

2 Population and Provinces

The Lower Mekong Basin (LMB) includes the catchments of all the Mekong's tributaries (south of China and Myanmar), and all the areas of land in the lower part of the basin that are normally flooded by Mekong waters each year or where watercourses form permanent or seasonal distributaries of the Mekong system. Population figures for each LMB province were obtained from databases held by MRC. National censuses were carried out in mid-2000 in Lao PDR, Thailand and Viet Nam. For Cambodia, the prior census was mid-1998 and figures were adjusted to equivalent mid-2000 figures by factoring by the annual growth rate (2.49%). Thus all population figures and the final consumption estimate are 'equivalent mid-2000 figures' as summarised in Table 1 and as detailed in Appendix 1.

Table 1. *Summary of surface area, population in 2000, and population density of the Lower Mekong Basin countries (based on Appendix 1).*

Surface area (km ²)				
Country	Whole country	Area in the LMB	% in LMB	% of LMB area
Cambodia	181,035	158,851	87.7%	25.5%
Lao PDR	236,800	207,313	87.5%	33.3%
Thailand	513,115	187,932	36.6%	30.2%
Viet Nam	325,490	68,489	21.0%	11.0%
Total	1,256,440	622,584	49.6%	100.0%

Population (mid-2000)				
Country	Whole country	LMB population	% in LMB	% of LMB population
Cambodia	12,014,343	11,421,458	95.1%	20.3%
Lao PDR	5,218,300	4,850,765	93.0%	8.6%
Thailand	60,617,200	22,528,171	37.2%	40.0%
Viet Nam	77,635,400	17,505,470	22.5%	31.1%
Total	155,485,243	56,305,864	36.2%	100.0%

Population density (persons/km ²)		
Country	Whole country	LMB
Cambodia	66.4	71.9
Lao PDR	22.0	23.4
Thailand	118.1	119.9
Viet Nam	238.5	255.6
Total	123.8	90.4

Note: These figures differ slightly from official national figures because GIS data were used to estimate province areas.

Censuses are meant to record people resident in on a particular night, but some residents may be living and working elsewhere. Within Cambodia and Lao PDR, which lie largely within the LMB, there would be little overall effect of this error, as short-term migration from one part of the basin would probably be balanced by gains in another part. But some people recorded in the Thai or Vietnamese parts of the LMB work outside the basin, especially in urban centres such as Bangkok or Ho Chi Minh City, so their inclusion would cause the LMB population to be overestimated. On the other hand, unrecorded LMB residents, particularly tourists, are likely to counterbalance any such effect, as all countries have a large and growing tourist industry. Allowing for these small errors, national census figures are generally accurate to within a few percent, so are not a significant source of error in the overall consumption calculation.

Table 1 and Figure 4 show that while 59% of the area of LMB lies within Cambodia and Lao PDR, these two countries contribute only 29% of its population. Thailand has the second largest proportion of the LMB area and the largest proportion of its population.

Most people in the four LMB countries are classed as rural. The censuses provide rural proportions as: Cambodia 84%, Thailand 69%, Viet Nam 75%. The rural proportion in the Lao PDR is not specified, but is probably similar to that in Cambodia.

Table 2. Summary of province proportions within the LMB (based on Appendix 1).

Category	No. of provinces	Area (km ²)	% of total	Estimated population	% of total
Partly within the LMB	32	200,153	32.1%	14,552,045	25.8%
Wholly within the LMB	54	422,431	67.9%	41,753,819	74.2%
Total	86	622,584	100.0%	56,305,864	100.0%

There are 54 provinces wholly within the LMB and 32 that are only partly within the LMB (Figure 5, Table 2, Appendix 1)¹. Estimating the proportion of population of these 32 provinces that live in the LMB simply pro rata based on land area may introduce errors because the population is not evenly distributed. In the case of provinces lying mostly within the basin, assuming an even population distribution causes underestimates because population is denser along the rivers and floodplains of the Mekong system, i.e. away from the boundaries of the catchment, which are the most elevated parts. Conversely, for provinces lying mostly outside the LMB, populations are likely to be overestimated. The likely bias introduced by pro rata estimation based on land area can be judged from the breakdown in Table 2. This error only applies to the 26% of the total population estimate that derives from the 32 provinces partly within the basin. Of these provinces, 16 are mostly within and 16 are mostly outside the basin, so any errors from this source should approximately balance.

In summary, any errors in the population figures are likely to be small, and inconsequential in comparison to the errors in consumption estimates which are discussed further below.

¹ One census area wholly within the LMB is Tonle Sap in Cambodia; it covers the Great Lake and its area is included in the figures, but it has no registered population as all residents are registered in the surrounding riparian provinces.

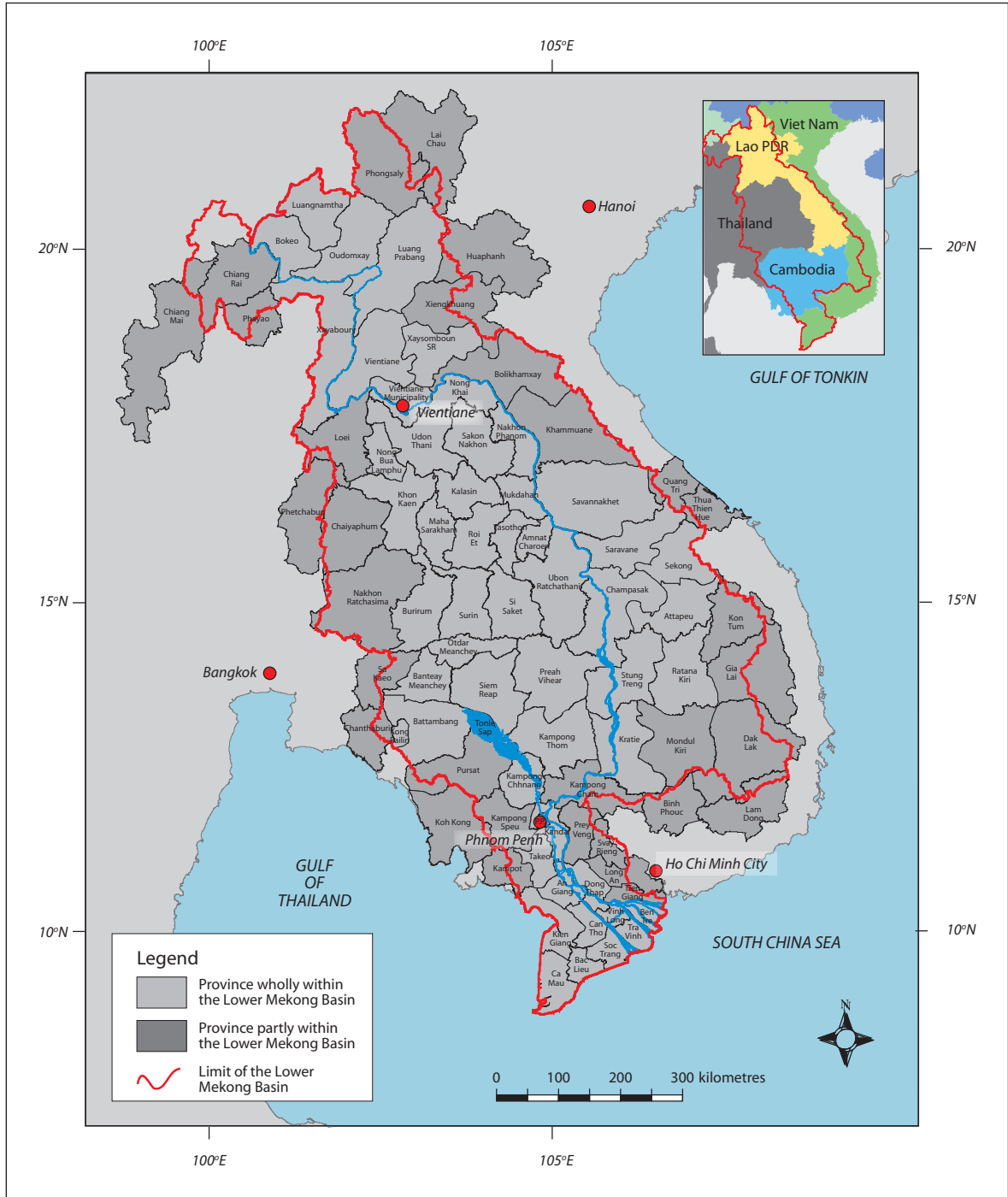


Figure 5. Provinces wholly or partly in the Lower Mekong Basin.

3 Terminology for Fishery Products

3.1 Introduction

The collective term ‘fish and OAAs’ includes four main categories: inland fresh fish (IFF), inland preserved fish (IPF), other aquatic animals (OAAs), and marine products (MPs). Many surveys of consumption do not include one or more of these categories or do not clearly state the coverage of their estimates; it is for example common to read ‘fish consumption’ without further clarification. It is therefore necessary to make some assumptions to standardise data for comparison or summation.

The surveys that were reviewed appear to refer to quantities of fresh fish and OAAs as ‘fresh whole animal equivalent weights’ (FWAEs), although definitions were not usually provided in the survey reports. FWAEs has the same meaning as ‘live weights’ as used by the FAO, i.e. the whole weight of fish or OAAs when caught. Preserved fish products are weights ‘prior to cooking’, i.e. after removal of some parts of the fish and processing. All products must either be converted to FWAEs or expressed as ‘actual consumption’, as discussed below. Actual consumption is actually less than weights ‘prior to cooking’, but the small wastage during cooking and eating has been ignored in this report.

Expressing quantities in terms of protein intake is another useful way of standardising data and comparing intakes of protein-rich foods, so is common in nutrition-focussed studies.

3.2 Inland fresh fish (IFF)

This term includes inland fish that are eaten soon after capture or that are held on ice or refrigerated prior to eating. People in the LMB will eat all parts of some small fish, but generally some portion of each fish is not eaten. Mogensen (2001) estimated that for four common fish species in a rural area of Cambodia the edible portion was between 62% and 93% of the weight of the fish. Large fish have a lower proportion of edible tissue, as their skeletons are proportionately larger. In this report, a factor of $\times 0.8$ is used (i.e. actual weight multiplied by 0.8) to convert fish as FWAEs to edible portions (actual consumption), on the assumption that people in the LMB mostly eat small fish. Using an average protein content of 19.9% for edible portions (taken from Mogensen, 2001) a factor of 15.9% ($19.9\% \times 0.8$) can be used to estimate the edible protein content in fish as FWAEs.

For comparison, data taken from Puwastien *et al.* (1999) shows that the flesh¹ (or flesh and skin) of 22 common LMB fishes (i.e. excluding other edible parts) had an average

¹ Flesh refers to muscular tissue, i.e. as normally removed in a fillet.

protein content of 17.7% (13.0–21.1%), an average moisture content when fresh of 76.6 % (65.1–80.8%), and an average fat content of 4.2% (0.2–16.5%). Thus the average protein content for **flesh** from a range of LMB fish is actually quite similar to that found by Mogensen for **edible portions**.

3.3 Inland preserved fish (IPF)

Fish catches vary seasonally throughout the LMB. At the beginning of the annual flood fish migrating upstream or onto floodplains are caught in large quantities. During the flood, fish feed and grow on inundated areas, so that large numbers of fish are caught while water levels are falling. During the dry season relatively few fish are caught. Seasonal excesses of fish have led to the development of many methods of preservation (Table 3).

Table 3. *Some local names for common kinds of preserved fish products.*

Language	Fermented fish products			Dried fish, salted/dried Fish	Smoked fish
	'Fish paste'	Fish sauce	Other fermented fish products		
Thai	<i>Pla Ra</i>	<i>Nam Pla</i>	<i>Ka Pi Pla, Pla Jom, Pla Som, Pla Jao</i>	<i>Pla Heng</i>	<i>Pla Yang</i>
Khmer	<i>Prahoc, Mam</i>	<i>Teuk Trey</i>	<i>Pa 'ok</i>	<i>Trey Ngiet, Trey Hal, Trey Pra Laak</i>	<i>Trey Ch'au</i>
Lao	<i>Pa Dek</i>	<i>Nam Pa</i>	<i>Ka Pi Pa, Som Pa, Pa Jao</i>	<i>Pa Heng</i>	<i>Pa Lon Fai</i>
Vietnamese	<i>Mam</i>	<i>Nuoc Mam</i>	<i>Mam (with local name of fish, eg. linh, sac, loc)</i>	<i>Ca Kho</i>	<i>Ca Xong Khoi</i>

Note: The words for fish paste are sometimes used generically to refer to any fermented fish.

The following section discusses the derivation of the conversion factors for preserved fish to FWAEs that are used in this report (Table 4 and Figure 3).

Preprocessing to edible portions

Conversion factors must correct for two steps, preprocessing of the fish to 'edible portions' and the subsequent process of preservation of the fish (drying, salting, smoking or fermentation). Preprocessing entails removal of some parts of the fish, with differences depending upon species and size. As the mixture of species and sizes is not known for the LMB it is necessary to assume an average loss from preprocessing. As for IFF (above) it was assumed that on average 20% of the weight of fish was discarded prior to the preservation process, with the exception

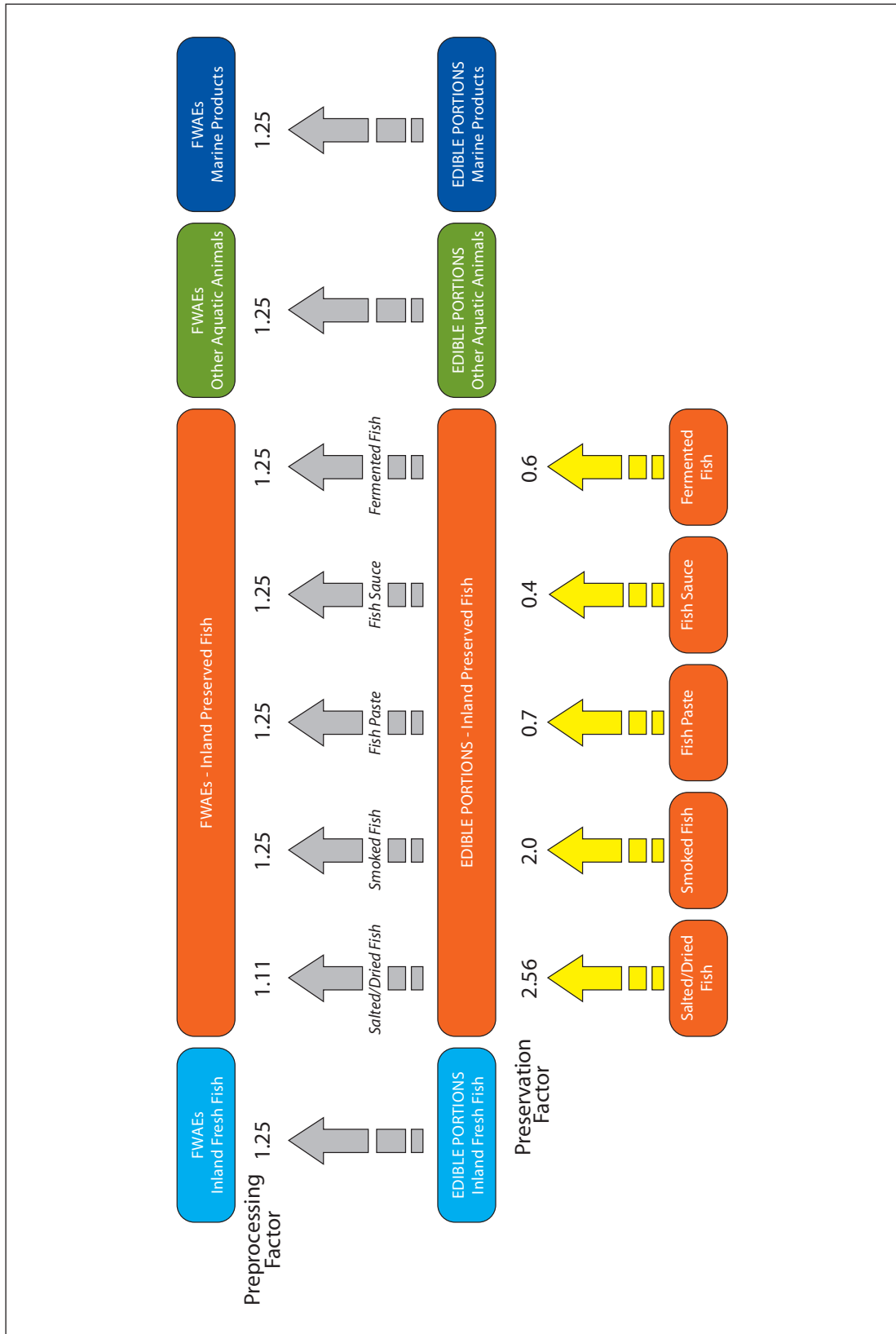


Figure 6. Conversion factors used to calculate FWAEs from preserved and edible portion weights of inland fresh fish, inland preserved fish, OAAAs, and marine products.

of dried or salted/dried fish where it was assumed that only 10% was discarded, because many small fish are processed whole. The preprocessing correction factors are therefore **x 1.25** (1/0.8) and **x 1.11** (1/0.9) respectively. The average protein content of 19.9% for edible portions from Mogensen (2001) was assumed to apply to the portions used for processing (see IFF discussion above).

Dried, salted-dried or smoked fish

For dried, salted-dried or smoked fish, conversion factors could be derived based on either moisture loss or protein content. In the LMB, dried or salted/dried fish products show highly variable contents of moisture (6.6–45.9%) (Puwastien *et al.*, 2000), so moisture loss is not useful for deriving general conversion factors.

Puwastien *et al.* (1999) also show that the mean (average) protein content of seven dried or dried/salted fish products from the LMB was 50.6% (range 38.5–63.0%), so the preservation factor is 2.54 (50.6/19.9), and after multiplying by the preprocessing factor (1.11) the overall conversion factor to FWAEs is **x 2.82**.

Ahmed *et al.* (1998) and Sjorslev (2000) used a factor of **x 2.5** for smoked fish, implying that less water is lost than during drying. This factor is similar to an FAO factor (2.3), so it was also used for this report (Figure 3 and Table 4). The preprocessing factor for smoked fish is assumed to be **x 1.25**, so the preservation factor is estimated as **x 2.0** (2.5/1.25) and the protein content is estimated as 39.8% (19.9 x 2.0).

Fermented fish products

Introduction

In humid tropical climates fish may dry very slowly (even in sunlight) so they begin to ferment, a natural process in which bacteria and enzymes in the fish break down the molecules that make up fish tissues (Saisithi, 1994). Fermentation involves two main reactions: firstly anaerobic decomposition of sugars in the fish, which produces lactic acid, a substance that preserves protein, and secondly, hydrolysis of protein, i.e. separation of the individual amino acids, which renders them soluble and also more digestible. This natural process is augmented by adding salt as a preservative, and has developed over many centuries in the LMB. For some products, fermentation is managed by adding a culture of micro-organisms. People of the LMB have acquired a taste for fermented fish products, and have developed many recipes by varying the types and sizes of fish used, the salt content and the processing time.

Fermented fish products can be divided into three basic groups as shown in Table 3 (Saisithi, 1994; Phithakpol *et al.*, 1995). The proportions of ingredients vary widely between different regions and producers, and the quantities of each type of product in the LMB are not known. Conversion factors for these products cannot be derived from moisture content, because

variable quantities of water are added or lost during processing. Protein content has been used for deriving conversion factors, assuming that little protein is lost during fermentation and that any protein added in other ingredients (such as rice) is negligible. An average preprocessing factor of **x 1.25** is also assumed because even small fish are not usually fermented whole (see preprocessing discussion above). Fermented fish products can be broadly classed as fermented fish, fish paste or fish sauce (Table 3), which are discussed separately below.

‘Fish Paste’

Fish paste is a concentrated form of fermented fish, separately itemised in some surveys. It is not ‘paste’ as commonly understood, but products where fermentation has digested the fish to the point where the form of the fish is no longer discernible. Fish paste is typically made from small fish such as the common small cyprinids (*Henicorhynchus* spp.). Preprocessing varies by species, some are used whole, some are headed and cleaned, and fatty species (*Henicorhynchus* spp. in particular) are kneaded or pounded to remove fat. Fish are mixed with salt, after some time liquid is decanted and may be used as fish sauce. The mixture is fermented, typically for three months to one year. In Lao PDR and Thailand a small amount of rice or rice bran may be added late in fermentation. Inland fish pastes have highly variable protein contents of 7.9–24% (Phithakpol *et al.*, 1995) and Suntornratana (2002, *pers. comm.*) also provided a figure of 24% for a fish paste from northeast Thailand. As the proportion of different quality fish pastes throughout the LMB is not known, a mid-range figure of 14% protein was assumed. This would imply a dilution during processing of 0.70 (14%/19.9%), which after applying the preprocessing factor (1.25) gives an overall conversion factor of **x 0.88**.

Other fermented fish

Other types of fermented fish products are usually made from larger fish that are gutted, and often beheaded and scaled, salt is added, and at some stage in the process small quantities of one or more of sugar, rice, fruit, herbs or spices are added (Saisithi, 1994). Unlike fish paste, in the final product the form of the fish is discernible.

Puwastien *et al.* (1999) showed that protein contents of six kinds of inland fermented fish products varied between 5.7% and 16.2%, and Phithakpol *et al.* (1995) reported a range of 3.3 –21.2% protein content for eight inland fish fermented products. Suntornratana (2002, *pers. comm.*) reported an average protein content of 14.8% for four samples from northeast Thailand. A low/mid-range figure of 12% gives a conversion factor **x 0.75** (12/19.9 x 1.25).

Fish sauce

To make sauce, inland fish is mixed with salt and usually fermented for about 5–18 months. Liquid decanted from the mixture provides a first-grade sauce. The remaining fish-salt mixture may be further fermented and extracted several times with brine to make different grades of sauce. Fish sauce may also be made from liquid that is decanted during the making of fish paste.

The protein content of fish sauce varies widely: about 2% (Phithakpol *et al.*, 1995), 2–11.6% (Puwastien *et al.*, 1999), 6.2% in the Songkhram Basin of northeast Thailand (Suntornratana, 2002) and 15.8% (Saisithi, 1994, Table 5.1). Processing methods and product characteristics vary greatly, and as for fish paste, the overall proportions of different sauces in the LMB are not known. A mid-range figure of 8% protein gives a conversion factor of **x 0.5** ($8/19.9 \times 1.25$), which has been used in this report. Mogensen (2001 p. 33) quotes one study in Cambodia that found that 10 kg of fish makes 8 L of sauce; this would give a factor of x 1.25.

Most fish sauce used in the Mekong Delta of Viet Nam and in Thailand originates from large processing plants for marine fish, but it appears that marine-derived sauce was either ignored or included within the marine fish component in field surveys, and fish sauce referred to inland fish sauce only. Only small quantities (or zero quantities) were recorded except for one inland province (An Giang, Study 15 in Chapter 4), where high usage of inland-derived fish sauce would be expected.

Summary and comparison of preserved fish conversion factors

Table 4 summarises the derivation of conversion factors for preserved fish. The figures used depend upon the assumptions made as discussed above.

Table 4. *Summary of the derivation of generic conversion factors for preserved fish to FWAEs. The overall factor is the weight of fish as FWAEs required to make 1kg of product.*

Product	Preprocessing factor	Protein content of final product (%)	Preservation factor	Overall factor FWAEs-processed	Edible protein as % of FWAEs weight
Salted/dried fish	1.11	50.6	2.54	2.82	17.9
Smoked fish	1.25	39.8	2.00	2.50	15.9
Fish paste	1.25	14.0	0.70	0.88	15.9
Other fermented fish	1.25	12.0	0.60	0.75	15.9
Fish sauce	1.25	8.0	0.40	0.50	15.9

Note: Preprocessing factor is the ratio of FWAEs to edible portions after cleaning (beheading, gutting etc.). Preservation factor is the ratio of protein content of final product to protein content of edible portions (19.9%). The overall factor is the preprocessing factor multiplied by the preservation factor.

The overall factors are in some cases different to those used in other studies (Table 5), which causes some differences in FWAEs figures. The factors used here are generic ‘best guesses’ from limited data and should be updated if better data become available or for specific cases. Factors were used as shown and final data were rounded.

Table 5. Comparison of conversion factors for preserved fish to FWAEs.

Product	Ahmed <i>et al.</i> (1998)	Sjorslev (2000)	FAO	This report
Salted/dried dish	2.5	3.0	3.5	2.82
Smoked fish	2.5	2.5	2.3	2.50
Fish paste	1.4	0.8		0.88
Other fermented fish	1.4	0.8		0.75
Fish sauce	0.8	0.1		0.50

Research to improve conversion factors for preserved fish should include:

- recipes for different kinds of preserved fish products;
- information on the proportions of different kinds of fermented fish products in different regions; and
- investigation of the extent to which protein is lost during preservation.

3.3 Conversion factors for inland OAAs and marine products

The term ‘OAAs’ includes all freshwater animals other than fish, including both vertebrates (aquatic mammals, amphibians, aquatic reptiles—including snakes, and water birds) and invertebrates (including molluscs, crustaceans and water insects).

Based on limited data reviewed in Chapter 4 (see also Table 23), it was assumed for conversion of OAAs to edible portions that frogs, shrimps and molluscs are generally eaten in about equal proportions by weight, so from the information in Table 6 it was estimated that the average edible portion of OAAs was 49% and the average protein content was 8.0% of the FWAEs weight.

Table 6. Conversion factors for edible portions of OAAs and percent protein in edible portions.

Taxon	% edible portions	% protein in edible portions	est. edible protein in whole animals
Frogs— <i>Rana</i> spp.	55	19.0	10.5
Shrimps— <i>Macrobrachium</i> spp.	70	15.6	10.9
Birds	71	20.6	14.6
Snakes	29	19.0	5.5
Crabs <i>Somanniathelphusa</i> spp.	38	10.7	4.1
Insects	54	12.4	6.7
Molluscs—Clams and Snails	22*	12.1**	2.7

Note: Data from Mogensen (2001), except: * factor for clams (www.fao.org), ** protein content of river snails from Puwastien *et al.* (1999).

3.4 Conversion factors for marine products (MPs)

The term MPs includes all products made from marine fish and other animals. In the LMB some common MPs are preserved fresh fish, mackerel (*Scombridae*), canned fish, some molluscs (including squids and octopi), and crustaceans such as prawns and crabs. Unfortunately, those studies that include reports of MPs do not also provide sufficient information to derive conversion factors for these products. Therefore, the reported weight was assumed to be FWAEs, and as for inland fresh fish, the weight actually eaten was assumed to be 80% of FWAEs weight, and the protein content was estimated as 15.9% of FWAEs.

3.5 Protein content of other foods

Some reports included data on the consumption of ‘other animals’, i.e. terrestrial animals, under categories as shown in Table 7, but with variable coverage of categories of ‘less conventional meats’. To convert the data to protein units it was assumed that protein content was the same as in flesh; people eat other parts of animals, but the bias introduced by using protein figures for flesh depends upon which parts are consumed; as no data were provided; clearly more information is needed on this aspect. Eggs were reported as numbers eaten and it was assumed that eggs weighed 50 grams each (a small size) when converting survey results to units of weight and protein. Some studies specified hen eggs, but an equal mixture of duck and hen eggs was assumed. For wild animals, as no data were available, it was assumed that protein content was 15%, which allows for losses during dressing and wastage of some parts.

Table 7. *Protein conversion factors for other (terrestrial) animals (from Puwastien et al., 1999).*

Conventional meats	% protein	Less conventional meats	% protein
Beef — average of 5 cuts	21.2	Fowl other (same as poultry)	19.0
Pork — tenderloin	21.8	Birds (same as poultry)	19.0
Chicken — matured dressed carcass	22.4	Buffalo (same as beef)	21.2
Duck — dressed carcass	15.5	Goat/sheep (same as beef)	21.2
Poultry carcass average	19.0	Dried meat (estimate)	50.0
Eggs, chicken	13.2	Reptiles/grubs (estimate)	15.0
Eggs, duck	12.6	Forest game/wildlife (estimate)	15.0
Eggs, average of chicken and duck	12.9	Insects (Mean of 13 insects)	15.0
		Others unspecified (estimate)	15.0

Only two reports included information on consumption of all foods, so this review only covers animal sources of protein. No attempt was made to convert terrestrial animal meat to FWAEs.