

4 Review of Consumption Studies

4.1 Overview and data quality assessment

As discussed in Chapter 2, population data are not a significant source of error compared with consumption data, for which 20 studies were reviewed. Of these, 16 studies of particular provinces or large parts of provinces covered 34 of the 86 provinces in the LMB; two studies were at national level and two covered a district or smaller area (Table 8). Most of the studies have not been published, and it was necessary to re-analyse some databases to generate estimates of consumption.

As shown in Table 8, basic characteristics of the studies varied widely because:

- various organisations sponsored or implemented the studies;
- the studies mostly focused on fisheries, but some were primarily aquaculture-related or capture fishery-related; and
- fieldwork was carried out in different years and during different seasons.

Only in Study 19 did the authors take into account the possible effect of seasonal variability on responses, by conducting interviews at random times during the year. In other studies that were solely based on interviews, no information was provided on seasonal response biases.

Table 9 shows that the studies also varied in their sampling approaches, as their specific objectives and resources differed. Various adjustments to data were necessary to derive province-level estimates, as is discussed in each of study reviews below. In general, the large number of households covered in most studies means that the data for inland fish are likely to be representative overall; at least of ‘responses to interviews’¹. The large total sample size (10,061 households) of the province-level studies represent ‘over-sampling’ relative to the objective of deriving yield in the LMB, as far fewer households would suffice to represent the basin as a whole. For example, under reasonable estimates of variance and assuming a simple normal distribution, a sample population of less than 200 households would provide estimates of the mean with a relative error of less than 5%².

Most of the studies were based on interviews in which respondents were asked to recall foods eaten (Table 10). Consumption was actually measured in only two province-level studies (Study 10 and 12), and in Studies 4 and 5 catches were measured to estimate consumption.

¹ i.e. the amounts reported to be eaten, as distinct from the actual weight eaten.

² This estimate assumes a normal distribution and a mean consumption of 60 kg/person/year, a variance of 400, a required error of ± 3 kg/person/year, so the required number of samples $n=4*400/3^2 = 178$, formula from Snedecor and Cochran (1989) p. 438.

Hence the bulk of the information for this review is from recall of foods eaten over extended periods, for which the level of bias is unknown. Consumption studies frequently rely upon recall of foods eaten in the previous 24 hours, but no LMB studies used this approach. Various units were used (Table 11), which may again lead to certain biases that were not considered in study reports.

Given the uncertainty about the accuracy of quantities recalled during interviews, it is suggested that priority should be given to standardising and validating methods for consumption studies. Indeed, this suggestion applies generally to all the interview-based methods used in fisheries socioeconomic surveys if the results are to be accepted without causing a great deal of controversy.

Results for all consumption values were converted to kg/capita/year as arithmetic means for all household members. Information about consumption could not be presented by gender or age, as only one report (Study 11) provided appropriate data. Examination of available data-sets showed that—as might be expected—the per capita distribution of consumption is skewed, so in general the medians can be assumed to be less than the means shown (Figure 7). However, consumption data span a relatively narrow range compared with data on catches, which may vary over several orders of magnitude.

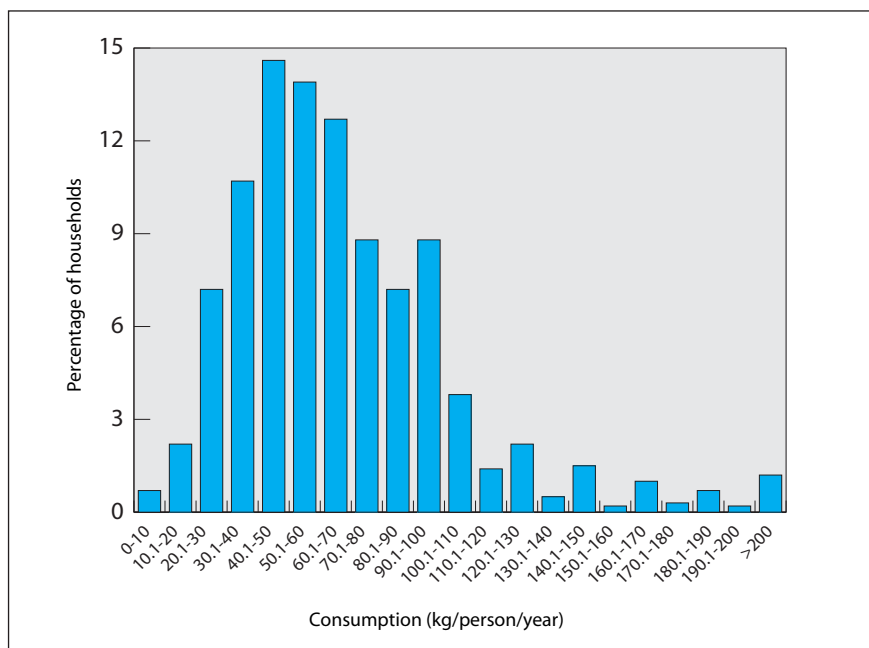


Figure 7. An example of a frequency distribution of fish consumption, from Study 13 (units are kg/person/year as FWAEs).

The median is perhaps a ‘better’ or more representative statistic, as 50% of people eat less than and 50% of people eat more than the median. But medians were not reported in most studies and arithmetic means are needed to calculate total provincial consumption, the main objective of this review. Confidence limits were not reported in most studies, and where

Table 8. Basic information on the studies that were reviewed in this report.

Studies which cover large parts of a province or provinces

No.	Study Report and Date	Study Sponsors	Country	Region	No. of provinces	Type of Study	Time of Study	Season	Number of Visits
1	Ahmed <i>et al.</i> (1998)	MRC & DoF, Cambodia	Cambodia	Tonle Sap–Great Lake	8	Capture Fisheries Baseline	Mid 1995–early 96	Mostly Wet	Once
2	Setboonsarng <i>et al.</i> (2001)	MRC & DoF, Cambodia	Cambodia	Kandal, Prey Veng, Takeo	3	Aquaculture Baseline	March–April 1999	Dry	Once
3	Touch <i>et al.</i> (1994)	AIT	Cambodia	Svay Rieng	1	Aquaculture Baseline	February–March 1993	Dry	Once
4	Gregory <i>et al.</i> (1996)	AIT	Cambodia	Svay Rieng		Fisheries Baseline	August 1995–April 1996	8.5 months	17
5	Mogensen (2001)	AIT	Cambodia	Svay Rieng		Nutritional Assessment	August 1997–July 1998	Whole year	26 times/1 year
6	Funge-Smith (1999a)	FAO & UNDP	Lao PDR	Northern Lao	5	Aquaculture Baseline	November 1997–January 1998	Late wet to early dry	Once
7	Sjorslev (2000)	MRC & LARReC	Lao PDR	Luang Prabang	1	Fisheries Baseline	May–August 1999	Wet	Once
8	Singhanouvong and Phouthavongs (2003)	MRC & LARReC	Lao PDR	Champassak	1	Fisheries Baseline	July 2002	Wet	Once
9	Baird <i>et al.</i> (1998)	EC and DoFor	Lao PDR	Khong District, Champassak	1	Fisheries Baseline	July–August 1997	Wet	Once
10	Garaway (2005)	ESRC and DFID	Lao PDR	Savanakhet	1	Fisheries related to wealth	May 1996–April 1997	Whole Year	6 times / 1 year
11	Mattson <i>et al.</i> (2000)	MRC & LARReC	Lao PDR	Vientiane	1	Fisheries Baseline	March–April 1999	Dry	Once
12	Prapertchob <i>et al.</i> (1989)	DoF and KKU, Thailand	Thailand	Five provinces in northeast Thailand, includes Study 14 provinces	5	Fish Consumption Baseline	Three seasons in 1988	Whole year	3
13	Suntornratana (2002)	MRC & DoF, Thailand	Thailand	Lowland parts of 3 provinces	3	Fisheries Baseline	January–June 2000	Dry	Once
14	Piumsombun (2001)	Kasetsart University and FAO	Thailand	Khon Kaen, Nakhon Ratchasima to represent the northeast	2	Fish Consumption and Marketing	1988–89	no data	Once
15	Sjorslev (2002)	MRC and RIA2	Viet Nam	An Giang	1	Fisheries Baseline	May–June 1999	Late Dry	Once
16	Pham and Guttman (1999)	CAF Viet Nam and AIT	Viet Nam	Long An, western half	1	Fisheries Baseline	July 1997	Early Wet	Once
17	Setboonsarng <i>et al.</i> (1999)	MRC and RIA2	Viet Nam	Tien Giang	1	Aquaculture Baseline	July–August 1998	Early Wet	Once
18	Phan <i>et al.</i> (2003)	MRC and RIA2	Viet Nam	Tra Vinh	1	Fisheries Baseline	October–November 2000	Late Wet	Once
					36				

Studies which cover an entire country, not disaggregated

No.	Study Report and Date	Study Sponsors	Country	Region	No. of provinces	Type of Study	Time of Study	Season	Number of Visits
19	NSC (2004)	NSC	Lao PDR	Lao PDR	All	National Socioeconomic Survey	March 2002–February 2003	Random over the year	Once
20	Lem and Nghia (2003)	FAO, Danida and MoF, Viet Nam	Viet Nam	Viet Nam	Not stated	National Fisheries Demand Study	2002	Not stated	Once

AIT	Asian Institute of Technology, Bangkok, Thailand	LARReC	Living Aquatic Resources Research Centre, Vientiane, Lao PDR
CAF	College of Agriculture and Forestry, Ho Chi Minh City, Viet Nam	MoF	Ministry of Fisheries, Hanoi, Viet Nam
DFID	Department for International Development, UK	MRC	Mekong River Commission, Vientiane, Lao PDR
DoFor	Dept of Forestry, Lao PDR	NSC	National Statistical Centre, Committee for Planning and Cooperation, Vientiane, Lao PDR
DoF	Dept of Fisheries	RIA2	Research Institute for Aquaculture 2, Ho Chi Minh City, Viet Nam
EC	European Commission	UNDP	United Nations Development Programme
ESRC	Economic and Social Research Council, UK		
FAO	Food and Agriculture Organisation of the United Nations		
KKU	Kon Khaen University, Kon Khaen, Thailand		

Table 9. Sampling details of the studies that were reviewed for this report.

Studies which cover large parts of a province or provinces							
No.	Study Report and Date	Region	Coverage of sampling (target)	Type of sampling	Sampling strata	Clustering/ randomisation of household survey	Households sampled
1	Ahmed <i>et al.</i> (1998)	Tonle Sap–Great Lake	Fishing-dependent communes within fishing districts	Clustered proportional stratified random	Weighted proportionally by strata - types of fishing and types of fishing grounds	Random households within 83 random communes	5,117
2	Setboonsarng <i>et al.</i> (2001)	Kandal, Prey Veng, Takeo	Pond-owners in fish-scarce, rainfed-rice pilot project areas; 3 pilot communes	Selective	na	50 households in each commune	150
3	Touch <i>et al.</i> (1994)	Svay Rieng	Whole province	Equally weighted clustered stratified random	Four ecozones based on soil type and rice yield	60 households per stratum, 240 hhs within 38 villages	240
4	Gregory <i>et al.</i> (1996)	Svay Rieng	Villages in one district, catchment of Saigon River.	Selective	Villages with low, medium and high access to waterbodies, 2 wealthy/3 poor households	5 households within each of 3 selected villages	15
5	Mogensen (2001)	Svay Rieng	3 of 6 districts, excludes upland and remote parts	Equally weighted stratified random	Low, medium and high trap-pond yields	About 20 households in 7-9 villages per stratum	64
6	Funge-Smith (1999a)	Northern Lao	Most of each province but only villagers interested in aquaculture	Selective	Includes both highland and lowland	Not random, clustering not stated	440
7	Sjorslev (2000)	Luang Phabang	Whole province	Clustered proportional random	na	Random households within 27 random villages	179
8	Singhanouvong and Phouthavongs (2003)	Champassak	Whole province	Clustered equally-weighted stratified representative	Ecozones, equal weighting: riparian 2, island 2 wetland 2 and highland 2	Random households within 8 representative villages	200
9	Baird <i>et al.</i> (1998)	Khong District, Champassak	Whole district	Equally weighted random households	Subdistricts	Random households equal weighting within 14 villages, one from each subdistrict	223
10	Garaway (2005)	Savanakhet	Lowland water-resource rich accessible areas	Selected for spread across wealth indicators	Rich, intermediate, poor	Equal sampling from 5 villages, linear systematic sampling of households relative to wealth	103
11	Mattson <i>et al.</i> (2000)	Vientiane	Around Nam Ngum Reservoir	Clustered random	na	Random households within 11 random villages	100
12	Prapertchob <i>et al.</i> (1989)	5 provinces in northeast Thailand	Whole provinces	Stratified random, proportional	Income, profession, education, location	Random households; 100 per province	500
13	Suntornratana (2002)	Lowland parts of 3 provinces	Lower Songkhram basin	Clustered random	na	Random households within 27 random villages	353
14	Piumsombun (2001)	Khon Kaen, Nakhon Ratchasima to represent the northeast	Whole provinces	Representative households	na	No details	99
15	Sjorslev (2002)	An Giang	Whole province, except 20% urban	Clustered, stratified random, proportional	Proximity of communes to main rivers: near-6, intermediate-2, far-2, approximately proportional	Random household within 58 random villages, within 10 selected communes	1,002
16	Pham and Guttman (1999)	Long An, western half	Mekong catchment part of the province	Stratified random, proportional	Low, medium and high income	Random households within target area, not clear if clustered	589
17	Setboonsarng <i>et al.</i> (1999)	Tien Giang	Whole province	Stratified random, proportional	Five kinds of fish culture practices, including no fish culture	Random households within aquaculture categories	361
18	Phan <i>et al.</i> (2003)	Tra Vinh	Whole province	Clustered, stratified random, proportional	Villages in ecozones: urban, inland, riparian, brackish, coastal	Random households within 38 random villages proportional within strata	651
Studies which cover an entire country, not disaggregated							
No.	Study Report and Date	Region	Coverage of sampling (target)	Type of sampling	Sampling strata	Sampling	Households sampled
19	NSC (2004)	Lao PDR	Whole Population	Stratified random villages, ratios between proportional and equal sampling, households systematic	Province (18) and 3 classes: urban, rural with access to road, rural with no access to road	15 households from each of 540 villages	8,100
20	Lem and Nghia (2003)	Viet Nam	Whole Population	Stratified random, proportional?	North/central/south, urban/suburban/rural	No details, assumed proportional	656

Table 10. *Methods and units used in studies that were reviewed for this report*

Studies which cover large parts of a province or provinces									
No.	Study Report and Date	Region	Households	Method	Units for Fresh Fish and/or OAAs	Units for Preserved Fish	Units for Other Animal Foods	Units for Catch	Units for purchases or gifts
1	Ahmed <i>et al.</i> (1998)	Tonle Sap - Great Lake	5,117	Recall	kg/HH/week in open (Oct-May) and closed (Jun-Sept) seasons	kg/HH/month in dry and wet seasons (Nov-May and June-Oct)	kg/HH/month averaged over the year	kg/season in open (Oct-May) and closed (Jun-Sept) seasons	nd
2	Setboonsarng <i>et al.</i> (2001)	Kandal, Prey Veng, Takeo	150	Recall	kg/HH/week in wet and dry seasons	na	nd	nd	nd
3	Touch <i>et al.</i> (1994)	Svay Rieng	240	Recall	Estimated from catch	Estimated from catch	nd	kg/season (3 seasons)	nd
4	Gregory <i>et al.</i> (1996)	Svay Rieng	15	Measurement of most recent catches	kg/hh in most recent catch	nd	nd	kg/household/last trip	kg/household/7 days?
5	Mogensen (2001)	Svay Rieng	64	Measurement of most recent catches, recall of frequency	estimated from catch plus purchases	nd	kg/hh/week	kg/household/last trip	kg/household/7 days
6	Funge-Smith (1999a)	Northern Lao PDR	440	Recall	Flexible measures per week or per month	Flexible measures per week or per month	Flexible measures per week or per month	kg/harvest from ponds	nd
7	Sjorslev (2000)	Luang Phabang	179	Recall	kg/HH/week in wet and dry seasons	kg/HH/week in wet and dry seasons	kg/HH/week in wet and dry seasons	kg/month; kg/year; kg/recent trip	nd
8	Singhanouvong and Phouthavongs (2003)	Champassak	200	Recall	kg/HH/week in wet and dry seasons	kg/HH/week in wet and dry seasons	kg/HH/week in wet and dry seasons	kg/hh/season - wet or dry	nd
9	Baird <i>et al.</i> (1998)	Khong District, Champassak	223	Recall	Flexible units converted to kg/hh/2-month season	Flexible units converted to kg/hh/year	nd	kg/hh/2-month season	kg/hh/2-month season
10	Garaway (2005)	Savanakhet	103	Recall of recent acquisitions	Flexible measures, 1-day to 1-week recall, frequency of acquisition over prior period	Flexible measures, 1-day to 1-week recall, frequency of acquisition over prior period	nd	Flexible measures, 1-day to 1-week recall, frequency of acquisition over prior period	Flexible measures, 1-day to 1-week recall, frequency of acquisition over prior period
11	Mattson <i>et al.</i> (2000)	Vientiane	100	Recall	kg/HH/year	kg/HH/year	kg/HH/year	kg/HH/week in wet and dry seasons	nd
12	Prapertchob <i>et al.</i> (1989)	5 provinces in northeast Thailand	500	Measurement	kg/hh/day for three periods	kg/day for three periods	kg/day for three periods	nd	nd
13	Suntornratana (2002)	Lowland parts of 3 provinces	353	Recall	Self-chosen units/hh/week in wet and dry seasons	Self-chosen units/hh/week in wet and dry seasons	Self-chosen units/hh/week in wet and dry seasons	Self-chosen units/hh/week in wet and dry seasons	Self-chosen units/hh/week in wet and dry seasons
14	Piumsombun (2001)	Khon Kaen, Nakhon Ratchasima to represent the northeast	99	Recall	not stated	not stated	nd	nd	nd
15	Sjorslev (2002)	An Giang	1,002	Recall	kg/hh/week in wet and dry seasons	kg/hh/week in wet and dry seasons	kg/hh/week in wet and dry seasons		
16	Pham and Guttman (1999)	Long An, western half	589	Recall	kg/hh/week in each of 4 seasons	kg/hh/week in each of 4 seasons	kg/hh/week in each of 4 seasons	kg/hh/week in each of 4 seasons	kg/hh/week in each of 4 seasons
17	Setboonsarng <i>et al.</i> (1999)	Tien Giang	361	Recall	kg/HH/month, summed for annual				
18	Phan <i>et al.</i> (2003)	Tra Vinh	651	Recall	kg/hh/week in wet and dry seasons	kg/hh/week in wet and dry seasons	kg/hh/week in wet and dry seasons		
Studies which cover an entire country, not disaggregated									
No.	Study Report and Date	Region	Households	Method	Units for Fresh Fish and/or OAAs	Units for Preserved Fish	Units for Other Animal Foods	Units for Catch	Units for purchases
19	NSC (2004)	Lao PDR	8,100	Recall	g/hh/week over the year	not clear	g/hh/week over the year	nd	Weekly value converted
20	Lem and Nghia (2003)	Viet Nam	656	Recall	kg/hh/month?				

Table 11. Coverage of food categories in the studies reviewed (within 'other animals' coverage also varied).

Studies which covered large parts of a province or provinces					Inland									Marine		Other Animals
No.	Study Report and Date	Country	Region	No. of provinces	Fresh Fish plus OAAs	Fresh Fish	Pres. Fish Aggregated	Fermented	Paste	Sauce	Smoked	Salted/dried	OAAs	Marine Fish	Marine OAAs	
1	Ahmed <i>et al.</i> (1998)	Cambodia	Tonle Sap - Great Lake	8												
2	Setboonsarng <i>et al.</i> (2001)	Cambodia	Kandal, Prey Veng, Takeo	3												
3	Touch <i>et al.</i> (1994)	Cambodia	Svay Rieng	1												
4	Gregory <i>et al.</i> (1996)	Cambodia	Svay Rieng				1									
5	Mogensen (2001)	Cambodia	Svay Rieng													
6	Funge-Smith (1999a)	Lao PDR	Northern Lao	5												
7	Sjorslev (2000)	Lao PDR	Luang Phabang	1												
8	Singhanouvong and Phouthavongs (2003)	Lao PDR	Champassak	1												
9	Baird <i>et al.</i> (1998)	Lao PDR	Khong District, Champassak	1												
10	Garaway (2005)	Lao PDR	Savanakhet, 4 villages	1	3											
11	Mattson <i>et al.</i> (2000)	Lao PDR	Vientiane	1									2			
12	Prapertchob <i>et al.</i> (1989)	Thailand	Five provinces in northeast Thailand	5												
13	Suntornratana (2002)	Thailand	Lowland parts of 3 provinces	3												
14	Piumsombun (2001)	Thailand	Khon Kaen, Nakhon Ratchasima	2												
15	Sjorslev (2002)	Viet Nam	An Giang	1												
16	Pham and Guttman (1999)	Viet Nam	Long An, western half	1												
17	Setboonsarng <i>et al.</i> (1999)	Viet Nam	Tien Giang	1												
18	Phan <i>et al.</i> (2003)	Viet Nam	Tra Vinh	1												
				36												

Studies which covered an entire country, not disaggregated					Inland									Marine		Other Animals
No.	Study Report and Date	Country	Coverage	No. of provinces	Fish plus OAAs	Fresh Fish	Pres. Fish Aggregated	Fermented	Paste	Sauce	Smoked	Salted/dried	OAAs	Marine Fish	Marine OAAs	
19	NSC (2004)	Lao PDR	Lao PDR	18												
20	Lem and Nghia (2003)	Viet Nam	Viet Nam	Not stated												

Notes: 1 No measurements of preserved fish which was estimated from catches
 2 Mentions only frogs, no other OAAs
 3 All fresh and preserved fish and OAAs were combined and shown as a single figure in FWAEs

databases were available calculation of confidence limits was usually not straightforward, because of clustering of samples (e.g. households within villages) and incomplete data on sample frames (Table 9). Because confidence limits could not be calculated for most individual studies confidence limits could not be calculated overall.

Table 11 shows the variable coverage of the main types of fishery products in each of the studies. Where studies did not provide data or where broad categories were used the approach for each study is discussed below. When studies did not state whether ‘fish’ referred to actual consumption or to FWAEs the figures were assumed to be FWAEs.

4.2 Review of studies

The following section discusses each study in terms of:

- background and methods used;
- consumption results;
- the way that consumption results were used to derive province estimates;
- other comparative data on catches or aquaculture, and;
- some other key findings of the study.

The studies are numbered in the same order as Tables 8 to 11 and ordered by country for ease of reference. The calculations for OAAs are presented in a single section summarised in Table 23, because of the limited amount of data.

Cambodia

Five studies were reviewed to obtain consumption estimates for inland fish for ten Cambodian provinces (Figure 8), as summarised in Table 12. The studies are discussed below.

Table 12. *Estimated consumption of inland fish in Cambodian provinces.*

Category	Study 1							
	Phnom Penh	Kandal	Kampong Cham	Kampong Chhnang	Siem Reap	Pursat	Battambang	Kampong Thom
Fresh Inland Fish	51.6	45.5	40.0	67.9	34.5	60.1	22.1	38.7
<i>Salted Dried Fish</i>	6.2	10.4	8.5	14.9	12.4	10.4	9.0	11.3
<i>Smoked Fish</i>	7.0	6.3	9.0	13.5	10.3	7.0	7.8	9.3
<i>Fish Paste</i>	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
<i>Other Fermented Fish</i>	2.2	1.9	3.7	3.5	1.8	1.8	1.7	2.6
<i>Fish Sauce (L)</i>	3.1	2.8	3.2	4.5	1.5	2.4	2.0	3.1
Preserved Inland Fish	19.3	22.2	25.2	37.3	26.8	22.5	21.3	27.0
Total as FWAEs	70.9	67.7	65.2	105.2	61.3	82.6	43.4	65.7

Category	Study 2		Study 3,4,5
	Pray Veng	Takeo	Svay Rieng
Fresh Inland Fish	21.0	23.0	22.8
<i>Salted Dried Fish</i>	3.2	3.9	4.8
<i>Smoked Fish</i>	2.2	2.7	0.6
<i>Fish Paste</i>	0.1	0.1	3.0
<i>Other Fermented Fish</i>	0.2	0.3	0.6
<i>Fish Sauce (L)</i>	0.2	0.2	2.6
Preserved Inland Fish	5.9	7.2	11.7
Total as FWAEs	26.9	30.2	34.5

Note: All values are kg/capita/year as fresh whole animal equivalents (FWAEs), not actual consumption. Data were adjusted to province level as explained in the text so they are not the same as in the source reports. Preserved fish amounts were converted to FWAEs from factors in Table 2.

Study 1. Cambodia: eight provinces—Ahmed *et al.* (1998)

This comprehensive baseline socioeconomic study covered eight provinces along the Tonle Sap and Great Lake, the most densely populated part of Cambodia and the most productive part of the basin for inland fisheries. Large areas of each province are inundated each year, either by flood-waters or where rainfall is held in rice paddies. The total population of the eight provinces was estimated at 5.6 million (close to half the national population) of which about 4.2 million were within ‘fishing districts’ (those with major water bodies); within these about 2.4 million people lived in ‘fishing-dependent communes’ (those where there was judged to be significant dependence on fishing), and the survey only covered these communes (i.e. 43% of the population of the surveyed provinces). Both ‘fishing’ and ‘non-fishing households’ were



Figure 8. Provinces of Cambodia that contributed data to the consumption study.

randomly surveyed to provide weighted averages. Villagers were asked to estimate their weekly household consumption of fish in the dry and wet seasons.

Direct extrapolation from these fishing communes (i.e. from a 42% coverage of the population) to whole provinces would overestimate provincial consumption because people in non-fishing areas eat less fish. People in non-fishing households in the study's fishing districts reportedly ate 91% and 97% of overall averages for fresh and preserved fish respectively. In a separate study (Study 2) villagers in drier parts of Kandal (i.e. in selected non-fishing districts) reportedly ate only 15.27 kg/capita/year of fresh fish, i.e. 41% of the amount reportedly eaten by people in fishing communes in fishing districts in Kandal. This difference is probably greater than applies to non-fishing districts generally, which are probably in closer proximity on average to fishing districts than those surveyed in Study 2. In a useful comparison from Study 3, people living far from water bodies in Svay Rieng reported that they catch only about one-third as much fish as those living near water bodies, but that they compensate by buying more fish, especially in preserved forms. Overall in Svay Rieng those people far from water bodies reported that they ate 86% of the amount eaten by the people near water bodies. Considering these two factors (41% and 82%) it was assumed that non-fishing districts in provinces covered by Ahmed *et al.*'s study had about 60% of the consumption of fishing districts; this percentage is considered the best approximation in the absence of better data. The non-fishing districts had on average 57% of the provinces' population; therefore the overall factor that was used to adjust the estimates in Study 1 to provincial level was **x 0.8** (i.e. $[0.57 \times 0.6] + [0.43 \times 1]$).

Table 12 shows the estimated province-level means. The highest values are from Kampong Chhnang and Pursat provinces, as would be expected, because these provinces include the

most productive fishing areas around the southeast edge of the Great Lake and the Tonle Sap River–Great Lake confluence. The lowest values are from Battambang and Siem Reap, which are furthest from the most productive central parts of the Tonle Sap system.

Fish catches were also estimated based on interviews. For the fishing communes in the eight provinces the total catch from middle-scale and family fishing was estimated at 199,204 tonnes per year (Ahmed *et al.* 1998, p. 62), or about 83 kg/capita/year, a figure which is consistent with the consumption estimate of about 69 kg/capita/year¹ as a weighted average in FWAEs across the surveyed communes, allowing for some export. This consistency suggests that both estimates are reasonably accurate, as it seems unlikely that each estimate would be subject to similar biases. Accurate figures were not available for large-scale (fully commercial) operations.

This large study generally highlighted the importance of fishing and related activities around the Tonle Sap–Great Lake–Mekong floodplains of Cambodia. For example, although farming was reported to be the primary occupation of 68% of household heads, 39% of the households had one or more members actively engaged in fishing, and fishing was the primary occupation for 11% of household heads. Most (92%) of the households depended on products from common-property, open access resources either for food or income, and people exploited a wide range of water bodies, including seasonally-flooded habitats, for fish, OAAs or other products. Most (99%) of the surveyed households were engaged in family-scale fishing, with about 39% fishing for sale, but with only 1% engaged in large-scale commercial fishing.

The study did not include information on OAAs or marine fish. Other meat products were reported separately for fishing and non-fishing households. As might be expected, non-fishing households reportedly ate more pork and eggs, but consumption of other meats was reportedly little different between fishing and non-fishing households. To extrapolate to province level it was assumed that the 57% of the population who were not surveyed had the same level of ‘other meat’ consumption as the non-fishing households and the provincial totals were calculated accordingly (see Table 22).

Study 2. Cambodia: Kandal, Prey Veng and Takeo—Setboonsarng *et al.* (2001)

This survey was carried out to evaluate aquaculture potential in drier areas, where land-use was primarily rain-fed lowland rice (also called wet-season rice)² in three provinces (Kandal, Prey Veng and Takeo). The survey excluded the more densely populated areas near waterways and wetlands, where annual flooding supports highly productive aquatic environments and dry season (recession) rice cultivation, so per capita consumption of fish and OAAs was likely to be less than provincial averages. Only pond-owning villagers were surveyed, but pond fishing and aquaculture were not important relative to wild capture, so the results can be considered to apply generally to drier areas of these provinces. Villagers from 50 households in each province were asked how much fresh fish they ate on average each week in wet and dry seasons, both

¹ The study report shows 75.6 kg/capita/year because different conversion factors were used for preserved fish. Confusingly, the report summary states that ‘nearly 40% of the fish catch was consumed within the fishing dependent communes’, a statement that does not match with the reported consumption and catch figures.

² In Kandal 10 of 50 households were in areas of irrigated lowland rice.

fresh and preserved, but they were not questioned about OAAs. Figures from this study were used as the basis for Prey Veng and Takeo Provinces, but required adjustment as they only applied to the drier, less populated areas. The figure for consumption of fresh fish in Kandal in this study was 15.27 kg/capita/year, whereas Study 1 reported 36.4 kg/capita/year in fishing districts in Kandal, approximately 2.4 x higher; figures for fermented fish were similar: 5.9 and 5.3 kg/capita/year (Study 2 and Study 1 respectively). To obtain more realistic estimates at province level, the ratio for fresh fish was also assumed to apply to fish-poor versus fish-rich parts of Prey Veng and Takeo and it was conservatively assumed that 50% of the population lives along watercourses or floodplains (fish-rich areas); for half of each province it was assumed that yield was 2.4 x the survey result. Preserved fish was not disaggregated in results, so it was necessary to assume that the proportions of each type of preserved fish were the same as the average for Study 1 so that adjustments to FWAEs could be made.

The study highlighted the general importance of the capture fishery despite it being carried out in fish-poor areas. People reported they spent the largest proportion of their work-time on rice cultivation, followed by fish capture, with aquaculture virtually insignificant, even though pond owners were selected for the study. In Kandal, Prey Veng and Takeo 70%, 82% and 90% of the households respectively engaged in fishing, mostly in rice-fields and in household ponds, which supported wild fish populations.

Studies 3, 4, 5. Cambodia: Svay Rieng—Touch *et al.* (1994), Gregory *et al.* (1996), and Mogensen (2001)

Svay Rieng is a very dry province in southeast Cambodia, bordering Viet Nam. This province is not usually shown as within the LMB in maps, but in fact the southwest part—about half—of the province is seasonally affected by overflows from the Mekong, and drains into the canal system in the eastern part of the Mekong Delta so it is within the Mekong catchment. The northeast part of Svay Rieng is in the Saigon River catchment, which is connected to the Mekong catchment during large floods.

This province is considered poor in aquatic resources, and it is particularly affected by an extended dry season, so Study 3 was undertaken to identify areas in particular need of aquaculture development. Study 4 documented the significance of the yield from rice-field fisheries, while Study 5 focused on nutrition.

In Study 3, Touch *et al.* (1994) surveyed 240 households spread through most of the province and selected equally from four ecozones; only 200 households completed questionnaires that could be used. The ecozones were based on soil type and agricultural production, and it is likely that this selective sampling biases the results towards less productive areas, as population density is highest on the best soil types which are usually on floodplains. Results were not disaggregated according to ecozones, so could not be re-adjusted for this possible bias. During interviews in early 1993, household heads were asked about their typical catches in three seasons—cold (Dec–Jan), wet (Jul–Nov) and dry (Feb–June). They were also asked about the disposal of catches—consumption, sale, processing or given away, and about

how much fish they bought. The results were then used to estimate consumption for households classified as close to or far from water bodies. The results were not presented by catchment, so LMB data cannot be separated from Saigon River catchment data. Households near water bodies reportedly caught, processed and sold more fish whereas households far from water bodies reported they ate most of what they caught and had to buy more fish or fish products seasonally. There was limited seasonality reported in catches (Table 5 of Touch *et al.*, 1994), which is rather inconsistent with actual data from Study 4 and with the pattern observed in many other studies in the Mekong. The values are also much less than those reported in Study 2 for drier areas of other provinces.

In Study 4, Gregory *et al.* (1996) carried out a more intensive survey in a floodplain area in the east of Svay Rieng in the catchment of the Saigon River. Three villages on a 7 km transect from the centre to the edge of a floodplain were studied. Selection of five houses in each village was based on their relative wealth (two wealthy, three poor) and their spacing. Study households were visited at fortnightly intervals over the 8.5-month period when fishing is significant (i.e. excluding the dry season). The species and weights of the most recent catches of 15 households were recorded and used with interview data on effort, disposal of catches, and purchases to estimate household consumption. Catches and effort were strongly seasonal in each village, peaking in November during the flood recession then falling to close to zero by April. The study stopped by mid-April 1996 when catches were close to zero, and it is likely that few fish are caught during the dry season (April–July), when preserved fish (mainly *prahoc*) is eaten instead. The study estimated the quantities of fresh fish that were processed and assumed one-third was eaten, but did not collect data on consumption of processed products, or on the disposal of fish which had been processed. Interestingly, this study showed mean catches of fish and OAAs of 72, 93, and 106 kg/capita/year over the 8.5-month period for the three villages in increasing proximity to the centre of the floodplain, with 18% of the weight on average comprising OAAs, but with no information on percentage consumed. Of the average catch of 90 kg/capita/year, 36% was eaten, 43% was sold and 21% was processed, mainly into *prahoc*. These values for catches are much greater than the mean values for fish catch—based on interviews only—in Study 3 of 20.3 kg/capita/year for households close to water bodies and 8.4 kg/capita/year for households far from water bodies. Values for consumption are also much higher. This very large discrepancy suggests that the interview data of Study 3 are underestimates or the households studied by Gregory *et al.* were extremely ‘fish-rich’, or both.

In Study 5, Mogensen (2001) focused on nutritional aspects of consumption of fresh fish and OAAs, and included data from one-year study in Svay Rieng province. This intensive study covered 64 households considered representative of rural farmers in the province and classed as having trap-ponds classified as low, intermediate or high yield. The households were surveyed approximately once per two weeks for a one-year period when the most recent catch or collection of fish and OAAs was weighed. Households were also interviewed about fishing effort and provided estimates of the amounts bought, sold, processed and given away. These data were used to estimate consumption as FWAEs. Additional information on preparation and cooking methods and on nutrient content was used to estimate actual consumption and intake of nutrients. Unfortunately, quantities of preserved fish were not recorded. Mogensen’s estimates

of quantities consumed are quite similar to those of Study 4 (also based on measurement of catches) but much higher than any mean estimates provided in Study 3 (based on interviews), suggesting that the results from Study 3 are underestimates.

Table 13. Consumption figures (kg/capita/year, inland fish, all FWAEs) for Svay Rieng from Study 3, 4 & 5 showing figures used for provincial estimates.

Category	Study 3	Study 5	Figures used	Study 4
Fresh Fish	10.5	35.0	22.8	22.7
<i>Salted and/or Dried Fish</i>	4.8		4.8	
<i>Smoked Fish</i>	0.6		0.6	
<i>Fish Paste</i>	3.0		3.0	
<i>Other Fermented Fish</i>	0.6		0.6	9.0
<i>Fish Sauce (L)</i>	2.6		2.6	
Preserved Fish as FWAEs	11.7		11.7	
Total fish as FWAEs	22.2		34.5	31.7
OAAAs FWAEs	nd	5.2	5.2	5.0

Given the difference in consumption figures between these studies, any figures used for provincial estimates are somewhat controversial. The three studies may each be biased towards drier or wetter areas. Study 3 was an aquaculture-related survey and given the situation in Cambodia at the time, villagers may also have deliberately understated fish catches in the expectation that the government or aid agencies might provide assistance. Conversely, the subsequent studies may have—perhaps unconsciously—tended to exaggerate the role of wild fish. Although catches were recorded each fortnight, calculations of daily catches depended upon the response to questionnaires about fishing effort over each two week period, and villagers may have wanted to please interviewers who were clearly interested in fishing. Given the apparent discrepancy in the results it was decided to choose the mean of the results from Study 3 and 5 for estimating the provincial totals, as shown in Table 13. Study 4 fresh fish figures were not used given the selectivity in choice of households in that study. Note that the use of Studies 3 and 5 and exclusion of Study 4 provides a conservative estimate of consumption.

Lao PDR

Three studies provided data for seven provinces in Lao PDR, three studies provided supporting data from smaller areas, and one national study provided estimates that were not disaggregated by province. Results of province-level studies are summarised in Table 14 and then discussed below.

Table 14. Consumption of fish and OAAs in Lao PDR as reported in studies.

Category	Province-level Studies						
	Study 6					Study 7	Study 8
	Oudomxay	Sayaboury	Xieng Khouang	Savannakhet	Sekong	Luang Prabang	Champassak
	North	North	North	Centre	South (upland)	North	South
Fresh Fish	9.5	6.3	12.7	9.3	6.8	11.36	25.6
<i>Salted Dried Fish</i>	5.5	5.2	9.9	6.6	5.8	12.4	6.4
<i>Smoked Fish</i>	0.0	0.0	0.0	0.0	0.0	0.9	0.1
<i>Fish Paste</i>	0.0	0.0	0.0	0.0	0.0	0.3	0.0
<i>Other Fermented Fish</i>	1.0	1.3	2.0	3.5	4.6	2.0	5.1
<i>Fish Sauce</i>	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Preserved Fish	6.5	6.6	11.9	10.2	10.3	16.2	11.6
Total Inland Fish	16.0	12.8	24.5	19.5	17.1	27.5	37.2
Total OAAs	3.5	4.0	5.9	6.2	5.0	4.6	10.3
Inland Fish + OAAs	19.4	16.9	30.5	25.6	22.2	32.1	47.5
Canned fish marine	0.6	0.3	0.7	0.6	0.4	0.5	0.5
Total Fish	16.6	13.2	25.2	20.1	17.5	28.0	37.7

Category	Local-level Studies		
	Study 9	Study 10	Study 11
	Khong District	Savanakhet	Nam Ngum
	South	South	Centre
Fresh Fish	33.4		36.0
<i>Salted Dried Fish</i>			0.0
<i>Smoked Fish</i>			9.0
<i>Fish Paste</i>			0.1
<i>Fermented Fish</i>	9.6		4.1
<i>Fish Sauce</i>			0.4
Preserved Fish	9.6		13.6
Total Inland Fish	43.0	10.0	49.6
Total OAAs			
Inland Fish + OAAs	43.0	10.0	49.6
Canned fish marine	0.5	0.5	0.5
Total Fish	43.5	10.5	50.1

Note: All values are kg/capita/year as fresh whole animal equivalents (FWAEs), not actual consumption. Preserved fish amounts were converted to FWAEs from factors in Table 2. Highlighted figures are estimates from Study 6.



Figure 9. Provinces of Lao PDR that contributed data to the consumption study.

Study 6. Lao PDR: five provinces—Funge-Smith (1999a)

Funge-Smith (1999a), as part of the FAO/UNDP Provincial Aquaculture Development Project, conducted a survey of a cross-section of 440 rural households in Oudomxay, Savanakhét, Sayaboury, Sekong and Xieng Khouang provinces in 1997 (Figure 9). The survey targeted people who were interested in aquaculture, and although about 85% of households already had fishponds, the survey is likely to be biased towards ‘low-fish’ villagers (Funge-Smith, *pers. comm.*). Respondents were asked to itemise their consumption in any units they wished, both in terms of amounts (e.g. kg, buckets, plates, cans) and in any time units (e.g. days or weeks). These units were then converted to kg/year. This method avoids conversion errors from mental arithmetic by respondents or surveyors, but may introduce random errors into results from people’s individual biases. The results are summarised in Table 14. As discussed under Study 19, the figures for fish appear to be generally low as compared with a national level study so they were not used directly for province-level estimates.

Study 7. Lao PDR: Luang Prabang—Sjorslev (2000)

This survey covered households in a province considered representative of northern Lao PDR. Much of Luang Prabang province is mountainous, but there are many streams and rivers and most people have access to rice-fields. People were asked how much ‘fish’ they eat per week in the dry season and the wet season. Fresh fish and OAAs were combined as ‘fish’ in the questionnaire. It was assumed that OAAs were 28.7% of total ‘fish plus OAAs’ (as in Study 8 in Champassak) for the purpose of separately estimating fresh fish and OAA consumption. The

report and database also included a breakdown of the previous day's catches of 286 fishers (during the early rainy season), in which 14.7% of the total weight of catches was OAAs (reptiles, amphibians, mammals and molluscs), a figure consistent with the consumption estimate, allowing for seasonality.

Consumption statistics were recalculated from the original survey databases because the figures shown in Tables 4.2.7 and 4.2.8 of Sjorslev (2000) were apparently calculated as the mean of each household's per capita consumption (household consumption divided by the number of household members). The resulting arithmetic means are generally higher than if the means are weighted correctly by dividing the total consumption of all households by the total population of all households (or by dividing mean household consumption by mean number of household members). Figure 7 illustrates how larger households tend to have lower per capita consumption, presumably because children—who eat less—form a higher percentage of the total number of people in the household, and perhaps because larger households can acquire less food per capita. This non-random relationship with household size applies to many consumption statistics and mandates caution when converting between household and per capita statistics.

People reported that 69% of their fresh fish and OAAs was self-caught; which equates to about 11 kg per year.

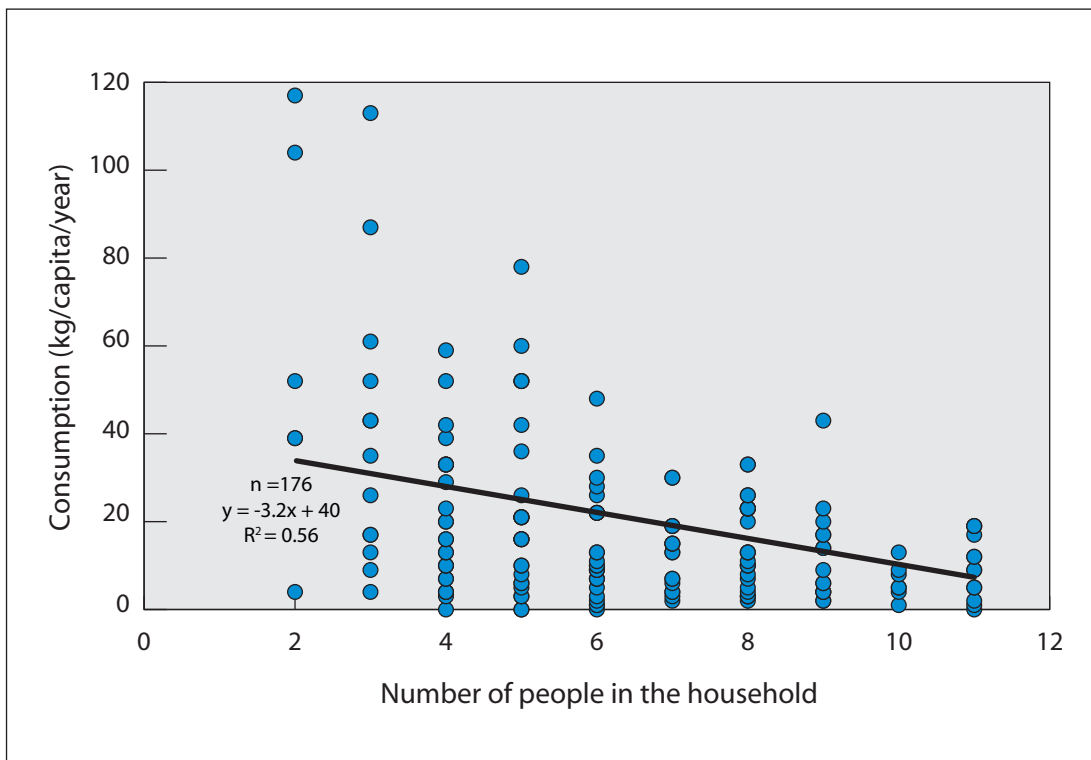


Figure 10. Household size and per capita consumption of fish and OAAs (kg/capita/year as FWAEs) in Luang Prabang (from the MRC database used in Study 7).

The survey also questioned villagers about catches. Annual catches estimated by household heads were only about 4.7 kg/capita/year (i.e. averaged across all household members), but they may have been unaware of all catches by all household members. Interviews of 286 individual fishers, gave different figures for annual catches depending on how questions were asked¹. When based on monthly fishing trips multiplied by average catches, mean annual catches were estimated at 60.7 kg/capita/year, but when based on monthly catches by each gear type total mean catches were 34.7 kg/capita/year, with data highly variable in each case. About 35% of all people go fishing, so the individual catch estimates provide for 12–21 kg/capita/year averaged across all people. The catches reported by individuals would be large enough to cover the reported fish and OAA consumption, assuming that most preserved fish is not self-produced, but the wide range in estimates (from less than half to about two times the portion of consumption reportedly derived from catches) shows the large potential errors in quantities estimated during interviews.

The report covered many aspects of socio-economics and highlighted the importance of inland fisheries in this mountainous area, where official statistics do not cover subsistence catches. Fishing was reported as the third most important activity after rice farming and livestock rearing, and 81% of households reported that one or more household members went fishing at some time. The most important fishing habitats were rivers, streams and rice-fields. Catches were extremely diverse; the previous days' catch comprised 67 species of fish and six taxa of OAAs.

Study 8. Lao PDR: Champassak — Singhanouvong and Phouthavongs (2003)

A pilot survey of fisheries in Champassak was conducted in eight representative villages in four districts; six villages were from lowland and two from highland areas; the villages were considered reasonably representative of four zones within the province (Table 15), including Khong district (Island).

Household members were asked about their average weekly consumption in the dry and wet seasons. Portion-size estimate aids (PSEAs) were used; these were either cardboard models of fish of several sizes or containers of various sizes that the respondents could use to estimate quantities consumed. The study asked villagers to separately estimate quantities of different kinds of preserved fish and also the amounts of the main kinds of OAAs eaten. The interviewers also asked about household catches and their disposal, but the units used were total catches in dry and wet season (i.e. per 6-month season, rather than weekly catches). Some preliminary results were reported by Singhanouvong and Pouthavongs (2003), who concluded that total fish and OAA consumption for the province was 50 kg/capita/yr, about half of which comprised preserved fish. Results for catches as reported by village heads were about 57% of the results for consumption. The database from this study was re-checked for errors and re-analysed for this report as summarised in Table 15 and 16. The recalculation indicates that total fish and OAA consumption was 45 kg/capita/year. The difference from the previously published figure of 50 kg/capita/year results from weighting the data by ecozone. The high proportion of the

¹ All figures were recalculated from the original databases.

province population living in the riparian zone has a large effect on the final weighted means, with high consumption in floodplain and island zones having relatively little effect on weighted means.

The order of consumption between the zones is as expected, as island and floodplain villages have highly conspicuous and productive fisheries. Fermented fish is a staple, with rather similar quantities reportedly consumed throughout the province. Less consumption of fresh fish in highland villages appears to be mitigated by greater consumption of dried fish.

Table 15. Summary of results for consumption from the database of Study 8 in Champassak.

In each zone, two households were sampled in each of two villages, 25 households per village.

All data is FWAEs.

Zone	Riparian	Floodplain	Island	Highland	
District	Sanasomboun	Patumphone	Khong	Paksong	
Percent of province population	68.6%	8.7%	13.3%	9.4%	
Households sampled	50	50	50	50	
People in households	323	339	300	322	
Consumption (kg/capita/year)					Weighted mean
Fresh wild fish	23.2	19.3	43.4	13.2	24.6
Eels	0.3	4.3	0.2	0.5	0.7
Fresh aquaculture fish	0.1	0.0	0.0	2.4	0.3
Total fresh fish	23.7	23.5	43.6	16.1	25.6
Dried fish	0.7	1.8	3.1	5.0	1.5
Smoked fish	0.0	0.0	0.9	0.0	0.1
Salted fish	0.5	0.8	1.4	0.9	0.7
Fermented fish	6.6	6.4	8.1	7.0	6.8
Total preserved fish	7.9	9	13.5	12.9	9.2
Total inland fish	31.6	32.5	57.0	28.9	34.8
Frogs and tadpoles	5.1	7.9	6.2	6.1	5.6
Crabs	0.2	0.3	0.1	0.6	0.2
Shrimps	0.1	1.8	1.4	0.5	0.5
Molluscs	2.6	15.5	4.6	3.2	4.0
Insects	0.0	0.1	0.0	0.0	0.0
Total OAAs	8.0	25.6	12.2	10.4	10.3
Total fish and OAAs	39.5	58.1	69.2	39.4	45.1

In this study the total quantities of OAAs were higher than in any other study, which probably shows that the effect of a reasonable level of disaggregation of the data in interviews is to increase the total estimate to a more realistic figure than where all fish and OAAs are simply lumped in one question. Interviews also specifically itemised eels (which are fish), and fish from aquaculture, so the total amount of fish is perhaps higher than if the question was simply 'fish'; again it is reasonable to disaggregate a common taxon that is perceived as different to 'fish' by villagers. The relatively high figures for fermented fish also may be a result

of the separation into three types in interviews, with the individual figures then summed. Asking separately about dried fish and salted fish may also have increased the final estimated quantities.

Household heads reported data on catches as kg per season, with the fate of catches itemised as in Table 16. Catches should approximately balance with consumption, with an excess in the island zone and a deficit in the highland zone. All zones were in apparent deficit, with the total reported catch being only 60% of total reported consumption. This deficit could indicate either over-estimation of consumption or under-estimation of catches; perhaps quantities caught and consumed are perceived differently. Alternatively, the results may simply reflect rounding-up or rounding down respectively, when people estimate quantities per week (consumption data) or per season (catch data). Clearly more investigation of this discrepancy is warranted.

Table 16. Summary of results for household catches from the database of Study 8 in Champassak.

In each zone two households were sampled in each of two villages, 25 households per village. All data is FWAEs.

Zone	Riparian	Floodplain	Island	Highland	
District	Sanasomboun	Patumphone	Khong	Paksong	
% of province population	68.6%	8.7%	13.3%	9.4%	
Households sampled	50	50	50	50	
Catch (kg/capita/year)					Weighted mean
Total fish and OAA catch	22.7	41.9	59.2	2.8	27.4
Eaten fresh	7.3	13.4	15.9	2.2	8.5
Dried	0.4	0.5	2.0	0.0	0.6
Fermented	5.1	9.4	13.9	0.3	6.2
Sold	8.0	16.8	25.2	0.1	10.3
Given away/bartered	1.5	1.6	2.0	0.1	1.4
Used in aquaculture	0.0	0.0	0.01	0.0	0.001
Sold in markets	0.4	0.3	0.2	0.0	0.3

Study 9. Lao PDR: Champassak, Khong district—Baird *et al.* (1998)

This rapid but thorough survey was carried out to describe the fishery of Khong Island and adjacent villages along the Mekong River in southern Lao PDR, an area well-known as having an important fishery and likely to have high levels of fish consumption. At the time of the survey there was very little documentation of capture fisheries in any part of Lao PDR. Surveyors used questionnaires and semi-structured interviewing techniques. Households were randomly selected within strata—southern/northern and mainland/island—to ensure representativeness. Fish consumption was estimated based on six 2-month seasons, and many questions were asked by interviewers to try to arrive at estimates for that season. All categories of fish were covered, but consumption of fish sauce and dried or dried/salted fish was negligible (Baird, *pers. comm.*). About 78% of meals reportedly had fish as the main animal protein and about 88% of the fish consumed was reported to be self-caught. About 98% of villagers reported that they ate fermented fish and about 90% made it themselves, showing the importance of this way of preserving seasonal excesses of fish.

Mean consumption was 43 kg/capita/year as FAWEs and of this about 9.6 kg was fermented fish. Catches were estimated at 62 kg/capita/year, a figure that matches nicely with the consumption estimate, allowing for some export from this district.

The consumption figures were about 75% of that found for 'island' villagers in Study 8 (Table 18), an acceptable match considering that the two villages sampled in Study 8 were on Khong Island where fishing is most intense.

The study found that 94% of households fished at some time, using at least 89 methods, and that the Mekong was the most important fishing habitat, with flooded rice-fields also important in the wet season. Aquaculture was of negligible importance. The most important species in catches were reportedly riverine cyprinids, primarily *pa soi* (*Henicorhynchus* spp.) and other small species. This study confirmed the great importance of river fisheries in this district. Elsewhere in the province it is likely that fisheries are also important, but presumably participation, catches and consumption are generally somewhat lower than in Khong.

Study 10. Lao PDR: Savannakhet—Garaway (2005)

Garaway studied four rural villages in a lowland district, where people had a wide range of access to aquatic resources. Representative households were selected for the survey based on wealth indicators. Data were collected six times over one year in a relatively intensive exercise. Calibrated bowls of various sizes and 'fish sticks' were used to assist respondents in quantifying their responses. Villagers were asked about their most recent fish and small shrimp 'acquisition' (caught, bought, earned and received) and fish disposal (given away or sold) over a period of one-day to one-week prior to the interview, with the period chosen by the respondent, depending on frequency of acquisition and their capability to recall. The resulting figures were then used with respondents' estimates of frequency of acquisition over the prior period to scale up the data to the prior eight-week period. Mean consumption was 17.5 kg/capita/year, all fish and shrimps combined, expressed in adult equivalent units (AEUs). Converting the figure to average per capita values would result in a figure about 30% lower, i.e. 12.3 kg/capita/year, and removing shrimps from this total would reduce the figure further; assuming OAAs are about ¼ of the total (Table 23) the fish consumption figure is about 10 kg/capita/year. This mean consumption figure is very low compared to that found in Study 8 (Table 17) in similar floodplain zones, albeit in a separate province. The study was not intended to be representative of quantities consumed across Savannakhet, and the discrepancy in estimates suggest that either the chosen villages were unrepresentative, or that the interview-based consumption estimates are too high.

Study 11. Lao PDR: Nam Ngum—Mattson *et al.* (2000)

This study covered villages around Nam Ngum reservoir, the largest man-made water body in the LMB. About 16,500 people (5% of the province's population) lived in 30 villages; from these 100 households were surveyed. Fishing was reportedly the second-most important occupation after farming and about 62% of households had one or more full-time fisher. The fishery was based on many species, caught using many kinds of gear, gillnets being the most

common. The total catch was estimated at 6,833 tonnes per year—about 143 kg/ha/year, or about 2 tonnes per fisher per year.

The questionnaire to household heads asked about average monthly consumption of fish and other meats per household over each year (i.e. not itemised by month or season). The questionnaire itemised all types of fish products except dried/salted fish, and all types of meat, but did not cover most categories of OAA. For example, shrimps, mussels and snails are common in the reservoir and are commonly eaten (based on personal observations). There were also no data for marine products, presumably because few are sold in this area. The reservoir is a significant exporter of fish, especially to other parts of Lao PDR, but also imports fish sauce from Thailand. The study report expressed results in protein units, so results were recalculated from the original database. Total fish consumption figure was 49.6 kg/capita/year of which 13.6 kg was preserved fish. These figures are consistent with those found for other fishing communities in Lao PDR, Khong—43 kg/capita/year (Study 9) and Khong Island—57.6 kg/capita/year (Study 8). Comparison with fishing communes in Cambodia is also of some interest, where consumption averaged around 69 kg/capita/year as FWAEs (Study 1). The difference can be partly accounted for by a reported higher consumption of other animal meat around Nam Ngum of around 18 kg/pers/year compared with about 8 kg/capita/year in Cambodia.

Study 19. Lao PDR: LECS3—NSC (2004)

The Lao Expenditure and Consumption Study (LECS) has been carried out three times: in 1992/3, in 1997/8 and in 2002/3. It is the largest and most important survey carried out by the National Statistical Centre of Lao, so the results should be given considerable weight in official planning. In the latest (third) survey, 540 villages were selected randomly within 54 strata, based on 18 provinces and three urban/rural classes. In each village 15 households were sampled—8,100 households in total—making this a very large and comprehensive socioeconomic study. The study also randomised villages by month of interview to remove seasonal bias. One part of the study recorded weekly expenditure on food and estimates of self-production of food; these were combined to estimate weekly intakes.

As shown in Table 17, fish consumption in the south and centre of the country was reportedly higher than in the north, as expected based on more abundant aquatic resources.

Table 17. *Reported consumption in Lao PDR in 2002/3 (kg/capita/year actual intake).*

Region	Meat	Fish	Vegetables	Fruit	Rice (cooked)
Entire Lao PDR	22.4	25.3	45.6	28.0	210.5
North	23.9	19.1	63.3	24.9	236.9
Centre	21.6	27.9	39.3	28.8	198.1
South	22.4	28.0	34.3	30.8	197.0
Urban	25.3	24.1	40.3	34.0	186.3
Rural with road access	21.8	27.7	45.6	26.9	217.8
Rural without road access	20.3	19.7	53.8	22.1	216.4

In rural areas, people with road access reportedly ate more fish and meat than those in areas without roads. Reported fish consumption increased over the last ten years, although the change was not statistically significant. Meat and fruit consumption both increased significantly as percentages, whereas consumption of rice and minor foods fell as percentages, indicating a general improvement in diet in Lao PDR. The survey reported actual consumption of food and did not separately itemise preserved fish or marine fish. To convert to FWAEs to allow comparison with other studies, it was assumed that the proportions of fresh and preserved fish were the same as the average percentages for other province-level studies (6–8) in Lao PDR (as shown in Table 14) after conversion to actual amounts eaten, and that marine fish was 0.5 kg/capita/year, the average from Study 6.

Table 18. *Estimated total inland fish consumption from LECS3 as FWAEs (kg/capita/year) compared with some other studies in Lao PDR.*

LECS values were converted to FWAEs as explained in the text.

Study	LECS3	Study 6	Study 7	Study 8	Study 9	Study 10	Study 11	
Survey coverage	Lao PDR	5 provinces	Luang Prabang	Champassak	Khong district, Champassak, high-fish area	Savannakhet, small part of province	Nam Ngum, high-fish area	
Region	Type	Interview	Interview	Interview	Interview	Interview	Measurement	Interview
Entire Lao PDR		34.6	18.0					
North		26.2	17.8*	27.5				
Centre		38.3	19.5			~10	49.6	
South		38.3	17.1		37.2	43.0		
Urban		33.0						
Rural with road access		38.0						
Rural with no access		27.0						

Note: * mean of 3 provinces

The values for Studies 7 and 8 (in which households were selected to represent provinces) are similar to the LECS3 figures for northern and southern Lao PDR respectively. The figures for Study 9 and 11 are also quite consistent with the LECS3 figures; being from high-fish areas they are somewhat higher than regional averages. The values from Study 6 are all much less than would be expected, which suggests a bias in the selection of households in that aquaculture-focused study. Results from Study 10 were also much lower than expected, so either that study's households were not representative of the province (as they were not selected to be) or there is a bias towards over-estimation in all the other interview-based data.

The LECS3 figures are based on an excellent sampling frame so they were used for province estimates based on the grouping of provinces in the study into regions: north, centre and south.

Northeast Thailand

Three studies provide data for northeast Thailand (Figure 11), with full or partial coverage for eight provinces, as summarised in Table 19. The studies are discussed individually below, followed by an explanation of the way that provincial figures were estimated.

Table 19. Summary of consumption data from studies in northeast Thailand.

All values are kg/capita/year as FWAEs, not actual consumption. These are the actual data which were later corrected and adjusted to province level as explained in the text. Preserved fish amounts were converted to FWAEs from factors in Table 2.

	Study 12	Study 13	Study 14
Category	Ubon Ratchathani, Udon Thani, Khon Kaen Nakhon Ratachsima, Roi Et	Part of Nakhon Phanom, Sakon Nakhon, Nong Khai	Khon Kaen and Nakhon Ratchasima
Fresh Inland Fish	21.3	19.87	30.1
Salted Dried Fish		9.20	6.4
Smoked Fish		5.37	
Fish Paste		0.32	
Other Fermented Fish	4.0	4.78	
Fish Sauce (L)		2.80	
Preserved Fish	4.0	22.47	6.4
Total as FWAEs	25.3	42.34	36.5
OAAAs	7.8	8.00	
Total	33.1	50.34	
Marine fish	5.9		1.4
Total Fish and OAAAs	39.0	50.34	

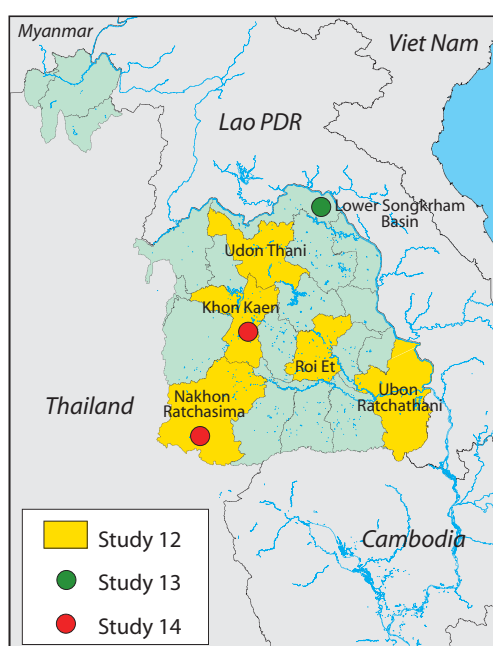


Figure 11. Provinces of Thailand that contributed data to the consumption study.

Study 12. Northeast Thailand: five provinces—Prapertchob et al. (1989)

This remains the most comprehensive study for northeast Thailand and the only large-scale study in which consumption was actually measured. The study was unique inasmuch as it focused specifically on fish marketing and consumption and on the consumption of other animal foods; it was not a general socio-economic study nor did it cover other aspects of fisheries. Households were randomly sampled within socioeconomic strata: rich, poor and medium, and results were disaggregated by categories: urban/rural and wet/dry areas. Households completed logbooks of their daily consumption in 10-day blocks at three times: April–June, July–September, both representing the wet season and October–December, representing the dry season. The study results do not include any fish paste, fish sauce, smoked fish or dried fish, which suggests these types of food were overlooked, combined with other categories, or were eaten in very small quantities. These kinds of preserved fish products are also probably commonly eaten in the season that was not surveyed (January–March), part of the dry season, when fresh fish are less common. The results for OAAs include only frogs and mussels, so under-reporting OAA consumption in this area where shrimps, insects, snails, and various other OAAs are commonly eaten.

The only IPF item recorded was fermented fish, with a value similar to that found in Study 13. Although preserved fish consumption may be lower generally in northeast Thailand than in the Songkhram Basin, the other forms of preserved fish are commonly eaten throughout the region, so this study under-reports preserved fish. Marine products were recorded by the study at 5.9 kg/capita/yr. This figure seems plausible, as it is about half of the values quoted for the Mekong Delta in Viet Nam.

The general lack of diversity in reporting of the foods that would be expected in this area—i.e. several groups are absent from the results—is usual in self-monitoring studies where respondents typically simplify their data recording or alter their diet to make the study less onerous (see e.g. Vuckovic *et al.*, 2006).

Study 13. Thailand: lower Songkhram Basin—Suntornratana (2002)

The Songkhram River is the largest Mekong tributary in northeast Thailand that is not yet dammed in its lower reaches. Fish and OAAs can move freely along the river and to and from the Mekong, as well as being able to access the extensive floodplains and associated wetlands during the wet season, so the system continues to support an important wild fishery. This survey collected many kinds of data on fisheries by surveying 353 households randomly selected in 27 randomly selected villages of the lowland (downstream) part of the Songkhram Basin. The survey area covered parts of three provinces—Nakhon Phanom, Sakon Nakhon and Nong Khai—in about equal proportions. Households were asked to estimate their weekly consumption of fresh ‘fish and OAAs’ combined, and the various forms of preserved fish, in kg per week in both the dry and wet seasons, as well as to estimate the percentage of their consumption from different sources. In the absence of any other data it was assumed that OAAs were 28.7% of the sum of fresh fish plus OAAs, based on Champassak data in Study 8. Mean consumption and confidence limits were re-calculated from the database using the SPSS complex samples

module, and results are summarised in Table 20. Mean estimates have moderate relative errors, e.g. about $\pm 14\%$ for consumption of all fish and OAAs, expressed as 95% confidence limits. The large number of households (353) would lead to very precise estimates if sampling was random, but in clustered random sampling the effective sampling size is less, as samples are drawn only from a subset of villages in the surveyed area.

Households were also asked to estimate their yearly catches in various kinds of habitat. The total annual catch of the surveyed households equated to 41.8 (± 9.9) kg/capita/year, which is about 83% of the mean consumption figure of 50.3 kg/capita/year (fresh plus processed fish and OAAs as FWAEs). Aquaculture yield was estimated at only 4.5 kg/capita/year, a total which included trapping of wild fish in ponds.

Table 20. Summary of consumption results from the lower Songkhram Basin.

All kg/capita/year as FWAEs. Fish and OAAs calculated as percentages of Fish + OAAs.

Category	Mean	95% Confidence Interval	
		Lower	Upper
Fresh Fish and OAAs	27.87	23.45	32.29
Fresh Fish est.	19.87	16.72	23.02
OAA est.	8.00	6.73	9.27
<i>Dried/salted Fish</i>	9.20	6.55	11.86
<i>Smoked Fish</i>	5.37	4.42	6.33
<i>Fish Paste</i>	0.32	0.18	0.46
<i>Other Fermented Fish</i>	4.78	4.27	5.29
<i>Fish Sauce</i>	2.80	2.56	3.04
All Preserved Fish	22.47	18.91	26.03
All Fish (Fresh and Preserved)	42.34	36.63	48.05
All fish and OAAs	50.34	43.54	57.14

Marine products were not included in the study, but it can be assumed the quantities are small in this area because of the abundant inland water resources and remoteness from the sea.

The total inland fish and OAA consumption estimate is about 1.29 times the figure found in Study 12, but higher consumption of marine fish and other meat products in Study 12 compensates for this difference. Higher consumption of preserved fish in the lower Songkhram Basin is to be expected, as catches are extremely seasonal, with most fish caught over a short period each year as flood waters recede. Elsewhere in northeast Thailand, water management and fish farming have tended to even out hydrology and fish production.

Study 14. Thailand: Khon Kaen and Nakhon Ratchasima—Piumsombun (2001)

This national survey covered fish consumption and marketing by surveying markets and consumers throughout most of the country in 1988–89. Various statistical data were used to build up a picture of production and demand throughout the country. For the northeast

region, only two provinces were surveyed, both in the western (upstream) part of the Mekong catchment. The survey results were extrapolated to the northeast region in this study, but could be quite unrepresentative for the majority of the population who live towards the more easterly parts of the region, where riparian land along the Mekong, Mun, Chi and other tributary rivers is likely to be more productive of fish and OAAs, both from the wild and from aquaculture. The survey did not include OAAs and fermented fish products, both significant omissions, but found a relatively high total inland fresh fish consumption of 30 kg/capita/year as FWAEs in the two provinces. In addition, a further 6.4 kg/capita/year of dried salted fish was consumed. This study asked about consumption of individual species separately; this disaggregation may have caused a difference in estimation of quantities compared with Study 13 (which asked about total fish plus OAAs), but there is no way to determine which method of questioning produced more accurate results. The report also included official aquaculture production figures in the northeast for 1997 (Table 4 in the report) of 33,521 tonnes with a similar quantity produced from capture, according to aggregated national figures (Table 1 in the report). This estimate of around 60,000 tonnes/year for the northeast is incompatible with the consumption estimates, which if multiplied by the northeast population (about 17 million in 1999–9) give a total consumption estimate of about 500,000 tonnes for the northeast alone, i.e. about eight times the official production figures. This major discrepancy was not discussed by Piumsomboun (2001), but is readily explained by underestimation in the official production figures of the large artisanal/subsistence catch.

Province estimates for northeast Thailand

As data are missing from each study, derivation of province estimates is complicated. The five provinces of Study 12 include the two provinces of Study 14, but as Study 12 data were not disaggregated by province the data cannot be directly compared. It was decided to use Study 12 data for these five provinces, and to add an additional 6.4 kg/capita/year as dried fish to increase the preserved fish total, as a conservative increase based on the Study 14 figures.

The lower Songkhram Basin has about 18% of the population of the three provinces within which it falls. None of these provinces was covered in Studies 12 or 14. To extrapolate to province level, the Songkhram figures were used to represent 18% of the province (i.e. multiplied by 0.18) and the Study 12 figures were used to represent the remaining 82% of the provinces' populations.

Viet Nam

Four studies aimed to estimate provincial fish consumption, and these nicely encompassed the broad range of zones in the delta, from inland to coastal (Figure 12). The figures, summarised in Table 21 are consistent with the zone of the province: more inland fish are eaten in inland provinces, more marine fish are eaten in maritime provinces, and Tien Giang had intermediate reported inland fish consumption.

Table 21. Consumption of inland fish in Viet Nam delta provinces.

All values are kg/capita/year as FWAEs, not actual consumption. Data were corrected and adjusted to province level as explained in the text, so may not be the same as in the source reports. Preserved fish amounts were converted to FWAEs from factors in Table 4.

Category	Study 15	Study 16	Study 17	Study 18
	An Giang	Long An	Tien Giang	Tra Vinh
	Inland	Inland	Intermediate-coastal	Coastal
Fresh inland fish	36.8	48.1	29.6	22.7
Salted dried fish	4.2			0.1
Smoked fish	0.1			5.4
Fish paste	1.5			1.4
Other Fermented fish	0.6			6.3
Fish sauce (L)	6.3			0.3
Preserved fish	12.7	12.1		13.5
Total inland fish	49.5	60.2		36.2
OAAs	12.1			7.6
Marine fish	*	0.1	12.5	9.9
Total fish and OAAs	61.6			53.7

Note: * assumed negligible.

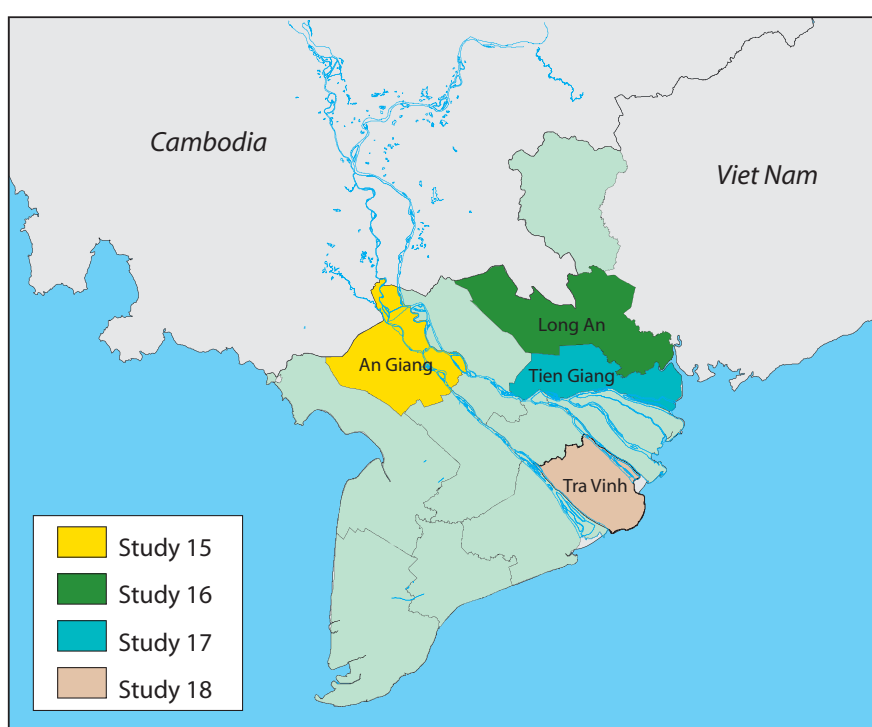


Figure 12. Provinces of Viet Nam that contributed data to the consumption study.

Study 15. Viet Nam: An Giang province—Sjorslev (2002)

An Giang is well-known as one of the most productive fisheries provinces in the LMB. Wild fish are caught throughout the province, mainly due to production on the large areas of annually flooded land, and extensive fisheries target the large seasonal migrations of fish to and from Cambodia. Aquaculture has expanded dramatically over the last decade, with *Pangasius* catfish now a major export. This socio-economic survey collected baseline information on many aspects of fisheries in nine rural districts of An Giang; i.e. excluding urban districts in which 21% of the population lives. This survey had a large coverage: 1,002 households in 58 villages that were selected to approximately represent population distribution. Within three strata about 74% of households were near the Mekong and Bassac rivers (one stratum), with others distant or intermediate from the rivers. Households were asked about many aspects of fisheries.

Respondents were asked to recall consumption of inland fish and OAAs combined, and various categories of processed fish, in the wet and dry season in kg/household/week. Marine fish were not specifically addressed, but it is assumed that consumption was negligible. The survey also asked people to rank their consumption of aquatic foods in the wet and dry seasons in terms of importance. Virtually all households eat inland fish fresh and also eat fish sauce frequently in small quantities and all households ranked fish sauce as No. 1 in terms of importance. Statistics were recalculated as the original report incorrectly reported the mean of household per capita consumption (as for Study 7), and some mistakes were corrected in databases. The survey asked individual fishers to specify the species and their weight in the most recent catch. At least 75 taxa were reported from catches, but just one taxon *Henicorhynchus* spp. (*ca linh*) made up 56% of the total catch weight, and together with other ‘white fish’ made up 86% of the catch weight. In consumption figures, fish and OAAs were not separately reported, so it was necessary to assume that the proportion of OAAs was 24.8%, the same proportion as in Tra Vinh province (Study 18).

Household catches averaged 783 kg/year or 139 kg/capita/year or 1.9 times consumption, a figure reasonably consistent with An Giang being a nett fish exporter.

Data on estimated catches and on production from aquaculture produced a province-level estimate of about 270,000 tonnes, of which about 36% was from aquaculture. However a significant part of the aquaculture production relied on the feeding of trash fish from both river and marine fisheries.

Study 16. Viet Nam: Long An province—Pham and Guttman (1999)

This survey covered use of aquatic resources in the six districts forming the western part of Long An province, which lies within the extensive ‘Plain of Reeds’ a wetland underlain by acid-sulphate soils which is seasonally flooded by Mekong overflows to about 0.5–3 m depth for 1–4 months. Flooding restricts development of secondary industries, so the province’s economy is based on agriculture, forestry and fishing.

Households were selected within four strata based on economic status and interviewed using a questionnaire. People were asked about average household consumption in kg/week in each of four seasons, but were asked about catches in kg/season and about aquaculture production in kg/harvest.

Farming was the most common economic occupation reported, with fishing a primary occupation for 3% of respondents and a secondary occupation for 13% of respondents. However, 83% of households (including the 16% of economic fishers) reported fishing for household consumption. As most households own ponds (a consequence of excavating land on which to construct elevated houses) about 61% of households cultured fish, mostly *Pangasius*, tilapia and silver barb. Aquaculture production reportedly averaged 408 kg/household/year, whereas catch from wild fisheries was reported at 552 kg/household/year (Figs 21 and 22 of the report), with a skewed distribution of catches; at a household size of 5.7 persons these figures convert to 71.6 and 96.8 kg/capita/year respectively. Total consumption of inland fish was reported to be 60.2 kg/capita/year, so there was a large excess of reported production of fish (168.4 kg/capita/year) over consumption. About 47% of the catch was reportedly consumed and most of the aquaculture production was reportedly sold, so the catch and consumption figures are quite consistent.

Preserved fish was reported in the study as a total amount of 13.7 kg/capita/year. To convert this to FWAEs and to generate estimates for the components of preserved fish, it was assumed that the composition was the same as in Study 16, where the total amount of preserved fish was similar at 15.2 kg/capita/year.

Provincial production was estimated at 36,000 tonnes, of which about 42% was from aquaculture. This is probably the highest percentage for any province in the LMB, consistent with the stated importance of aquaculture and the decline of the wild fishery, which nevertheless still appeared to contribute the majority of the yield.

Study 17. Viet Nam: Tien Giang province—Setboonsarng *et al.* (1999)

This survey was carried out to assess aquaculture production and potential in this densely-populated delta province, where it was estimated that about 84% of rural households owned at least one pond and 75% were practising aquaculture. As 20% of the population was urban, about 60% of households practised aquaculture. The survey was biased towards aquaculture households (300 of 331) and households were randomly selected within the main strata of aquaculture types. Respondents were asked to list the quantities of fish harvested on each cycle over one year, and to estimate the percentages consumed, sold, restocked or given away. They were also asked to list quantities of the three main inland and marine fish species they bought for consumption in kg/month. In Tien Giang province, capture of wild fish was thought to have declined greatly due to pesticide impacts and over-fishing, so only 9.1% of households reported they caught wild fish, although quantities were not reported nor added to consumption figures. Even allowing for low catches, it seems likely that catches from small-scale fishing may have been underestimated, perhaps because households (or the surveyors) regarded them as unimportant. Mean consumption was calculated as a weighted mean based on the values

of aquaculture households (60% of the province) and non-aquaculture households, assumed to include urban dwellers. The study did not ask about preserved fish or about OAAs. For extrapolation, preserved fish was estimated as the average of Tra Vinh and An Giang figures. The main fish species bought were indigenous: snakeheads, walking catfish, climbing perch and snakeskin gouramy, all of which are floodplain/rice-field 'blackfish' species, which may have originated from capture or culture. The main cultured fish were tilapia, silver barb, giant gouramy and carp.

Aquaculture families were found to consume almost 100% more fresh fish than families with no aquaculture. Inland fresh fish consumption estimated for the province (29.6 kg/capita/year) was about 70% of the total fresh fish consumption for the province.

Inland fish consumption differed between aquaculture and non-aquaculture households by 29.7 kg/capita/yr (41.5 vs. 11.8 kg/capita/year) with an overall average of 29.6 kg/capita/yr, which was 70% of the total estimated consumption figure of 42.2 kg/capita/yr.

Study 18. Viet Nam: Tra Vinh province—Phan *et al.* (2003)

This province was selected for a socio-economic survey as coastal fishery to compare with An Giang during MRC Fisheries Programme surveys. Tra Vinh is intensively farmed and an elaborate network of canals covers the province; wild fishery production is from seasonally inundated rice-fields and from the canal system. Much of the southern coastal portion (about one quarter) of the province has been converted to brackish water shrimp ponds, as is common along the coastline of the delta.

Consumption tables were recalculated from the original databases after correction of some errors and using complex sample methods and re-weighting by strata, so figures differ from those previously published. Fresh fish and OAAs were not separated in questions about total consumption, but people were asked to estimate the percentages of their total consumption comprising marine fish, inland fish, shrimps and other OAAs. Relative errors (confidence limits/means) varied from 9% to 26% for the consumption estimates for these individual categories of aquatic foods. Table 21 shows mean consumption figures.

Reported production from inland catches and aquaculture for the province equated to about 48.7 kg/person/year, of which 26% was from aquaculture; this production figure is about 11% higher than the consumption estimate for inland fish and OAAs, an acceptable difference that allows for some export from the province or use in aquaculture feed. Calculation of a province-level production balance is complicated by a large marine catch for which only approximate estimates are available.

Study 20. Viet Nam: Lem and Nghia (2003)

This interesting study aimed to develop an economic model based on fish consumption, prices, economic growth and population growth to enable prediction of future demand as an aid to planning in the fisheries sector. The study included a survey of 656 households stratified by

region and by degree of urbanisation. The report includes limited information on the survey methods, and the make up of 'fish' is not clearly stated, so comparisons should be made with caution. Table 22 shows that reported consumption was highest in rural areas in the south of the country (52.3 kg/person/year), which would include most of the people of the Mekong delta. Results from this study were not used directly in the present report, but the figures are consistent with those for the Viet Nam delta as shown in Table 23, suggesting that responses to interview questions about fish consumption appear to be consistent across studies. The lowest consumption figure (in the rural north) was about half of the highest figure (in the rural south), indicating the likely range in reported consumption figures across the country.

Table 22. *Reported fish consumption in Viet Nam (kg/person/year).*

Stratum	North	Central	South	Total
Cities	29.2	35.6	30.4	31.8
Suburban	38.6	44.0	43.7	41.6
Rural	28.2	39.8	52.3	39.4
Total	32.0	37.7	37.0	35.6

4.3 Extrapolating consumption figures

Inland fish

Consumption figures from the above study reviews of 33 provinces were tabulated, some data were in-filled, and then figures were extrapolated for the other 53 LMB provinces to obtain total estimates of inland fish consumption, based on:

- proximity, i.e. figures were used from adjacent or nearby provinces;
- geographic similarity, especially elevation and latitude;
- averaging of data where several provinces could be used as the basis for extrapolation;
- use of conservative assumptions for drier or mountainous provinces.

Appendix 1 sets out the tabulations with notes that explain in each case how extrapolation or infilling of data was achieved. Some notes on each country follow.

Cambodia: Data were available for 11 of 23 provinces, which include 73% of the Cambodian LMB population. Extrapolation for Banteay Meanchey is uncontroversial, as it is adjacent and similar to Great Lake provinces, and includes a further 5% of the Cambodian LMB population. Extrapolation for the more mountainous and/or drier provinces, which include only 22% of the Cambodian LMB population, was derived conservatively by halving the figures from Svay Rieng, which had the lowest total fish consumption. For Kratie, Ratana Kiri and Stung Treng,

all of which have significant river and wetland fisheries, Svay Rieng figures were used, a conservative approach.

Lao PDR: Extrapolation was not necessary because consumption estimates were based on the LECS3 study which covered all provinces, and the results from LECS3 were consistent with province-level studies where comparisons were possible (Table 18).

Thailand: The eight provinces for which some information is available include about 46% of the population of the 25 LMB provinces in northeast Thailand. As data were not disaggregated by province in the original studies there is little variation seen across all provinces; therefore extrapolation was from adjacent provinces.

Viet Nam: The four sampled provinces covered only 27% of the population of the Delta, but they encompassed nicely the range of geographic variation expected through the Delta. Consumption of the other eight provinces was estimated as either the same as adjacent provinces or the average of two adjacent provinces. There were no data available for the eight highland provinces in Viet Nam which are partly within the LMB. All have significant capture and culture fisheries, and fishery products from coastal areas and the delta are widely sold. In the absence of data it was assumed that these highland provinces had 50% of the estimated fish consumption of the average for the delta provinces. Based on the national range reported in Study 20 this is a conservative assumption.

Other aquatic animals

Inland OAA consumption was reported in five of the surveys reviewed above, with data from 13 provinces (Table 23). No data were available for preserved OAAs. The studies are reviewed above in Section 4.2.

Study 8 explicitly covered (i.e. disaggregated) all main taxa of OAAs and in Studies 12 and 18 data were partly aggregated. Where some common taxa were not included data were infilled; the Svay Rieng value for molluscs was estimated as the average of other reported data, whereas the values for crabs and shrimps in northeast Thailand were infilled with the same value as reported for Champassak.

To estimate basin-wide consumption of OAAs it was assumed that the ratio of OAA consumption to inland fresh fish consumption from studies within each country was constant across each country, except that in Lao PDR different ratios were used for different parts of the country: northern (Study 6), southern (Study 8) and central (mean of Studies 6 and 8) provinces.

Table 23. Available data on inland OAA consumption.

Data from studies as numbered in Table 8. All values are as kg/capita/year as FWAEs. In Study 6, OAAs were classed as aquatic and amphibious and have been combined for this table, note that Study 6 was of 'low-fish' households, which were unlikely to be representative.

Country	Cambodia	Lao PDR	Lao PDR	Thailand	Viet Nam
Location	Svay Rieng	North	Champassak	NE Thailand	Tra Vinh
Study No.	5	6	8	12	18
Fresh inland fish consumption	25.7	8.9	25.6	21.3	22.7
Reported OAA consumption	5.17	4.93	10.29	7.80	7.61
Corrected OAA consumption	8.67	4.93	10.29	8.49	7.61
Ratio of corrected OAA/fresh fish consumption	0.337	0.554	0.402	0.399	0.355
As reported percent of total OAAs:					
Frogs and Tadpoles	2.74		5.57	4.80	
Crabs	0.13		0.23	0.23*	
Shrimps	1.09		0.46	0.46*	4.72
Mollusks	3.50*		4.01	3.00	
Insects			0.01		
Birds	0.89				
Snakes	0.19				
Other not specified	0.13				

Note: * values were infilled based on other studies, corrected OAA consumption includes the infilled values.

Other animal foods

Data for consumption of other animal foods were less complete than for inland fish, in terms of number of studies (7), areal coverage (22 provinces), and coverage of categories. Figure 13 illustrates how consumption of other foods appears to increase as inland fish consumption decreases, but also shows a wide scatter in the data. However, Cambodia (Study 1) does not follow this trend; over a wide range of fish consumption there is little apparent trend in the consumption of other meats.

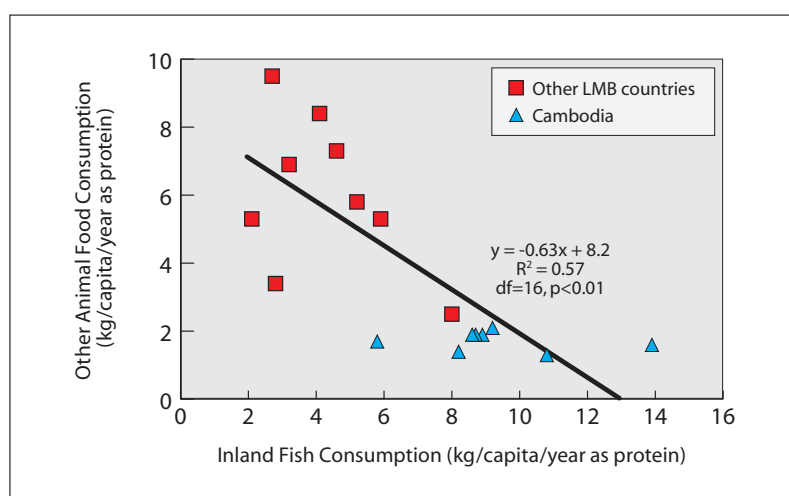


Figure 13. Relationship between other animal consumption and inland fish consumption.

In Study 1 information was only collected on conventional meat foods, ignoring wildlife and less-conventional domestic animals such as buffalo, goats, and sheep, so the intake of other animal foods is likely to be underestimated.

Nevertheless, these data were used without adjustment and extrapolated using the same general principles as for inland fish and as noted in Appendix 1.

Marine products

Only 5 studies which covered 14 provinces provided data for marine products; no data were available for Cambodia. The final extrapolated figures (Appendix 1) should be regarded as likely to be the least accurate among the categories of foods.

4.4 Summary of consumption figures

Table 24 summarises the total figures for each country and Appendix 1 provides a more detailed breakdown including the different kinds of preserved fish and consumption as actual (prior to cooking) amounts.

The consumption of inland fish in the LMB in 2000 is estimated at about 2.1 million tonnes/year as FWAEs and consumption of OAAs is estimated at about 0.5 million tonnes/year; total consumption is about 2.6 million tonnes/year as FWAEs. Actual consumption (that is flesh eaten) totals about 1.9 million tonnes. About two thirds of inland fish is eaten fresh, with the proportions and composition varying somewhat between countries, with Lao PDR for example having more salted/dried fish (see Appendix 1) and more preserved fish overall, and Viet Nam having the highest proportion of fish consumed fresh. Thailand and Viet Nam consume similar amounts of inland fish and OAAs and together account for about 69% of the total, with high total consumption being a result of moderate per capita consumption coupled with large populations. Cambodia with a large average per capita consumption but moderate population consumes about 23%, and Lao PDR accounts for only 8% because per capita consumption is moderate but its population is small.

Marine product consumption is estimated to be about 0.3 million tonnes as FWAEs, and is most important in Thailand and Viet Nam, which is consistent with their high population density and well-established marine fisheries.

Annual consumption of inland fish plus OAAs as country averages varies from 41 to 51 kg/per capita as FWAEs, or 29 to 39 kg/capita as actual consumption. When converted to protein units, aquatic foods basinwide account for about 49–82% of all animal protein consumption. Inland fish and OAAs are most important in Cambodia and Viet Nam, whereas Lao PDR and Thailand have about equal contributions from aquatic foods and other animals.

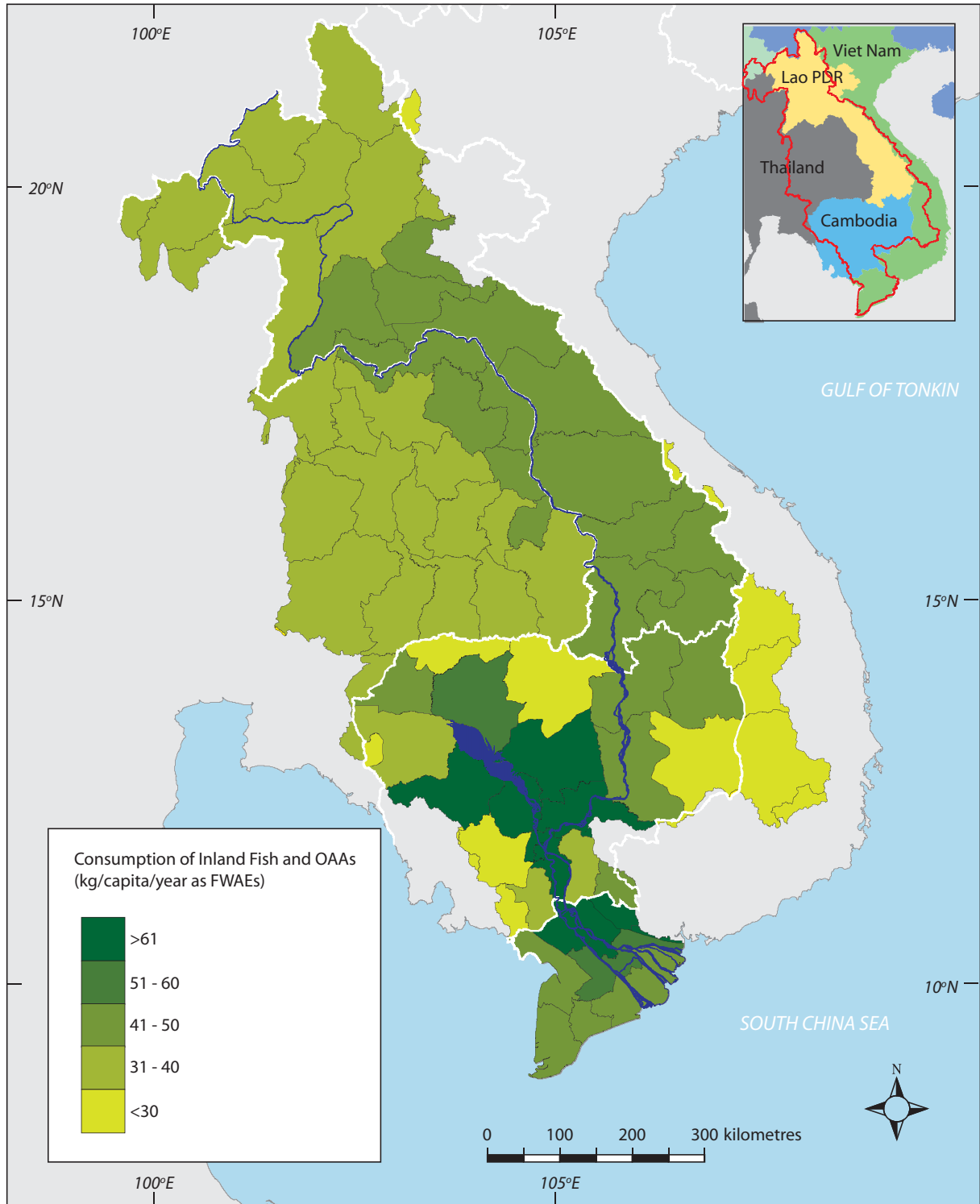


Figure 14. Distribution of per capita consumption of inland fish plus OoAs by province.

Values are mean consumption (kg/capita/year as FWAEs). Excludes marine product consumption.

Values are typically lower in elevated parts of provinces, but data are not available to show variations within provinces.

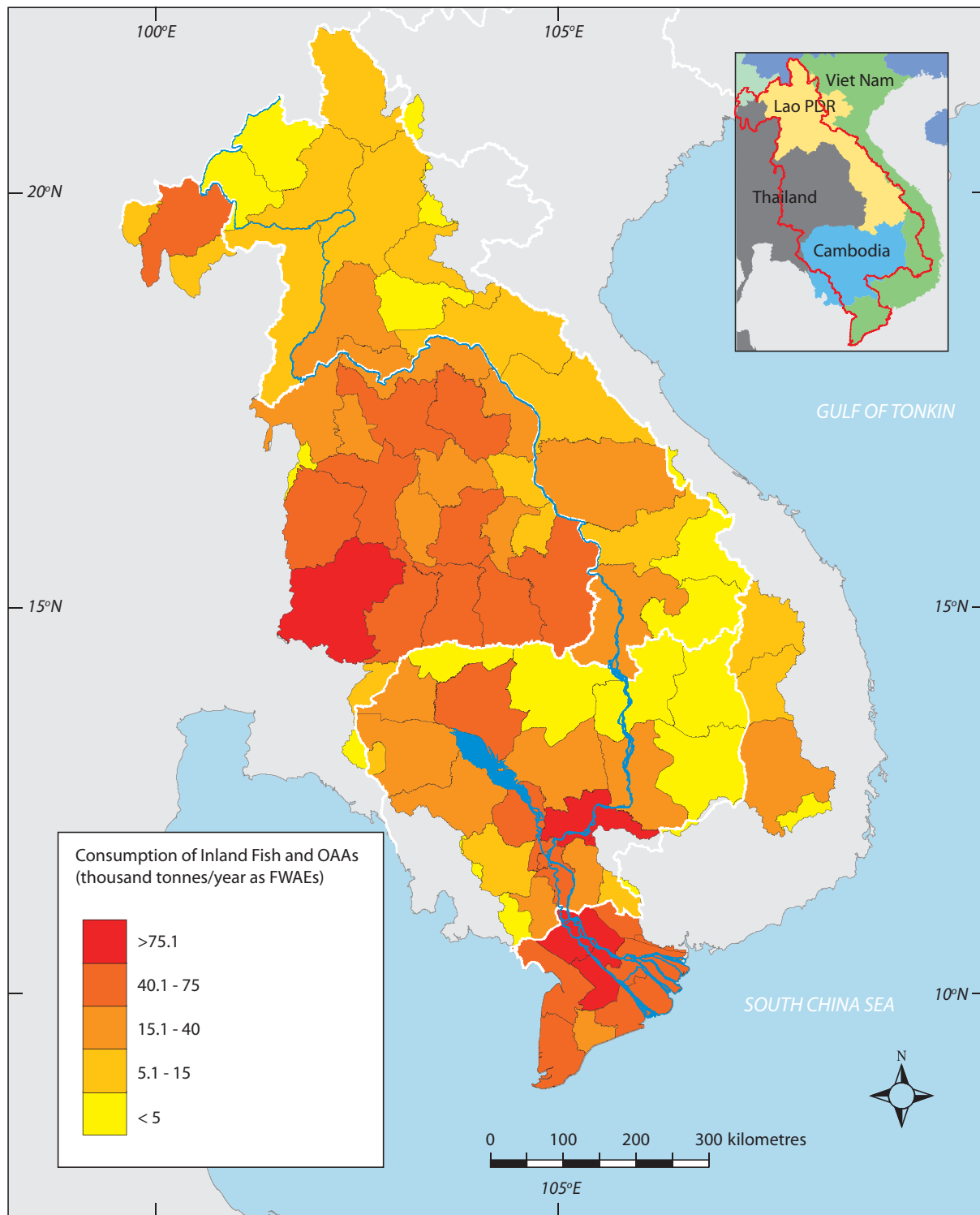


Figure 15. Distribution of total consumption of inland fish plus OoAs by province.
Values are mean consumption (thousand tonnes/year as FWAEs).

Table 24. Summary of estimated consumption of aquatic products, tonnes/year as FWAEs and as actual consumption (conversion factors are discussed in Section 3).

FWAEs (tonnes/year)							
Country	Inland					Marine Products	Total Aquatic
	Fresh Fish	Preserved Fish	Total Inland Fish	OAAs	Inland Fish plus OAAs		
Cambodia	312,631	168,906	481,537	105,467	587,004	11,421	598,426
Lao PDR	85,076	82,846	167,922	40,581	208,503	2,480	210,982
Thailand	479,147	241,354	720,501	190,984	911,485	130,075	1,041,560
Viet Nam	479,370	212,748	692,118	160,705	852,823	129,418	982,241
TOTAL	1,356,224	705,854	2,062,077	497,737	2,559,815	273,394	2,833,209

As % of total aquatic foods from each country

Country	Inland					Marine Products	Total Aquatic
	Fresh Fish	Preserved Fish	Total Inland Fish	OAAs	Inland Fish plus OAAs		
Cambodia	52.2%	28.2%	80.5%	17.6%	98.1%	1.9%	100.0%
Lao PDR	40.3%	39.3%	79.6%	19.2%	98.8%	1.2%	100.0%
Thailand	46.0%	23.2%	69.2%	18.3%	87.5%	12.5%	100.0%
Viet Nam	48.8%	21.7%	70.5%	16.4%	86.8%	13.2%	100.0%
TOTAL	47.9%	24.9%	72.8%	17.6%	90.4%	9.6%	100.0%

As % of each category from each country

Country	Inland					Marine Products	Total Aquatic
	Fresh Fish	Preserved Fish	Total Inland Fish	OAAs	Inland Fish plus OAAs		
Cambodia	23.1%	23.9%	23.4%	21.2%	22.9%	4.2%	21.1%
Lao PDR	6.3%	11.7%	8.1%	8.2%	8.1%	0.9%	7.4%
Thailand	35.3%	34.2%	34.9%	38.4%	35.6%	47.6%	36.8%
Viet Nam	35.3%	30.1%	33.6%	32.3%	33.3%	47.3%	34.7%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

As actual consumption

Country	Inland					Marine Products	Total Aquatic
	Fresh Fish	Preserved Fish	Total Inland Fish	OAAs	Inland Fish plus OAAs		
Cambodia	250,105	118,388	368,492	51,679	420,171	9,137	429,308
Lao PDR	68,060	50,933	118,993	19,885	138,878	1,984	140,862
Thailand	383,318	176,591	559,909	93,582	653,491	104,060	757,551
Viet Nam	383,496	221,175	604,671	78,746	683,417	103,534	786,951
TOTAL	1,084,979	567,087	1,652,065	243,891	1,895,957	218,715	2,114,672

Table 25. Estimated per capita consumption of fish and other animals (based on Appendix 1).

As FWAEs, kg/capita/year

Country	Inland			Marine Products	Total Aquatic
	Fish	OAAs	Fish plus OAAs		
Cambodia	42.2	9.2	51.4	1.0	52.4
Lao PDR	34.6	8.4	43.0	0.5	43.5
Thailand	32.0	8.5	40.5	5.8	46.2
Viet Nam	39.5	9.2	48.7	7.4	56.1
TOTAL	36.6	8.8	45.5	4.9	50.3

As actual consumption, kg/capita/year

Country	Inland			Marine Products	Total Aquatic	Other Animals	Total Animal consumption
	Fish	OAAs	Fish plus OAAs				
Cambodia	32.3	4.5	36.8	0.8	37.6	8.5	46.1
Lao PDR	24.5	4.1	28.6	0.4	29.0	33.0	62.1
Thailand	24.9	4.2	29.0	4.6	33.6	30.2	63.8
Viet Nam	34.5	4.5	39.0	5.9	45.0	19.8	64.7
TOTAL	29.3	4.3	33.7	3.9	37.6	22.8	60.4

As protein consumption g/capita/day

Country	Inland			Marine Products	Total Aquatic	Other Animals	Total Animal consumption
	Fish	OAAs	Fish plus OAAs				
Cambodia	19.0	2.0	21.0	0.4	21.4	4.85	26.3
Lao PDR	15.8	1.8	17.6	0.2	17.9	18.69	36.6
Thailand	14.3	1.9	16.1	2.5	18.6	15.83	34.5
Viet Nam	17.5	2.0	19.5	3.2	22.7	10.31	33.0
TOTAL	16.3	1.9	18.3	2.1	20.4	12.13	32.5

As % of total animal protein consumption

Country	Inland			Marine Products	Total Aquatic	Other Animals	Total Animal consumption
	Fish	OAAs	Fish plus OAAs				
Cambodia	72.2%	7.7%	79.9%	1.7%	81.5%	18.5%	100.0%
Lao PDR	43.2%	5.0%	48.2%	0.6%	48.9%	51.1%	100.0%
Thailand	41.4%	5.4%	46.8%	7.3%	54.1%	45.9%	100.0%
Viet Nam	52.9%	6.1%	59.0%	9.7%	68.8%	31.2%	100.0%
TOTAL	50.3%	6.0%	56.2%	6.5%	62.7%	37.3%	100.0%

Table 26. Data on relative capture/culture proportion and participation in fisheries.

No.	Study Report and Date	Country	Region	No. of provinces	%Capture %Culture	% professional fishing	%in capture fisheries	% in aquaculture	Notes
1	Ahmed <i>et al.</i> (1998)	Cambodia	Tonle Sap - Great Lake	8	No data, assumed very minor importance of aquaculture, mainly for grow-out	38.8%	99.0%	2.5%	% in capture fisheries judged by significant dependence - one or more family member Tables 3.2 and 3.45
2	Setboonsarng <i>et al.</i> (2001)	Cambodia	Kandal, Prey Veng, Takeo	3	Average 25% of own-produced fish from aquaculture, study biased to pond-owners	nd	80.7%	5.0%	Table 60, p.52 only 5% actually doing fish culture
3	Touch <i>et al.</i> (1994)	Cambodia	Svay Rieng	1	All based on wild fish, aquaculture negligible	nd	84.5%	nd	Households who fish or collect other aquatic animals
4	Gregory <i>et al.</i> (1996)	Cambodia	Svay Rieng			0.0%	100.0%	0.0%	Trap ponds important
5	Mogensen (2001)	Cambodia	Svay Rieng			0.0%	100.0%	0.0%	Trap ponds important
6	Funge-Smith (1999a)	Lao PDR	Northern Lao PDR	5	Study biased towards pond-owners, most from ponds or rice fields	nd	nd	84.5%	Survey biased to pond owners, but many not actually culturing
7	Sjorslev (2000)	Lao PDR	Luang Prabang	1	Fresh fish: 68.9% from self-capture, 1.72% from aquaculture, 29.4% purchase or gift	2.2%	81.0%	7.3%	Recalculated from databases
8	Singhanouvong and Phouthavongs (2003)	Lao PDR	Champassak	1	No data, assume virtually all is wild fishery	13.5%	96.2%	15.0%	From village (not household) survey
9	Baird <i>et al.</i> (1998)	Lao PDR	Khong District, Champassak	1	All wild capture fish	56.0%	94.2%	0.5%	56% of households sell fish
10	Garaway (2005)	Lao PDR	Savanakhet	1	Appears to be all wild capture fish	nd	98.1%	nd	Selective survey in one district
11	Mattson <i>et al.</i> (2000)	Lao PDR	Vientiane	1	Little aquaculture except grow-out of wild fish	62.0%	100%	1.2%	Professional fisher defined as main income and one or more family member □ □
12	Prapertchob <i>et al.</i> (1989)	Thailand	5 provinces in northeast Thailand	5	No data	nd	nd	nd	
13	Suntornratana (2002)	Thailand	Lowland parts of 3 provinces	3	Aquaculture production 1% of total consumption	9.4%	93.6%	3.5%	Recalculated from database using weightings
14	Piumsombun (2001)	Thailand	Khon Kaen, Nakhon Ratchasima	2	No data	nd	nd	nd	
15	Sjorslev (2002)	Viet Nam	An Giang	1	Aquaculture yields about 36% of the total production, most is exported	7.1%	61.0%	14.2%	Recalculated from database, professional fishing means one or more professional fisher in household
16	Pham and Guttman (1999)	Viet Nam	Long An, western half	1	Aquaculture yields about 42% of the total production	3.4%	82.5%	61.0%	Professional fishing means household's main income
17	Setboonsarng <i>et al.</i> (1999)	Viet Nam	Tien Giang	1	Incomplete data on wild fishery	9.1%	nd	91.4%	Survey was biased towards aquaculture, 330 of 361 hhs
18	Phan <i>et al.</i> (2003)	Viet Nam	Tra Vinh	1	Aquaculture yields about 26% of the total production, most is exported	4.3%	62.2%	43.5%	Professional fishing means household's main income
19	NSC (2004)	Lao PDR	Lao PDR	All	nd	nd	nd	nd	
20	Lem and Nghia (2003)	Viet Nam	Viet Nam	Not stated	nd	nd	nd	nd	

Animal protein consumption is estimated at about 26–37 g/capita/day as country averages. Based on the recommended daily allowance (RDA) of 0.8 g/kg/day¹, an ‘average’ LMB person 50 kg in weight needs to eat 40 g/day of protein. If correct, and assuming limited wastage during cooking and eating, the consumption figures imply a high intake of animal protein which would make up 65–93% of the total RDA as the range of LMB country means.

4.5 Relative contribution from aquaculture and capture fisheries

Consumption data generally cannot be used directly to discriminate the source of fish as being from capture or culture fisheries, because:

- consumers usually have no information on the origin of fish which are not self-produced;
- many aquaculture operations involve grow-out of wild-caught fish;
- some fisheries are intermediate between aquaculture and capture; for example rice-fields that are stocked where the harvest includes wild fish; and
- many indigenous species are cultured and most species of introduced aquaculture fish are also present in wild catches.

As summarised in Table 26, some production data from the reviewed reports indicate the relative yield from aquaculture and capture, as well as participation in fisheries, which also gives some indication of the relative size of the subsectors. Production figures cannot be related directly to consumption figures, as a significant proportion of the aquaculture production is exported out of the LMB, so representing additional production rather than being a component of consumption. Aquaculture is important in the delta in Viet Nam, contributing up to 42% of the total production, but most of that aquaculture production appears to be exported. Aquaculture is of less importance in Cambodia and Lao PDR, and perhaps of intermediate importance in Thailand. A portion of the aquaculture production is also supported by feeding cultured fish with inland fish trash fish, so it actually represents a large yield of wild fish.

Officially, aquaculture in the LMB accounted for about 260,000 tonnes/year in 1998–2000 (Phillips, 2002, p. 30). Given that a large proportion of all aquaculture is exported, and based on the limited summary data in Table 26, it can be concluded that aquaculture in 2000 produced less than 10% of the inland fish consumed in the LMB. A recent expansion is indicated by figures for 2005 (Anh Tuan & Quynh Mai, 2005); the Viet Nam delta now officially produces in excess of 600,000 tonnes per year (up from 172,000 tonnes as quoted in Phillips, 2002), much of which is *Pangasius* catfish and snakeheads, which are fed primarily on marine trash-fish.

¹ RDAs are established and widely published by the Food and Nutrition Board of the US National Academy of Sciences, see also Institute of Medicine (2002)

4.6 Fishery yield

The total capture fishery yield from the LMB can be estimated as:

$$\text{Yield} = \text{Consumption} - \text{Imports} + \text{Exports} + \text{Animal Feeds} + \text{Waste} + \text{Aquaculture Feed}$$

Imports of inland fish from adjacent basins or from overseas would be very minor relative to exports. Animal feed and waste quantities are unknown, but would be certainly at least an additional 10% per year, which may approximately balance with the small component of consumption which derives from aquaculture.

Use of inland fish for aquaculture feed is insignificant in Lao PDR or Thailand (of the order of a few thousand tonnes per year) as most trash fish is marine-derived (Ingthamjitr *et al.*, 2005). Inland trash fish is important in Cambodia where, based on field surveys it is estimated that about 55,000 tonnes per year is used in aquaculture (So *et al.*, 2005). In Viet Nam most trash fish is marine-derived; Anh Tuan & Quynh Mai (2005) found that only 13% of fresh fish fed to catfish and snakeheads was from inland waters and almost no inland trash fish was used in pelleted feed. In the Year 2000, the use of inland trash fish in aquaculture in the Viet Nam delta was probably of the order of 55,000 tonnes/year, based on the official aquaculture yield of 172,000 tonnes/year¹. Therefore, the total use of inland trash fish in aquaculture in the LMB during 2000 can be estimated at about 120,000 tonnes per year.

From this limited information and that discussed in the preceding section the consumption figures are likely to be less than the yield from the wild capture fishery; the figures can be summarised as follows:

1. Total consumption estimate: 2.63 million tonnes/year;
2. Assumed proportion from aquaculture: 10% or 0.26 Mt/year;
3. Proportion of consumption which is from capture fishery: 90% or 2.37 Mt/year;
4. Inland capture trash fish for aquaculture feed: 0.12 Mt/year;
5. Minimum estimate of wild fishery used for animal feed or wasted: 0.26 Mt/year;
6. Exports of capture fishery products: no reliable information, but quantities exceed imports.

Hence the consumption estimates indicate a wild capture fishery yield of at least 2.63 million tonnes per year as FWAEs from the LMB.

¹ Assuming half are carnivorous species, a one-year growth period, and a feed conversion ratio of 4 for carnivorous species, and 13% from inland fish : trash fish use = $172,000/2 * 4 * 0.13 = 44,720$ tonnes/year; and assuming an additional 10,000 tonnes/year in omnivorous fish feeds.