5 Validation of Consumption Estimates

In this section the results from the analysis of consumption data are compared with other data: (i) a study which monitored actual consumption of some LMB residents (5.1), (iii) catches, where considered in the study reports (5.2), (iii) typical world consumption data and data from other studies (5.3), and (iv) data from areal fishery yield from floodplains (5.4).

5.1 A trial monitoring study

Garrison *et al*. (2006, and unpublished data) carried out a 12-month study (2003–4) in which consumption of all foods by 32 typical family households (8 from each LMB country) was monitored for three 2-week periods—42 days in total—by trained technicians. The households were spread between the four countries and represented equal numbers of families classed as living by aquaculture, fishing, trading and in urban jobs. The consumption recorded during this study can be considered very accurate for the families that were covered, although not necessarily representative for the LMB. It is therefore of interest to compare these actual monitoring data with the consumption estimated for the LMB in this study, which was based primarily on interviews (Table 27).

Table 27. *Comparison of consumption actually recorded for selected households and that estimated for the LMB based on regional studies.*

All data are kg/capita/year as FWAEs.

Country	Source	Type	Monitored	LMB estimate
Cambodia	Inland	Fish	41.7	42.2
		OAA	7.6	9.2
	Marine	Fish	1.1	
		OAA	4.6	1.0
	Total		55.0	52.4
Lao PDR	Inland	Fish	29.0	34.6
		OAA	2.4	8.4
	Marine	Fish	2.2	
		OAA	0.9	0.5
	Total		34.5	43.5
Thailand	Inland	Fish	38.2	31.9
		OAA	5.7	9.2
	Marine	Fish	5.0	
		OAA	1.1	5.8
	Total		50.0	47.7
Viet Nam	Inland	Fish	42.1	39.5
		OAA	6.7	10.0
	Marine	Fish	4.2	
		OAA	3.5	7.4
	Total		56.5	56.1
Total	Inland	Fish	37.7	36.6
		OAA	5.6	8.8
	Marine	Fish	3.1	
		OAA	2.5	4.9
	Total		48.9	50.3

Table 28. *Summary of data on catches.*

Studies which covered large parts of a province or provinces

No.	Study Report and Date	Country	Region	No. of provinces	Catches compared with consumption
1	Ahmed *et al*. (1998)	Cambodia	Tonle Sap - Great Lake	8	Small and middle-scale catches 20% more than consumption, allows for some sales. Large-scale catches additional.
2	Setboonsarng *et al*. (2001)	Cambodia	Kandal, Prey Veng, Takeo	3	Not separately calculated
3	Touch *et al*. (1994)	Cambodia	Svay Rieng	1	Based on catches
4	Gregory *et al*. (1996)	Cambodia	Svay Rieng		Based on catches
5	Mogensen (2001)	Cambodia	Svay Rieng		Based on catches
6	Funge-Smith (1999a)	Lao PDR	Northern Lao PDR	5	No separate data, most from aquaculture or rice-fields
7	Sjorslev (2000)	Lao PDR	Luang Prabang	1	Wide range in catch estimates; less than half to about 2 times the catch-derived part of consumption estimates
8	Singhanouvong and Phouthavongs (2003)	Lao PDR	Champassak	1	Catches only 60% of consumption, should be approximately equal
9	Baird *et al*. (1998)	Lao PDR	Khong district, Champassak	1	Data based on household catches
10	Garaway (2005)	Lao PDR	Savannakhet, 4 villages	1	Data based on household acquisition
11	Mattson *et al*. (2000)	Lao PDR	Vientiane	1	Catches much greater than consumption as expected in this commercial fishery
12	Prapertchob *et al*. (1989)	Thailand	5 provinces in northeast Thailand	5	Consumption only
13	Suntornratana (2002)	Thailand	Lowland parts of 3 provinces	3	Household catches about 80% of consumption, reasonable agreement
14	Piumsombun (2001)	Thailand	Khon Kaen, Nakhon Ratchasima	2	No data on catches
15	Sjorslev (2002)	Viet Nam	An Giang	1	Catches approx. 1.9 x consumption, consistent with nett fish export from this province
16	Pham and Guttman (1999)	Viet Nam	Long An, western half	1	Catches and aquaculture production 2.6x consumption, consistent data as excess is sold.
17	Setboonsarng et al. (1999)	Viet Nam	Tien Giang	1	Only aquaculture reported.
18	Phan *et al*. (2003)	Viet Nam	Tra Vinh	1	Catches 1.11x consumption, acceptable agreement

Studies which covered an entire country, not disaggregated

No.	Study Report and Date	Country	Coverage	No. of provinces	Catches compared with consumption
19	NSC (2004)	Lao PDR	Lao PDR	18	nd
20	Lem and Nghia (2003)	Viet Nam	Viet Nam	Not stated	nd

As shown in Table 27 there is a very good agreement between the results of monitoring and the estimates for the LMB. The results for Lao PDR are somewhat higher and for Thailand somewhat lower than the estimates, but overall the mean results are within 3% of each other. Assuming that the selected households were unremarkable (neither particularly low nor high fish eaters) this excellent concordance tends to support the LMB consumption estimates.

5.2 Catches and consumption

Households obtain fish for consumption by capture, culture, purchase, exchange or as gifts. At provincial level, a balance should be evident in production data, where capture plus culture should balance household consumption, plus exports, minus imports, plus wastage and feed. Catch data were not collected in all studies, and in some catch data were used to estimate consumption. Table 28 shows the extent to which catch and consumption figures can be compared.

In studies of provinces where there is little export or aquaculture (Studies 7, 8 and 13) there was considerable variation between catch and consumption estimates. In Study 7, catch estimates depended upon who was asked (household heads or individual fishers) and how questions were asked. In Study 8 there was a large discrepancy in input/consumption figures at the household level, perhaps due to use of different time scales in questioning. In Study 12, catches and consumption were approximately in balance, allowing for aquaculture and imports of fish.

In studies where exports were significant (Studies 1, 11, 15, 16 and 18) production data (catches plus aquaculture) always exceeded consumption, which indicates some consistency in the data. But because exports are unknown it is not possible to use the production data to precisely validate consumption estimates; i.e. exports are calculated as production minus consumption and other uses.

In summary, catch data in most cases are consistent with consumption data, so providing some level of confidence in the accuracy of the estimates.

5.3 Other consumption data

Official figures for consumption from developed countries

Based on reported trade figures, the FAO estimates annual per capita ‘apparent consumption’ figures, which are intended to include all fish and OAAs that pass through formal trade systems. National governments provide official figures on catches, imports, exports, and sales for animal feed, and the FAO uses these to derive ‘whole animal’ figures for ‘world apparent consumption of fish and fishery products’ which are updated regularly and published on www.faostat.fao.org.

For developed countries that have cash-based economies, the FAO consumption figures can be considered accurate to within a few percent, as most trade in food is accurately monitored[1].

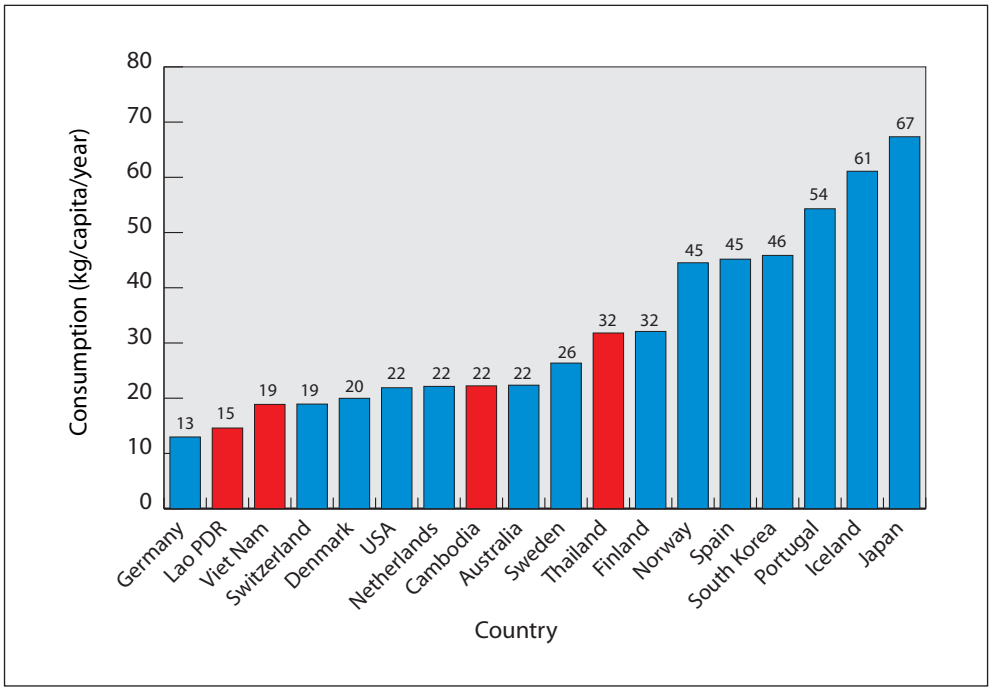

Figure 16. FAO estimates for 'apparent consumption' of all fish and OAAs for some developed countries, compared with FAO data for LMB countries (Year 2000 data from www.faostat.fao.org, updated data downloaded in 2006).

The FAO consumption figures for all fish and OAAs (marine plus inland) developed countries range from about 13 to 67 kg/capita/year, with mid-range consumers in developed countries eating about 30–40 kg/capita/year as FWAEs (Figure 16). The FAO estimates for inland fish in all LMB countries are much less than those from this study (average 23%, range 18–47%, see Table 29), and the FAO figures for inland OAAs are clearly unrealistic, being zero in three countries. Overall the FAO figures are about half of the consumption figures estimated in this study. This discrepancy is a result, at least in part, of the FAO figures excluding data from subsistence/artisanal inland fisheries as well as probable under-reporting in official trade figures.

Given that the LMB peoples are moderate to high consumers of fisheries products, we can assume from Figure 3 that a realistic range for the LMB countries (based on FAO world figures for well-monitored countries) is 40–60 kg/capita/year. The figure estimated for LMB

1 The developed-country figures are subject to two sources of error which may balance each other to some extent: wastage is not subtracted from the whole-animal figures, but consumption from recreational fisheries is underestimated or not included.

consumption in this report of 51.5 kg/capita/year as FWAEs for all aquatic foods (inland fish and OAAs as well as marine products) thus appears to be plausible from this perspective.

Table 29. *Comparison of FAO 'apparent consumption' figures with the consumption figures from this study.*

Country	Source	Type	This study, LMB estimate	FAO whole country estimate	FAO estimate / this study estimate
Cambodia	Inland	Fish	42.2	19.8	47%
		OAA	9.2	0.0	0%
	Marine	Fish and OAAs	1.0	2.5	248%
	Total		52.4	22.2	42%
Lao PDR	Inland	Fish	34.6	13.5	39%
		OAA	8.4	0.0	0%
	Marine	Fish and OAAs	0.5	1.1	219%
	Total		43.5	14.6	34%
Thailand	Inland	Fish	32.0	7.8	24%
		OAA	8.5	1.1	13%
	Marine	Fish and OAAs	5.8	23.0	396%
	Total		46.3	31.8	69%
Vietnam	Inland	Fish	39.5	7.0	18%
		OAA	9.2	0.0	0%
	Marine	Fish and OAAs	7.4	11.9	161%
	Total		56.1	18.9	34%
Total	Inland	Fish	36.6	8.5	23%
		OAA	8.8	0.4	5%
	Marine	Fish and OAAs	4.9	15.1	307%
	Total (weighted)		50.3	24.0	48%

Other tropical countries

Comparisons may also be made to studies of similar environments. Bayley and Petrere (1989) summarised results from consumption studies of inland fish from the Amazon basin; in lowland areas consumption varied from 27–101 kg/capita/year, and in highlands where cheap beef was available, the lowest fish consumption was 4 kg/capita/year. The LMB is more intensively exploited than the Amazon, so yields per unit area may be larger, but per capita consumption also depends upon many other factors, including population density. The LMB average is in the mid-region of the lowland Amazon range, suggesting it is of the correct order.

Roos *et al*. (2003) in a rather intensive study in Bangladesh of typical poor rural people found that they ate 16–36 kg/capita/year of fish as FWAEs. This figure fits well with the LMB estimates, allowing for some substitution of fish in Bangladesh by pulses (peas, beans, etc.). The study was based on five-day recall, which is probably less accurate than 24 hour recall.

Consumption by expatriate LMB country people

Sechena *et al*. (1999) used quality-assured standardised interview protocols among expatriate Asians in Washington State (USA) and found high annual seafood consumption among people from LMB countries, as summarised in Table 30. In this study, older respondents reportedly ate more seafood than younger respondents, perhaps indicating retention of original eating habits as is also suggested by the low consumption rates among highland Hmong and Mien people.

Table 30. *Consumption of fish and seafood by expatriate Asians in the USA. Estimated actual intakes in people living in King Country, Washington State, (from Sechena* et al*., 2002). Seaweed/kelp was subtracted from totals and an average body weight of 62 kg was used for converting these figures from g/kg/day.*

Ethnicity	Reported actual consumption (kg/capita/year)			
	N	Total	Shellfish	Fish
Cambodian	20	32.2	20.8	11.4
Laotian	20	43.5	20.3	23.1
Mien	10	13.1	7.7	5.5
Hmong	10	13.2	5.6	7.6
Vietnamese	26	59.1	35.7	23.4

These figures for reported actual consumption should be increased to derive FWAEs. They are then much higher than the figures for LMB people and for US citizens generally, suggesting that LMB people do indeed have an above-average tendency to consume seafood given the opportunity. Although this study does not support any particular figures for LMB people, it does suggest that consumption of fish and OAAs in the LMB is likely to be higher than world averages.

5.4 Yield calculations based on floodplain area x production/ha

Yields from large tropical floodplain rivers are thought to depend mainly on the area of land that is flooded and the duration of flooding each year. Welcomme (1985) reviewing world data suggested that 70% of the production in large river systems is predictable from floodplain area alone. In the LMB the size of the flood each year has a direct effect on the production and subsequent yield of fish, as shown by monitoring data from the Cambodian *dai* fishery (Hortle *et al*., 2005). While many fish and OAAs are caught in rivers or streams, much of their biomass actually originates from growth during the time that they were feeding on productive flooded areas during the wet season.

Sverdrup-Jensen (2002) estimated a yield of fish of 230 kg/ha/year of floodplain, which he multiplied by a floodplain area in the LMB of 96,900 km^2 to estimate a yield of 2.23 million tonnes for the LMB. The figure of 230 kg/ha/year was derived from a very approximate estimation of yield from the entire Cambodian floodplain area by Baran *et al*. (2001), which

Table 31. *Areal estimates for LMB fishery yield.*

Mekong System — Floodplains

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Mekong Delta Floodplain, deep water flooded areas	Rice fields, black water area	42–63	Fish 46.9% OAAs 53.1%	Intensive monitoring at one site	de Graaf and Chinh (2000)
Mekong Delta Floodplain, deep water flooded areas	Rice fields, non-acid area	80–119	Fish 88.9%, OAAs 11.1%	Intensive monitoring at one site	
Battambong, near Great Lake, Cambodia	Rice fields, single crop rain fed	67–162, mean 119	Fish 76.6%, OAAs 23.4%	Yields from 10 plots of 25 ha each, monitoring of all catches	Troeung *et al*. (2005)
Mekong Delta, Viet Nam	Rice fields, stocked with fry	95–619 per 10 months	Fish, mostly exotic	Yields from 50 trial farms, double or triple rice-cropping, fish not fed	Nguyen *et al*. (2002) Table 13
Northeast Thailand	Rice fields, wild fish Rice fields, wild and stocked	25–125 56–303	Fish	Range from one study in Khu Khat Range from two sites	Little *et al*. (1996)
Uplands, Lao PDR	Rice fields, stocked with fry	31–640 per crop	Fish, mostly exotic	Range from several studies, approximate	Funge-Smith (1999b)
Prey Veng, Cambodia	Rice fields, single-crop, former forest	55	Fish	Includes only large and middle-scale fisheries catches in fishing lots, does not include artisanal catch	Troeung *et al*. (2003)
Prey Veng, Cambodia	Degraded forest 31% cover and rice fields, single crop	92	Fish		
Battambong, near Great Lake, Cambodia	Flooded forest	95	Fish		
Tonle Sap Floodplain, Kampong Chhnang	Natural grassland	113 kg/ha	Fish 95% OAA 2%	Standing crop of 13 sites	Lieng *et al*. (2006)
Tonle Sap Floodplain, Kampong Chhnang	Natural swampland	84 kg/ha	Fish 90% OAA 3%	Standing crop of 20 sites	Lieng *et al*. (2006)

Mekong System — Reservoirs

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Sirindhorn Res., NE Thailand	Reservoir	21	Fish only	Stabilised catch	Sricharoendham *et al*. (2000)
Ubolratana Res., NE Thailand	Reservoir	23–64	Fish only	Initial rise then fall, 1965-1993	Pholprasith and Sirmongkonthaworn (1999)
Nam Ngum, Lao PDR	Reservoir	40–185	Fish only	Indigenous species, fishery not yet stabilised	Mattson *et al*. (2000)
Ea Kao, Highlands of Viet Nam	Reservoir	400–450	Fish only	Mainly stocked exotic species, euthrophic reservoir	Phan and De Silva (2000)
7 tropical countries	Asian Reservoirs	15–576	Fish?	Mixed species	de Silva and Amarasinghe (1996)

Other rivers — Floodplains - wild fish

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Africa, South America, Asia	Tropical floodplain rivers	typically 40–60, range 7–143	Fish?	Review of data	Welcomme (1985) p. 214 and Table 7.13
Bangladesh	Unregulated Floodplains 8 studies	51–215	Fish	Intensively fished	Ali (1997) Table 31
Bangladesh	Floodplain enclosed by levees	77–102	Fish	Intensively fished	Ali (1997) Table 33 - non-stocked yield only
Bangladesh	Open floodplain	423–574	Fish	Intensively fished	Ali (1997) Table 33 - non-stocked yield only
Bangladesh	Floodplain - low-lying areas with permanent water bodies	165	Fish	Intensively fished	de Graaf *et al*. (2001)
Bangladesh	Floodplain seasonally inundated	83	Fish	Intensively fished	
Bangladesh	Rivers and riparian land	102–157	Fish	Intensively fished	
Bangladesh	Floodplain–Natural	104–130	Fish	Intensively fished	Halls *et al*. (1999)
	Floodplain–Modified	51–81	Fish	Intensively fished	

Other systems — rice fields

Malaysia	Rice fields, wild fish	68–140	Fish	Double rice cropping, artisanal fishery	Tan *et al*. (1973), cited in Fernando (1993) Table 3
Northeast India	Rice fields, stocked	907–1,282 per 120 days	Fish and Shrimp	120 day rice crop, heavy organic fertiliser, no feeding	Mohanty (2003)

Crude Estimates from the LMB, not based on exact areas or measured yields

Tonle Sap System	Floodplain, total	230	Fish?	Crude estimate, see text	Baran *et al*. (2001)
Tonle Sap Floodplain	Floodplain, total for 1995–99	139–190	Fish?	Crude estimate, see text	Lieng and van Zalinge (2001)
Prey Veng, single rice rain fed, low-moderate yield	Rice fields	50–100	Fish?	Estimates based on catches, villages may not be representative, approximate area	Guttman (1999)

was itself partly based on consumption figures of Ahmed *et al*. (1998), so it cannot be used to validate consumption estimates. Moreover, Cambodian floodplains are generally more productive than those in Thailand and Lao PDR, where land is inundated for shorter periods.

A wide range of yields has been reported from floodplain river systems elsewhere (from <100 to >1,000 kg/ha/year), and Welcomme (1985 p. 214) believed a range of 40–60 kg/ha/year was typical for floodplain river systems. Data from other areas of the world may not be applicable to the LMB because of differences in productivity of the systems, differences in level of exploitation, and inaccuracies in the methods used. A preferred approach is to use the results from studies in the LMB where catches and areas were accurately estimated, and to use these to extrapolate for the LMB.

Table 31 shows the range of relevant reliable areal yield estimates in the LMB. It should be noted that many studies under-estimate yields to some extent as not all catches can be monitored. Yields from rice-fields of fish and OAAs combined are 42–165 kg/ha/year, with one quarter typically comprising OAAs, a proportion consistent with the limited consumption data (see Table 23). Stocking of rice-fields shows how natural yields can be augmented (Little *et al*., 1996; Nguyen *et al*., 2002) and perhaps provides some indication of the upper limits to yield (around 700kg/ha/year) for wild fish in very productive rice-fields. Middendorp (1992) reported a maximum wild fish yield of 1,199 kg/ha in rice-fish culture systems in northeast Thailand, but his very high figures suggest that his study sites might have included some drain-in from upstream rice paddies (i.e. from a larger area than that used to calculate yield). In floodplains, Troueng *et al*. (2003) showed that partly- or well-forested areas may produce 1.7 times as much fish as unforested areas; note that their study does not include artisanal and subsistence catch which would increase the yield figures. If this ratio of 1.7 is applied to the more complete data from rice-fields (i.e. including all fish and OAAs), the range for forested floodplains could be 71–281 kg/ha/year (i.e. the rice-field range multiplied by 1.7). Figures for standing crop show a minimum estimate for yield of 84 and 113 kg/ha for natural swamp and grassland as the figures are based on a single harvest (Lieng *et al*., 2006). Data for typical rice-fields or other aquatic habitats in Lao PDR and Thailand are limited (Little *et al*., 1996). However, it is reasonable to expect that the yields in these countries would be lower than in Viet Nam and Cambodia where rice-field habitat includes most of the large areas seasonally flooded by the Mekong (Figure 3).

Floodplains in Bangladesh have a similar fauna to the LMB and appear to have similar yields, but in some cases yields are higher, perhaps as a result of more intense fishing pressure. The yield from rice-fields in other systems appears to be similar to yields from LMB rice-fields (Fernando, 1993), and heavy stocking with fry and fertilisation may lead to yields greater than 1,000 kg/ha/year.

Table 31 also shows the various levels of yield that can be expected in reservoirs in the LMB; yields are high when reservoirs first fill and then decline to around 20 kg/ha/year of reservoir surface after some decades, except where nutrients are constantly added to the reservoir as can be seen for Ea Kao.

The total area of the Lower Mekong Basin is 622,584 km^2, and of this about 193,896 km^2 (24.8%) is classed as wetlands, a figure much higher than that used by Sverdrup-Jensen (2002) in his estimate of basinwide production. A breakdown of the wetland area (Table 32) shows that most is classed as rice-fields, although much of this may actually be other land uses (e.g. scrub, other agricultural fields, idle land or small water bodies) that are in blocks that are too small to be discriminated. For comparison, Cambodia officially has about 23,000 km^2 of rice-fields (McKenney & Prom, 2002) which is 77% of the area classed as rice-fields under the GIS system. Thailand has the largest share of the LMB wetland (and rice-field) area, but flooding has been limited in extent and duration by water management schemes, so capture fisheries production (per unit area) is likely to be less than in Viet Nam and Cambodia.

Table 32. *Estimates of area of wetland areas in the Lower Mekong Basin from MRC GIS databases.*
Broad categories follow Figure 3 and these may include small blocks of other habitats.

	Area (km^2)					% of total
Wetland type	Cambodia	Lao PDR	Thailand	Vietnam	Total	
Bank/Beach bar/Estuarine	24	22			46	0.02%
Flooded Forest or Plantation	52			120	172	0.09%
Lakes or Ponds, Man-made or Natural	3,086	602	1,757		5,445	2.81%
Marine/Coastal Mangrove and Aquaculture	515			16,034	16,549	8.53%
Rice: Wet/Recession and Other Crops	31,494	7,186	82,846	18,068	139,594	71.99%
Rivers and Channels	1,446	1,126	569	730	3,871	2.00%
Swamp, Backswamp, Grassland, Marsh	10,426	1,260	1,562	1,156	14,404	7.43%
Others	2,350			11,465	13,815	7.12%
Total	49,393	10,196	86,734	47,573	193,896	100.00%
% of Total	25.5%	5.3%	44.7%	24.5%	100.0%	

Note: Figures from the MRC GIS database, based on data from 1992 – 1998

Because rice-fields forms such a large proportion of the total wetland area, a basin wide estimate of yield depends largely upon the yield estimate (per unit area) that is used for rice-fields. All LMB studies are from Cambodian or Vietnamese rice-fields, so in the absence of field data it was assumed that areal yields in Lao PDR and Thailand are on average 50% of areal yields in Viet Nam and Cambodia.

Three levels of yield were assumed — 'low', 'medium' and 'high': 50, 100 and 200 kg/ha/year respectively — as shown in Table 33 and based on data in Table 31. The 'high' level allows for possible underestimation in studies in which all the yield was not recorded. These areal yield estimates were then multiplied by the estimated wetland areas to derive total yield estimates. Table 33 shows that under these assumptions the estimated yield from Cambodia is the highest among the four countries, while Thailand and Viet Nam have similar but slightly lower yields; the lower areal yield in Thailand is compensated for by its larger total area of wetland habitat. Lao PDR yields relatively little because of its small wetland area and assumed low areal yield.

Table 33. *Estimated fisheries yield from the LMB based on yield per unit area, compared with consumption estimates.* *OAAs estimated as 25% of fish.*

	Cambodia	Lao PDR	Thailand	Viet Nam	Total
Total wetland area (km²)	49,393	10,196	86,734	47,573	193,896

Estimated yield (kg/ha/year)	Cambodia	Lao PDR	Thailand	Viet Nam	Weighted Total
Low estimate	50.0	25.0	25.0	50.0	37.5
Fish	40.0	20.0	20.0	40.0	30.0
OAA	10.0	5.0	5.0	10.0	7.5
Medium estimate	100.0	50.0	50.0	100.0	75.0
Fish	80.0	40.0	40.0	80.0	60.0
OAA	20.0	10.0	10.0	20.0	15.0
High estimate	200.0	100.0	100.0	200.0	150.0
Fish	160.0	80.0	80.0	160.0	120.0
OAA	40.0	25.0	25.0	50.0	37.5

Estimated yield (tonnes/year)	Cambodia	Lao PDR	Thailand	Viet Nam	Total
Low estimate	246,965	25,490	216,835	237,865	727,110
Fish	197,572	20,392	173,468	190,292	581,688
OAA	49,393	5,098	43,367	47,573	145,422
Medium estimate	493,930	50,980	433,670	475,730	1,454,220
Fish	395,144	40,784	346,936	380,584	1,163,376
OAA	98,786	10,196	86,734	95,146	290,844
High estimate	987,860	101,960	867,340	951,460	2,908,440
Fish	790,288	81,568	693,872	761,168	2,326,752
OAA	197,572	20,392	173,468	190,292	581,688

Consumption Estimates (tonnes/year)					
Fish plus OAAs	587,004	208,503	911,485	852,823	2,559,815
Total Inland Fish	481,537	167,922	720,501	692,118	2,062,077
Inland OAAs	105,467	40,581	190,984	160,705	497,737

Consumption Estimates as percentage of low yield estimates					
Fish plus OAAs	238%	818%	420%	359%	352%
Total Inland Fish	244%	823%	415%	364%	354%
Inland OAAs	214%	796%	440%	338%	342%

Consumption Estimates as percentage of medium yield estimates					
Fish plus OAAs	119%	409%	210%	179%	176%
Total Inland Fish	122%	412%	208%	182%	177%
Inland OAAs	107%	398%	220%	169%	171%

Consumption Estimates as percentage of high yield estimates					
Fish plus OAAs	59%	204%	105%	90%	88%
Total Inland Fish	61%	206%	104%	91%	89%
Inland OAAs	53%	199%	110%	84%	86%

The estimated range for yield of 0.7 – 2.9 million tonnes/year is only indicative, because it depends upon various estimates and assumptions. It should also be noted that yield from year-to-year would vary depending upon the extent and nature of flooding and the intensity of fishing pressure. The differences between countries only apply to the **source** of yield rather than the point of capture, because fish and OAAs may migrate and be caught hundreds of kilometres away across international borders (Poulsen *et al*., 2004), moreover some fish are transported and consumed away from the point of capture. The yield estimate of Sverdrup-Jensen (2002) is at the upper end of the range suggested here, because his use of a much lower wetland area was balanced by a much higher areal yield estimate.

The estimate of consumption is towards the upper end of the estimated range for yield, which is to be expected because the Mekong is a productive system and is intensively fished.

Assuming a high level of yield in the LMB, in both Viet Nam and Thailand the yield approximately balances with consumption. In Cambodia, yield greatly exceeds consumption, a finding consistent with its position as a nett exporter of fish to the other LMB countries. Conversely, Lao PDR in particular appears to be in deficit as it probably imports a significant part of its total consumption. Lao PDR's imports are likely to be primarily preserved fish, in particular salted/dried fish (see Table 14), which would be consistent with limited availability of fresh fish during the extended dry season in this part of the LMB.

6. Conclusions

This report reviews a range of consumption studies which were based primarily on interviews. From these studies, it is estimated that about 2.6 million tonnes per year as FWAEs of fish and OAAs were eaten by a LMB population of about 56 million in 2000; about one quarter of this figure is estimated to comprise OAAs. The consumption estimate leads to *per capita* estimates for animal protein intake which would indicate that an average LMB resident eats more than the recommended daily allowance intakes once additional vegetable protein is taken into account. Other data (a trial monitoring study, catches, and comparative data from elsewhere in the world, and yield estimates) together provide support for the validity of the consumption figures. Information on sampling precision in two studies suggests a relative error of about 10% is likely, and given possible bias in the data the general agreement between the overall estimates and the validation data is very encouraging.

Table 34. *Official figures for inland fisheries yield compared with the estimates for LMB consumption and medium-level yield estimates.*

Consumption estimate is fish only. The yield estimate for the LMB is the official national yield multiplied by the proportion of that country which is within the LMB, from Table 1. This table differs from some others; it is not always clear what 'official' yield is. For Long An and Tien Giang official production was estimated pro-rata based on LMB area as in Appendix 1.

Country	Official Yield (production) tonnes/year					Consumption comparison		Areal yield comparison	
	Official Yield	Origin	Year	Reference	Assumed from LMB	Consumption estimate, tonnes/year (Table 24)	Discrepancy	Medium Areal Yield Estimate, tonnes/year (Table 33)	Discrepancy
Cambodia	385,000	Whole Country	2001	Sam *et al*. (2003) consumption and catch estimates	337,645	587,004	174%	493,930	146%
Lao PDR	71,316	Whole Country	2000	Souvanaphanh *et al*. (2003) areal yield times areas of habitat	62,402	208,503	334%	50,980	82%
Thailand	206,900	Whole Country	1999	Pawaputanon *et al*. (2003) commercial figures, mainly reservoirs	75,725	911,485	1204%	433,670	573%
Viet Nam	703,360	Delta, whole 12 provinces	2000	GSO (2003) Production minus sea catches	681,653	852,823	125%	475,730	70%
				TOTAL	1,157,425	2,559,815	221%	1,454,220	126%

Available data on yields per unit area suggest a possible range of 0.7-2.9 million tonnes/year of fish and OAAs from the LMB. To the consumption-based estimate (2.6 million/tonnes/year) must be added exports from the LMB and wastage, certainly an additional 10-20% of the consumption estimate, as well as trash fish used in aquaculture, which amounts to about

120,000 tonnes/year. The estimated overall yield in the LMB therefore appears to be close to the upper end of the possible range, a finding which seems reasonable, because the Mekong is a highly productive system with intensively exploited fisheries.

Various data suggest that most (>90%) of the yield is from capture fisheries, with relatively little production from aquaculture in the Year 2000, despite large investments in the sector. A high level of participation in capture fisheries is evident throughout the basin, consistent with high areal and total yields.

The consumption and areal-based yield figures are somewhat at odds with the official production (yield) figures within each LMB country (Table 34). The best match is for Viet Nam and the largest discrepancy is for northeast Thailand, where the consumption figures are close to 10 times the official production figures. The difference between official and estimated consumption figures for Thailand may be partly caused by this region importing fish from Lao and Cambodia, but even allowing for imports and a possible overestimation of consumption the official yield figures are clearly too low, as even the medium areal yield estimate is more than five times the official figure.

Most of the wetland area in the LMB is classed as rice-fields (i.e. rice-fields as well as smaller areas of habitat not discriminated by GIS), so it is likely that rice-fields and related habitats make a large contribution to the total yield. There are no representative data for large areas of rice-field habitat, so further studies on yield per unit area, especially in Thailand and Lao PDR, would also refine the overall estimate of yield from the basin.

Although the exact size of the LMB fisheries will continue to be debated, the importance of wild capture fisheries is undeniable and clearly under-recognised. More attention should be focused on accurately assessing the size and value of capture fisheries and on measures to maintain and where possible increase their yield. While stocking has been a common response, environmental management is likely to be more cost-effective. In the Mekong context, it follows that rice-fish production systems in particular should receive a higher priority for environmental management for fisheries production.

This report shows the inconsistencies between different data sets that are quoted widely and used for various purposes. All official data of fisheries yield are less than estimates derived from consumption data. National data exclude or under-report the important artisanal and subsistence fisheries which make a major contribution to yield. The FAO's 'apparent consumption' figures—compiled from data provided by countries—are based on questionable data on trade figures and also do not account for subsistence and the large informal or unreported economy in LMB countries. Users of such 'official' figures may draw incorrect conclusions about the relative importance fisheries. A regular basinwide consumption survey, supported by national statistics and fisheries agencies, would greatly assist in reconciling conflicting yield estimates and in institutionalising methodologies and results for basinwide fish yield estimates.

The studies reviewed for this report suffer from a general lack of quality assurance, a problem compounded for this review by their poor comparability in terms of approach,

coverage and units. Most of the surveys were based on interviews, during which biases may have been introduced, and most provided no information on precision. Given the lack of consistency in methods and the uncertainty as to the accuracy of results it is important to consider some approaches for collecting better data to produce a more precise estimate of yield.

Consumption survey design

The surveys were not designed with the aim of producing an estimate of yield for the LMB, so the survey design is far from optimal. A random survey of households from the entire basin would provide a much more accurate overall consumption estimate with far less effort on data collection; far fewer households would be required than in studies where highly variable statistics (such as catch) are investigated. As the range of individual consumption estimates is not wide compared to the range of individual catch estimates (which span several orders of magnitude), a stratified sampling approach (which adds to cost and complexity) may not be necessary. If individual estimates are required from each country or from any particular region, the number of samples to be taken should be increased.

Data quality

The quality of surveys should be improved, with adequate attention to the main data quality indicators (DQIs): bias, precision, representativeness, completeness and comparability. Surveys that cover these indicators are likely to be generally less controversial and so of more value for management.

Sampling to estimate consumption

Food consumption is usually assessed by either retrospective (recall) or prospective (measurement) methods (Seaman, 1995; Anderson, 1995). Virtually all retrospective surveys are based on recall of consumption during the previous 24 hours, so any future studies in the LMB should also follow this standardised approach. For validation, direct methods based on daily weighed food inventories are considered accurate, but still subject to some bias: if people weigh their own foods they will simplify their diet or simplify their records; if investigators keep records their presence will affect the behaviour of subjects. Nevertheless, many investigators refer to daily food records as the ‘gold standard’ against which other methods should be validated. Hence a reasonable approach is to use interviews to achieve coverage of sufficient households and to measure consumption in a subset of the interviewed households to calibrate the interview data. Portion-size estimation aids (PSEAs) are widely used elsewhere and should be standardised and incorporated in future consumption surveys.

Consumption coverage and units

Surveys have used various units with varying degrees of coverage of food types with the result that many data are difficult to compare. A minimum list of food types is suggested in

Appendix 2. This list aims to avoid overestimation of quantities during interviews caused by disaggregation (or decomposition) (see Belli *et al*., 2006). A more detailed list could be formulated during monitoring. Units should be standardised; for most foods, kilograms or grams per household per day would match the recommendation to base surveys around 24-hour recall and weighed daily food records. Surveys are usually based on households, but because household size varies, per capita estimates are necessary for comparison or compilation of survey results. Surveyors should take care to record actual numbers of people present at meals (rather than household members) and should correctly weight data when converting between household and per capita units.

Survey implementation

Future large-scale surveys could be part of the routine work of national statistics agencies, as they could be readily incorporated in rural and agricultural censuses (e.g. GSO, 2003) or national household censuses (e.g. NSC, 2004). Such surveys are probably beyond the expertise and mandate of fisheries agencies.

More intensive surveys can be successfully carried out by fisheries agencies, but should involve statistics agencies to ensure that methods and results are broadly accepted.

Areal-based yield estimates

This review highlights the importance of the large areas of habitat classified as rice-fields. Studies of yield in representative habitats in Thailand and Lao PDR, as well as more data from Viet Nam and Cambodia would greatly improve yield estimates based on area. Such studies are properly the purview of fisheries agencies and complement consumption data.

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Appendix 1 Consumption summary tabulations

Appendix 1 is a large Excel workbook that contains all the key data that was used in the compilation of this report. The table is too large to be presented in this report but is available in the CD-ROM that is included in the back of this document.

Appendix 2 Recommended minimum categories for consumption surveys

FRESH FISH
Itemise the main species
Eels
PRESERVED FISH
Fermented Fish
Separately itemise the different types
Fish Paste
Fish Sauce (L) marine
Fish Sauce (L) inland
Smoked Fish
Salted and/or Dried Fish
MARINE FISH
MARINE OAAs

OTHER AQUATIC ANIMALS (OAAs)
Tadpoles
Small Frogs
Big Frogs
Crabs
Shrimps
Molluscs (bivalves & gastropods)
Aquatic Insects
Snakes
Turtles
Birds

OTHER ANIMAL FOODS
Beef
Buffalo
Goat/Sheep
Pork
Chicken
Duck
Other poultry
Eggs
Dried meat
Fowl other
Wild land animals
Wild birds
Reptiles
Forest game/wildlife
Insects—terrestrial

For further information please contact

Mekong River Commission
P.O. Box 6101, Vientiane 01000, Lao PDR.
Telephone: (856) (21) 263 263 Facsimile: (856) (21) 263 264
Email: mrcs@mrcmekong.org
Website: www.mrcmekong.org