phnom Penh and Dr Pomeroy is a professor with the Department of Agricultural and Resource Economics at the University of Connecticut*

Nutrients of fish and other aquatic animals

Analysis by the Industrial Laboratory Centre of Cambodia of 16 freshwater animal species (13 fishes, 1 snail, 1 prawn and 1 crab) randomly collected from markets in Phnom Penh, Kampong Chhnang, Kandal and Takeo. Processed fish refers to smoked mud carps known as *trey riel* (*Henicorhynchus* sp.) and dried snakeheads known as *trey ros* (*Channa* sp.).

	Fresh		Processed	
	Min (%)	Max (%)	Min (%)	Max (%)
Macronutrients				
Protein	10.11	16.81	37.38	38.52
Fat	0.99	4.25	6.01	24.65
Micronutrients	Min (mg/100g)	Max (mg/100g)	Min (mg/100g)	Max (mg/100g)
Calcium	15	123.9	19.1	83.3
Phosphorous	0.57	3.98	1.15	2.06
Iron	0.26	0.83	0.3	0.38

NACA publishes book on regional meeting on culture-based fisheries

The Network of Aquaculture Centres in Asia-Pacific (NACA) has published the proceedings of a regional consultation on culture-based fisheries development in Asia in Siem Reap in 2014. Organised by NACA and the Cambodian Fisheries Administration, the consultation was held under the auspices of the Australian Centre for International Agricultural Research (ACIAR), the MRC Fisheries Programme and NACA (see *Catch and Culture*, Vol 20, No 3). Below is an extract from the preface of the book which includes selected case studies from Cambodia, Lao PDR and Thailand as well as China, Indonesia, Sri Lanka.

It is estimated that the global population will reach 9.5 billion by 2050. Providing the food needs for nine billion people is a major global concern with projections suggesting that the current level of food production needs to be increased by 70 percent. Specific projections for example include an increase in production of 1 billion tonnes of cereals and 200 million tonnes of meat.

Since 1950 the per capita fish consumption has increased from 6 kg/year to 19.2 kg/year in 2012, with Asia accounting for two thirds of the global fish consumption, averaging 21.4 kg/caput/year in 2011. It is estimated that even at the current rate of fish consumption the world will require an additional 30-40 million tonnes of food fish by 2050 to account for the expected population increase.

Global food fish supplies, until recently, were predominantly of a hunted origin - based on wild capture fisheries, but in the last few decades this predominance changed to a farmed origin, like all our other staples, resulting from the sustained development of aquaculture, approximately at 6 percent per year over the last three decades or so. Aquaculture production reached 76,321,310 tonnes in 2011, with the Asia-Pacific region

contributing over 80 percent, and PR China being the leading nation accounting for 65.7 percent of the total global production.

The question arises whether this growth impetus in intensive aquaculture can be maintained as in the last three decades, especially in the wake of increasing competition for primary resources, physical and biological, and the need to maintain environmental integrity. It is in this context that use of existing water bodies for the secondary purpose of food fish production, particularly in rural areas in developing countries, becomes important. Culture-based fisheries is an environmentally friendly practice being an effective secondary use of existing water resources for food fish production in which the only external input is seed stock.

The primary objectives of the consultation were threefold:

- To showcase the achievements of the ACIAR funded project, "Culture-based fisheries development in Lao PDR and Cambodia", coordinated by NACA.
- To evaluate important and relevant principles pertaining to sustained developments in culture-based practices, mostly emanating from research and development projects on the subject area conducted under the auspices of the ACIAR since 1995.
- To bring to the public domain specific examples of gains from adoption of culture-based fisheries as an effective means of increasing food fish supplies, benefitting rural communities in particular.

Further reading

De Silva, S.S., Ingram, B.A. and Wilkinson, S. (eds.) 2015. Perspectives on culture-based fisheries developments in Asia. NACA Monograph Series No. 3, 126p. <http://enaca.org/publications/inland-aquaculture/perspectives-on-culture-based-fisheries-developments-in-asia.pdf>

Selected abstracts from *Perspectives on culture-based fisheries developments in Asia*

Culture-based fisheries: Why, what, where, how and for whom?

Sena S. De Silva

School of Life & Environmental Sciences, Deakin University, Warrnambool, Victoria 3280, Australia.

In the wake of increasing population and rising average per caput consumption of food fish and a plateauing off of the traditional food fish supplies there is an urgent need to close the increasing gap between supply and demand. It is generally acknowledged that aquaculture would increasingly contribute to closing this gap. Aquaculture production is still and likely to continue to be dominated by freshwater finfish production well into the foreseeable future, concentrated in developing countries.

However, increasing intensification of inland aquaculture is confronted with resource limitations such as land and water, and biological inputs such as feeds and consequently other plausible alternatives have to be explored. One such alternative is to utilise small and medium sized water bodies, which are estimated to be found in great abundance in developing countries of the tropics (e.g. estimated around 67 x 106 ha in Asia alone). These are mostly incapable of supporting even subsistence fisheries through natural recruitment, but could be utilised, secondarily, for culture-based fisheries development (CBF). CBF is essentially a stock and recapture strategy, where the stocked fish feed and grow on naturally produced food resources, and which are most effective when communally managed. The returns from CBF could be very significant in terms of nutritional as well as monetary benefits to the communities.

In this presentation the relevant background information on food fish needs and the ways and means of introducing CBF practices in inland waters are dealt with. The importance of this environmentally "friendly" practice to enhance food fish production in rural

communities are emphasised and the way such practices need to be conducted for optimal benefits are discussed.

Reference:

De Silva, S.S., 2015. Culture-based fisheries: Why, what, where, how and for whom? In: Sena S. De Silva, B.A. Ingram and S. Wilkinson (eds.), *Perspectives on culture-based fisheries developments in Asia*, pp. 17-25. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

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General aspects of stock enhancement in fisheries developments

Brett A. Ingram¹ and Sena S. De Silva²

¹ Fisheries Victoria, Department of Economic Development, Jobs, Transport & Resources, Alexandra, Victoria 3714, Australia.

² School of Life & Environmental Sciences, Deakin University, Warrnambool, Victoria 3280, Australia.

Stocking occurs in freshwater, estuarine and marine environments worldwide to replenish, maintain or enhance populations of aquatic organisms, especially fish as well as gastropods and crustaceans. Stock enhancement is used by fisheries managers to restore depleted populations of recreationally and commercially significant fish species. Stock enhancement is also used to increase productivity of a fishery by augmenting the natural supply of juveniles, and optimising harvests by overcoming recruitment limitation. Stock enhancement in culture-based fisheries is most often undertaken in small waterbodies on a regular basis to sustain or increase yields. Stocking typically involves the release of large numbers of early-life stage animals that are mass-produced in hatcheries.

The primary purposes of stocking in developed countries is for recovery of threatened species and to support recreational fishing, whereas in developing countries it is more to increase food fish supplies for rural communities and improve their livelihood through income from fish harvested.

Stocking programs use seedstock produced for aquaculture purposes and in some cases captive breeding techniques have been established specifically to support stocking programs. Advances in techniques to breed fish in captivity have seen a proliferation in the number of species and quantities of juveniles produced in hatcheries for stocking. In recent years, however, stocking programs have been subjected to substantial criticism due to perceived impact of hatchery-bred fish on genetic structure and fitness of wild stocks, transfer of disease, introduction of exotic species and non-target species, and their effects on other aquatic species and the environment.

To maximise the potential benefits to fisheries from stock enhancement, and to address the above criticisms, a responsible and ecologically sustainable approach should be adopted for all stocking programs. This requires, clear and well-defined objectives, an a priori evaluation of the need for stocking, well-formulated stocking strategies that consider the risks, benefits, the water to be stocked, and the fish to be used (e.g. species used, source of fish, size of fish, and number stocked). Equally important is the evaluation of stocking success in terms harvest yields as well as social, economic and cultural benefits. Other fisheries management measures will also need to be implemented to support stock enhancement, such as fisheries policies, regulations and guidelines for dealing with property and access rights. There are also technical aspects to consider, such as managing the stocked water bodies, harvesting, marketing, and education and training for participating communities.

Key words: *Culture-based fisheries, stakeholders, impacts of stocking, risk management.*

Reference:

Ingram, B.A. and De Silva, S.S., 2015. General aspects of stock enhancement in fisheries developments. In: Sena S. De Silva, B.A. Ingram and S. Wilkinson (eds.), *Perspectives on culture-based fisheries developments in Asia*, pp. 27-37. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

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Challenges and constraints for developing CBF in Cambodia and a possible strategy for success

Sena S. De Silva¹ and Srun Lim Song²

¹ School of Life & Environmental Sciences, Deakin University, Warrnambool, Victoria 3280, Australia.

² Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries, Cambodia.

Fish is the most important source of animal protein in Cambodia. On average it makes up more than 75 % of animal protein and in some areas of the country aquatic resources make up 80 % of the available animal protein. Overall, fish consumption is estimated to be around 63 kg/caput/year (FiA, 2013) (whole fish equivalent) and is many times greater than the global average, reflecting the importance of the fisheries sector to the diet and culture of Cambodian people.

The application of culture-based fisheries in Cambodian waters commenced with the initiation of a project under the auspices of the Australian Centre for International Agricultural Research (ACIAR Project FIS/2011/013), coordinated by NACA. For the initial trial, 16 small reservoirs located in four provinces were selected. These reservoirs differed from each other in surface area, mean depth and the catchment land use features, the latter evaluated using GIS software. In choosing the reservoirs, initial consultations with the village communities responsible for the water regime management were held and their agreement obtained for monitoring and cooperating through the trial period. One common feature in all the reservoirs selected, and for that matter in all water bodies in Cambodia, is the provision of a "conservation zone", generally in the deeper areas of the water body, where fishing is prohibited.

Culture-based fisheries are a form of aquaculture that utilise small water bodies, both perennial and non-perennial, which cannot support a fishery through natural recruitment processes, for food fish production through a stock-recapture strategy. Culture-

based fisheries are environmentally friendly as the only external input is seed stock. It also engages a co-management approach utilising the downstream farming communities in most instances already organised into functional entities for dry land agriculture as the principal beneficiaries (De Silva 2003). Culture-based fisheries are an attractive development strategy as it mobilises dry land farming communities (e.g. rice farmers) to use existing water bodies for the secondary purpose of food fish production. The strategies to optimise benefits from culture-based fisheries, however, vary in detail from country to country and across climatic regimes.

Culture-based fisheries activities were conducted over two growth cycles and in all instances the fish production increased above the levels that were obtained prior to the implementation of culture-based fisheries. In this presentation the stocking strategies and the yields obtained are presented. It is believed, however, the yields could be further enhanced by utilisation of the conservation as nursery areas which will be dealt with in a separate presentation.

Key words: Fish consumption, small water bodies, culture-based fisheries, free access, conservation zone, co-management.

Reference

De Silva, S.S. and Song, S.L. (2015) Challenges and constraints for developing CBF in Cambodia and a possible strategy for success. In: Sena S. De Silva, B.A. Ingram and S. Wilkinson (eds.), Perspectives on culture-based fisheries developments in Asia, pp. 53-57. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

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Culture-based fishery of giant freshwater prawn: Experiences from Thailand

Tuantong Jutagate¹ and Wachira Kwangkhang²

¹ Fisheries Program, Faculty of Agricultures, Ubon Ratchathani University, Thailand, 34190.

² Ubon Ratchathani Inland Fisheries Research and Development Center, Ubon Ratchathani Thailand, 34000.

Releasing of giant freshwater prawn (*Macrobrachium rosenbergii*) for the purposes of stock enhancement and to create a fishery has been conducted in Thailand since the 1980s. In each year, over a hundred million post larvae (30 day old post larvae of ~1 cm) of *M. rosenbergii* have been released into inland waters nationwide. The stocking density is, generally, about 2,500 prawn larvae/ha. Average age at harvest is around 6 to 8 months, with an average total length of 20 cm. The individual weights can range between 100 and 200 g after a year of release. Common fishing gears are gillnet, long-lines and traps, the latter designed exclusively for *M. rosenbergii*. Overall, the success of stocking *M. rosenbergii* is poor since the recapture rate is generally less than 5 %. However, the economic return is high. Average market price of *M. rosenbergii* is 150 Thai Baht/kg, which is about 3 times more than the average price of marketed freshwater fish. The profit is reported to be as high as 800 %. Moreover, the high market price of *M. rosenbergii* benefits traders at various levels, job creation and income for all related sectors. Although the economic profit is very high, the low rate of recapture of stocked *M. rosenbergii* makes this culture-based practice not entirely satisfactory. The major problem is that there are no guidelines in regard to the optimum size of seed for release as well as appropriate time and location to be stocked, that could enhance the rate of return and economic returns.

Key words: *Macrobrachium rosenbergii*, culture-based fishery, Thailand, stocking practices, rate of recapture.

Reference

Jutagate, T. and Kwangkhang, W., 2015. Culture-based fishery of giant freshwater prawn: Experiences from Thailand. In: Sena S. De Silva, B.A. Ingram and S. Wilkinson (eds.), Perspectives on culture-based fisheries developments in Asia, pp. 91-97. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

Genetic considerations in culture-based fisheries in Asia

By THUY T.T. NGUYEN *

The growing preference for indigenous species in culture-based fisheries is believed to counter negative impacts of alien species, perceived or otherwise, especially in countries such as Cambodia and Lao PDR. But hatchery-produced fingerlings of native species that escape pose a potential threat to genetic diversity and integrity of their wild counterparts.

Culture-based fisheries (CBF) is a practice in which fish are stocked in small water bodies which are unable to sustain artisanal fisheries through natural recruitment. It is often a secondary user of water resources and is seen as an important strategy to improve food security in rural areas of developing countries (De Silva, 2003; De Silva *et al.*, 2006a; Amarasinghe and Nguyen, 2010). In earlier stages of development, CBF in countries for example Sri Lanka and Viet Nam were largely dependent on exotic species such as tilapia, and major Indian and Chinese carps due to availability of fingerlings as well as a lack of suitable fast growing indigenous species (Amarasinghe and Nguyen, 2010). The current trend, however, is moving towards including indigenous species for stocking. This change is driven by the need to mitigate the negative impacts of alien species, perceived or otherwise (Sverdrup-Jensen, 2002, Mattson, 2005, Ingthamjitr, 2009), especially in some of the Mekong riparian countries such as Lao PDR and Cambodia.

The preference to use indigenous species in CBF brings about new challenges. CBF, as any other food production sector, needs to be practised in a manner that minimally impacts the environment, including genetic diversity of natural fish populations. Fingerlings used for stocking are often derived from hatcheries that produce seed for aquaculture purposes as there are no hatcheries dedicated to CBF or stock enhancement in the region. Hatchery-produced

fish are known to be more adapted to hatchery conditions and therefore less fit in the wild (Araki *et al.*, 2008). Water bodies that are suitable for CBF are often prone to flooding and stocked fish has the potential and a greater chance to escape and interbreed with their wild counterparts, when compared to intensive aquaculture practices in ponds, cages among others. This will potentially result in reduced fitness and adaptability of wild stocks (Hindar *et al.*, 1991, Waples and Do, 1994, Araki *et al.*, 2008).

Consultation with local communities often takes place when choosing species for CBF. Species are selected based on local preferences, seed availability and ability to reach a harvest size before the onset of the dry season (De Silva *et al.*, 2006a). Exotic species used for CBF in the Asian region are mainly Indian carps (e.g. rohu, *Labeo rohita*; mrigal, *Cirrhinus cirrhosus*; and catla, *Catla catla*), Chinese major carps (e.g. silver carp, *Hypophthalmichthys molitrix*; bighead carp, *H. nobilis*; and grass carp, *Ctenopharyngodon idellus*), and Nile tilapia (*Oreochromis niloticus*). Of all exotic species used for aquaculture, species that are commonly used in CBF have shown no impacts on local environment (De Silva *et al.*, 2006b), except the African walking catfish (*Clarias gariepinus*) (Na-Nakorn *et al.*, 2004). Species that can interbreed and produce viable offspring with local species, such as the African walking catfish, are therefore discouraged from being used in CBF and not discussed further in this paper.

The aims of this paper are to discuss issues pertaining to genetic management of species used in CBF. These species can be categorised into two groups: exotic species that do not interbreed with local species and indigenous species. Objectives of genetic management for these two groups of species are different: optimising productivity for the former and mimicking natural level of genetic diversity and minimising adaptation to hatchery conditions in the stocked materials for the latter.



A reservoir in northern Cambodia selected for a culture-based fisheries project implemented by the Network of Aquaculture Centres in Asia-Pacific (NACA) with funding from the Australian Centre for International Agricultural Research (ACIAR). Launched in 2012, the three-year project covered 16 reservoirs and focused on five indigenous species — striped catfish (*Pangasianodon hypophthalmus*), silver barb (*Barbonymus gonionotus*), red-tailed tinfoil barb (*B. altus*), snakeskin gourami (*Trichogaster pectoralis*) and the giant freshwater prawn (*Macrobrachium rosenbergii*).

Existing exotic species that do not interbreed with local species

Species that fall into this category include tilapia, major Indian and Chinese carps. Artificial propagation of these species has been established for many decades and fingerlings are often readily available. The successes in artificial propagation of these species possibly paved the way for initial expansion of intensive aquaculture in tropical Asia in the early growth phases of the sector, and still continues to make the highest contribution to cultured food fish production globally (FAO, 2012). The aim of genetic management for species in this category is to maximise productivity. Water bodies used for CBF are often non-perennial, and stocked fish need to reach a marketable size before water levels recede appreciably. Fast growing fish are therefore needed. It is unfortunate that fish selected for fast growth in an aquaculture environment do not always perform as well in CBF due to its reduced adaptability to feed on naturally produced food organisms and competition for resources with other species. For example, Genetically Improved Farmed Tilapia (GIFT) was outperformed by feral tilapia in reservoirs in Sri Lanka (Wijeynayake *et al.*, 2007). Other technologies could be used to develop fast growing strains included triploidy and monosex.

These technologies have proven effective in some species, for example triploid oysters (Stanley *et al.*, 1984) and monosex tilapia (Mair *et al.*, 1997).

Indigenous species

Recently artificial propagation of indigenous fish have been successfully conducted for many species. As a result, more indigenous species have been used for aquaculture and for stocking in natural waters. As mentioned earlier, the use of indigenous species in stocking may relieve the perceived issues brought about by exotic species, but the use of the former also brings to focus a new set of challenges. Fish, once domesticated and reproduced under hatchery conditions, results in reduced genetic variability (Hamasaki *et al.*, 2010, Nock *et al.*, 2011), changes in behaviour (Jonsson *et al.*, 2003), and reduced fitness within one or two generations of captive rearing (Araki *et al.*, 2008). Hatchery-produced fish once stocked in natural waters could become a major part of the fishery, for example up to 70% of silver barb (*Barbonymus gonionotus*) collected in Thailand waters were of hatchery origin (Kamonrat, 1996). Genetic interactions between less fit hatchery-produced fish and wild stocks may result in reduced fitness of wild populations. As such, the aim of genetic management here would be to

maintain the hatchery stock as comparable or similar to the wild stock as possible. To achieve this, the broodstock used for fingerling production should be as similar to the local wild fish as possible, and procedures in hatcheries should minimise the difference to wild processes.

Sustainable CBF practices should use fingerlings with a similar level of genetic diversity to wild stock. Choosing an appropriate source of broodstock is an important step. The best option here is to apply supportive breeding, a practice in which mature broodstock from local waters are caught and bred, and their offspring are released into the same area (Ryman and Laikre, 1991). This practice prevents exogenous genes being introduced into the local population. There is also evidence suggesting that hatchery stocks that use wild local fish for captive propagation generally perform better than non-local stocks (Araki *et al.*, 2008), another reason justifying the use of local broodstock for breeding. An example of such a breeding program is Murray cod (*Maccullochella peelii*) breeding at the Fisheries Victoria Snobs Creek Hatchery, Australia, a hatchery dedicated to breeding fish for stocking. Mature wild caught males and females are kept in earthen ponds and spawned naturally (mostly monogamous). Larvae are reared to fingerling size (40-60 cm total length) in fertilised ponds before being released into the wild. Such practices have resulted in an increase in effective population size of the wild stocks (Ingram *et al.*, 2011).

When the number of broodstock sourced from one place are inadequate to achieve production targets and there is a need to recruit broodstock from elsewhere, it is important to understand population genetic structure of the species. Introducing new stocks of the same species to local waters may result in changes in population genetic structure (Eldridge and Naish 2007, Marie *et al.* 2010, Horreo *et al.*, 2011). Genetic DNA markers such as microsatellites have been extensively used for investigation of population structures and identifying management units. Some studies in the Asian region suggest strong population genetic structure in species that have been candidates for CBF such as mud carp, *Cirrhinus molitorella* (Nguyen and Sunnucks, 2012), or for stock enhancement such as mahseer, *Tor douronensis* (Nguyen, 2008), and as such the use of local broodstock is recommended.

It is understood that in the Asian region where CBF is gaining popularity, resources required to undertake population genetic studies are lacking and hence information on population structure of species of interest is often unavailable. Collaboration with better equipped laboratories for such a task is recommended. Otherwise, it is advisable that broodstock should be collected in proximity of the CBF site, or from water bodies with most similar habitats, and fish with similar life history and behaviour (FAO, 2008).

When mature wild broodstock are not abundant, domestication is required to maintain a breeding population. In this case, a structured breeding program to maintain genetic diversity and avoid inbreeding of hatchery stock is required. Methods to achieve this are entailed in the FAO Guidelines for Responsible Fisheries (FAO, 2008). These include:

- **Minimise inbreeding:** Inbreeding can be avoided by not mating closely related individuals. This can be achieved by tagging and maintaining a pedigree for all broodstock. When tagging of broodstock cannot be done, increased effective breeding number can be used to minimise inbreeding (below). FAO (2008) recommends for stocking, inbreeding level should be maintained below 0.01. The number of broodstock required depends on the number of generations the hatchery is designed to reach production targets, the sex ratio used and successful spawning rates. For example, in a close breeding population, i.e. no new genetic materials are introduced for 5 generations, assuming pair mating is applied, it requires 250 males and 250 females with 100% spawning rate to achieve an inbreeding level of 0.01. In reality spawning rates are lower than 100% and the number of male and female broodstock required in such a case are much higher.
- **Maximise effective breeding number:** This can be achieved by practising the following:
 - ◆ Ensure many fish are spawned and maintain sex ratio as close to 1:1 as possible – this will improve the chance of all genetic materials to be passed to the next generation. This should be followed by improving technologies to enhance spawning, fertilisation, hatching and nursing

rates. It is understood that most hatcheries would like to maintain a minimal number of broodstock and use a skewed sex ratio to reduced production costs, but in the long term this practice would result in an undesirable outcome.

- ◆ Apply pedigreed mating (keep one daughter from each female and one son from each male to be broodstock for the next generation), or each parent leave the same number of offspring to be broodstock for the next generation.
- ◆ Equalise the number of offspring from each parent pair to be broodstock for the next generation. This requires each family to be maintained separately until offspring can be selected for broodstock.
- ◆ Milt among males should not be pooled prior to, or added in a sequential manner, during fertilisation – this is to avoid sperm competition and sperm from one male may fertilising most of the eggs, which reduces effective breeding number.
- ◆ Stretch generation time – lengthening the broodstock recruitment interval will slow down the inbreeding process.
- ◆ Maintain separate breeding lines and then hybridise between these lines – this requires structured facilities and resources.
- ◆ Apply factorial mating – instead of breeding full-sib families, a factorial design could be used to improve effective breeding number.
- ◆ Avoid selection – selecting larger or better appearance fish will reduce the chance of smaller or less attractive fish passing their genes to the next generation, which reduces genetic diversity.
- ◆ Influx new genetic material to the broodstock population regularly – it is suggested that if 10-15% new broodstock are introduced each generation, inbreeding can be drastically reduced. An example in this regard is the fish stocking programs in Myanmar, where hatcheries are licensed to recruit new broodstock from the wild periodically, based

on the agreement with the government that a proportion of fingerlings produced should be released into public waters as part of the national stock enhancement programs (Aung *et al.*, 2009).

Apart from ensuring genetic similarity between stock and local wild fish, hatchery procedures from breeding to nursing should mimic wild processes as much as possible (FAO, 2008). For example, natural diets should be used rather than artificial feed, ponds are recommended instead of tanks, or stock younger fish which are less adapted to hatchery conditions than larger, older, fish. The latter recommendation however faces the paradox that larger fish survive better in CBF environment.

Conclusions

Given the importance of CBF in providing food security and livelihood of the rural poor, and its popularity as an “environmental friendly” practice due to low input requirements, responsible use of genetic resources should be considered. While improving productivity using better management practices, negative impacts on the environment should be minimised. This can be achieved by careful planning, incorporating conservation aspects in management of CBF together with technology development to improve productivity. A desirable outcome should be better livelihood for the rural poor and their surrounding environment is minimally impacted.

Acknowledgements

I have been involved in two projects funded by ACIAR, “Development of culture-based fisheries in Lao”, and “Culture-based development in Lao and Cambodia”. This paper is written as part of my presentation at the regional consultation on “Culture-based fisheries development in Asia”, 21-13 October 2014, Siem Reap, Cambodia.

** Dr Thuy, a former senior researcher at the Research Institute for Aquaculture (RIA2), works at the BioSciences Research Division of the Department of Economic Development, Jobs, Transport and Resources in Victoria, Australia. The paper is reprinted from De Silva, S.S., Ingram, B.A. and Wilkinson, S. (eds.) 2015. Perspectives on culture-based fisheries developments in Asia. NACA Monograph Series No. 3, 126p.*

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Dr Sang named director of Viet Nam's Research Institute for Aquaculture No. 2

Fish geneticist assumes the helm at country's leading research institute for fisheries in the Mekong Delta

The Vietnamese Ministry of Agriculture and Rural Development has appointed Dr Nguyen Van Sang as director of its Research Institute for Aquaculture No. 2 (RIA2) in Ho Chi Minh City to succeed Dr Nguyen Van Hao who retired in August.

Dr Sang was previously a deputy director of the institute, with responsibility for science, technology and international cooperation. Before that, he worked in the Mekong Delta province of Tien Giang as deputy director of the National Breeding Centre for Southern Freshwater Aquaculture in Cai Be.

Before joining the government research institute in 1997, Dr Sang worked at Kim Hung Aquarium Company in Binh Duong Province for almost a year as a technical manager. At RIA2, he initially worked in the Department of Biology as a researcher for seven years before being appointed senior researcher in 2005. Dr Sang became deputy head of the department in 2008 before moving to Cai Be in 2009, the same year he was appointed as a deputy director of the institute.

Born in the central coastal province of Binh Dinh in 1973, Dr Sang completed his BsC in aquaculture at Nong Lam University in Ho Chi Minh City in 1997. He earned his MSc on the genetics of rainbow trout (*Oncorhynchus mykiss*) at the Norwegian University of Life Sciences in 2004. He completed his PhD at the same university in 2010 with his doctoral thesis on genetic studies on the improvement

of striped catfish (*Pangasianodon hypophthalmus*) for economically important traits.

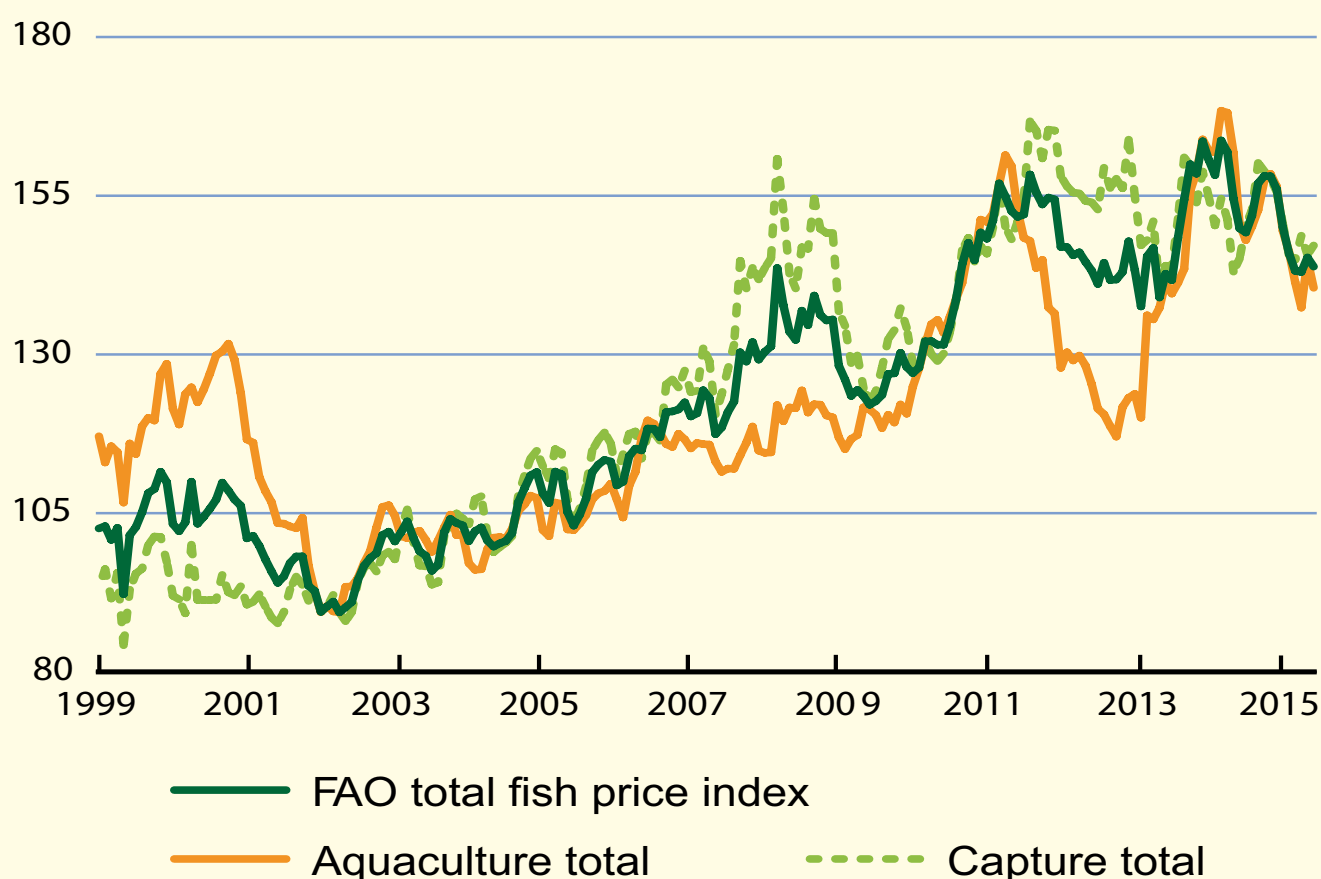
Between 1999 and 2006, Dr Sang took part in numerous training courses in China, France, Malaysia, the Philippines, Thailand, the United States and Viet Nam including several related to Mekong fisheries. Since 2002, he has co-authored two dozen scientific papers on various subjects related to aquaculture in both Vietnamese and English. These include numerous papers on the genetic parameters of striped catfish, the native Mekong species for which Viet Nam is the world's largest producer.



Dr Sang during a visit to Viet Nam's National Breeding Centre for Southern Marine Aquaculture in Vung Tau in April

PHOTO: LEM CHAMNAP

FAO Fish Price Index
Norwegian Seafood Council (2002-2004 = 100)



Production, trade, utilisation and consumption FAO Food Outlook, October 2015	2013	2014 Estimate	2015 Forecast	Change 2015/2014
	Million tonnes			%
Production	162.8	164.3	168.6	2.6
Capture fisheries	92.6	90.0	90.6	0.7
Aquaculture	70.2	74.3	78.0	5.0
Trade value (exports USD billion)	136.1	143.5	129.8	-9.6
Trade volume (live weight)	58.8	59.5	59.8	0.5
Total utilization	162.8	164.3	168.6	2.6
Food	141.0	144.6	147.5	2.0
Feed	16.8	15.0	16.4	9.7
Other uses	5.0	4.8	4.7	-2.1
Other uses	5.0	4.8	4.7	-2.1
Consumption per person				
Food fish (kg/yr)	19.7	20.0	20.1	0.9
From capture fisheries (kg/year)	9.9	9.7	9.5	-2.2
From aquaculture (kg/year)	9.8	10.3	10.6	3.8
FAO Fish Price Index (2002-2004 = 100)	2013	2014	2015 Jan-Jun	Change Jan-Jun 2015/Jan-Jun 2014
	148	157	145	-8.2

Thailand Talaad Thai Wholesale Market, Pathum Thani Province	THB per kg	
	July, 2015	November, 2015
Slender rasbora (<i>Rasbora daniconius</i>)	50 - 53	55 - 60
Chinese edible frog (<i>Haplobatrachus rugulosus</i>) (large)	85 - 90	85 - 90
Chinese edible frog (<i>Haplobatrachus rugulosus</i>) (small)	75 - 80	70 - 80
Asian redbelly catfish (<i>Hemibagrus wyckii</i>)	160 - 180	180
Yellow mystus (<i>Hemibagrus filamentus</i>)	110 - 120	120 - 140
Tire track eel (<i>Mastacembelus favus</i>)	200 - 230	250 - 280
Clown featherback (<i>Chitala ornata</i>)	190 - 220	210
Iridescent mystus (<i>Mystus radiatus</i>) (large)	50 - 70	120
Iridescent mystus (<i>Mystus radiatus</i>) (small)	40 - 45	90
Wallago (<i>Wallago attu</i>) (large)	150 - 160	180
Wallago (<i>Wallago attu</i>) (small)	40	100 - 110
Bronze featherback (<i>Notopterus notopterus</i>)	90 - 100	90 - 100
Wild striped snakehead (<i>Channa striata</i>) (large)	130 - 135	135 - 145
Wild striped snakehead (<i>Channa striata</i>) (small)	60 - 70	80
Farmed Indonesian snakehead (<i>Channa micropeltes</i>) (large)	130 - 135	145 - 150
Farmed Indonesian snakehead (<i>Channa micropeltes</i>) (small)	55 - 90	100 - 120
Bighead catfish (<i>Clarias macrocephalus</i>) (large)	90 - 120	110 - 120
Bighead catfish (<i>Clarias macrocephalus</i>) (small)	110 - 120	110 - 120
Farmed North African walking catfish hybrid (large)	40 - 43	38 - 42
Farmed North African walking catfish hybrid (small)	34 - 37	34 - 37
Siamese red catfish (<i>Phalocronotus bleekeri</i>) (large)	350 - 380	350 - 380
Siamese red catfish (<i>Phalocronotus bleekeri</i>) (small)	180 - 200	200 - 240
Silver barb (<i>Barbonymus gonionotus</i>) (large)	50 - 55	55 - 60
Silver barb (<i>Barbonymus gonionotus</i>) (small)	40	45 - 50
Red tilapia hybrid (large)	90 - 98	75 - 78
Red tilapia hybrid (small)	65 - 75	55 - 60
Nile tilapia (<i>Oreochromus niloticus</i>) (large)	58 - 65	58 - 60
Nile tilapia (<i>Oreochromus niloticus</i>) (small)	25 - 45	30 - 45
Whisker sheatfish (<i>Kryptopterus</i> spp.) (large)	150 - 160	140 - 150
Whisker sheatfish (<i>Kryptopterus</i> spp.) (small)	80 - 90	80 - 100
Common carp (<i>Cyprinus carpio</i>) (large)	40	40
Giant Mekong catfish (<i>Pangasianodon gigas</i>)	65	55 - 60
Boeseman croaker (<i>Boesemania microlepis</i>)	190 - 250	180 - 190
Horseface loach (<i>Acanthopsis choirorhynchus</i>)	140 - 155	120 - 160
Giant gourami (<i>Osphronemus goramy</i>)	100 - 115	80 - 100
Siamese mud carp (<i>Henicorhynchus siamensis</i>)	45 - 50	45 - 50
Snakeskin gourami (<i>Trichopodus pectoralis</i>)	90 - 180	90 - 195
Striped catfish (<i>Pangasianodon hypophthalmus</i>)	32 - 33	32 - 35
Climbing perch (<i>Anabas testudineus</i>) from rice paddy (large)	100 - 115	100 - 115
Climbing perch (<i>Anabas testudineus</i>) from rice paddy (small)	50 - 70	65 - 85
Farmed climbing perch (<i>Anabas testudineus</i>) (large)	95 - 105	95 - 105
Farmed climbing perch (<i>Anabas testudineus</i>) (small)	50 - 60	45 - 75
Peacock eel (<i>Macrognathus siamensis</i>) (large)	120 - 130	120 - 140
Peacock eel (<i>Macrognathus siamensis</i>) (small)	100 - 110	100 - 110
Swamp eel (<i>Monopterus albus</i>) (large)	220 - 240	200 - 230
Swamp eel (<i>Monopterus albus</i>) (small)	300	300
Pond snail (<i>Filopaludina martsensi</i>)	30 - 35	30 - 35
Viet Nam Vietnam Association of Seafood Exporters and Producers, Dong Thap Province and Danang	VND per kg unless otherwise stated	
	February, 2015	June, 2015
White pangasius (<i>Pangasianodon hypophthalmus</i>) (Type 1)	24,300 - 26,300	20,000
White pangasius (<i>Pangasianodon hypophthalmus</i>) (Type 2)	23,500 - 24,300	18,700
Pangasius fry (<i>Pangasianodon hypophthalmus</i>) (1 pc)	1.5 - 2.0	0.5 - 0.7
Pangasius fingerlings (<i>Pangasianodon hypophthalmus</i>) (3,000 pcs)	50 - 60	30 - 35
Pangasius seed (<i>Pangasianodon hypophthalmus</i>) (2 cm)	900 - 1,200	500 - 600
Giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) (>100 grams)	250,000 - 280,000	350,000 - 370,000
Giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) (75 - 99 grams)	200,000 - 220,000	300,000 - 340,000
Giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) (50 - 74 grams)	170,000 - 190,000	250,000 - 280,000
Giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) (gravid, <50pcs/kg)	100,000 - 120,000	150,000 - 200,000
Black tiger shrimp (<i>Penaeus monodon</i>) (8 pcs/kg)	540,000	500,000
Black tiger shrimp (<i>Penaeus monodon</i>) (15 pcs/kg)	430,000	410,000
Black tiger shrimp (<i>Penaeus monodon</i>) (25 - 30 pcs/kg)	270,000	240,000
Black tiger shrimp (<i>Penaeus monodon</i>) (40 pcs/kg)	160,000	140,000



Fish on display at Fish Village in Ratchaburi Province in Thailand. The ornamental fish market is the largest in Southeast Asia with more than 200 species and annual sales of more than \$20 million (see page 16).

PHOTO: WITCHAMAI SOMCHARN



**Office of the Secretariat in Vientiane (OSV),
Office of the Chief Executive Officer**
184 Fa Ngoum Road,
PO Box 6101, Vientiane, Lao PDR
Tel: (856-21) 263 263 Fax: (856-21) 263 264

Office of the Secretariat in Phnom Penh (OSP)
576 National Road #2, Chak Angre Krom,
PO Box 623, Phnom Penh, Cambodia
Tel: (855-23) 425 353 Fax: (855-23) 425 363