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Mekong River Commission

Socio-economics of the fisheries of the lower Songkhram River Basin, northeast Thailand

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Photographs: Ubolratana Suntornratana, Joseph G. Garrison, and Kent G. Hortle

Abbreviations and Acronyms

ASL	Above sea level
cls	Confidence limits
DCD	Dept of Community Development
DoF	Department of Fisheries
EIA	Environmental Impact Assessment
FWAEs	Fresh whole animal equivalent weights
kt	Thousand tonnes
LSB	Lower Songkhram River Basin
masl	Metres above sea level
OAAs	Other aquatic animals
SRB	Songkhram River Basin
TEI	Thailand Environment Institute

Summary

The Songkhram River is a large tributary of the Mekong River which runs through the northern part of northeast Thailand. The river system supports a large but previously undescribed capture fishery. This survey covered villages within the lower one-third of the Songkhram River Basin (SRB), where extensive wetlands are associated with the most productive fisheries.

The survey used two approaches (i) a census (by questionnaire) of all village leaders, to provide a broad coverage of the LSB, and (ii) a sample survey carried out by surveyors within 27 randomly selected villages that covered 353 households.

Key findings from the study are:

- While most land in the LSB has been modified for agriculture, principally for rice-farming, much of it still floods for at least one month each year, providing extensive habitat that supports natural fisheries production. Most village leaders responding to the census ranked fisheries as important or very important for food and income.

- Based on three different parts of the survey, between 80% and 93% of households fish part-time and about 3–6% fish commercially. Most households can be classed as rice farming and part-time fishing households. Farming and labouring were the most important activities for household income. Males and females both engaged in a range of occupations. Gender differences include: about 74% of part-time fishers were male, about 60% of fish processors were female, about 92% of handicraft workers were female, and about 89% of government workers were male.

- Fishing is primarily for household food supply, but about 28% of households reported that they sold wild fish, about 3% sold aquaculture-products, and about 13% made money from other fisheries-related activities.

- Modern gears such as cast nets, gillnets and hooks were most commonly used, but traditional gears such as small traps were still widespread.

- Swamps, rice fields, rivers, reservoirs and streams produced most of the estimated annual catch. Catches were very large relative to effort in small streams, swamps, rivers and natural lakes, showing the importance of these natural habitats, and catches were low relative to effort in rice fields, the most extensive habitat. Nevertheless, rice fields are likely to contribute to fish production by providing temporary feeding areas with fish caught later in refuge habitats.

- In 'most-recent catches', during the dry-season, fishers reported 56 species of fish and 8 taxa of OAAs. Only two species (of fish) were exotic and both made up a small proportion of catches. About 93% of the catches comprised fish and 7% comprised OAAs. The fish catch comprised about 62% grey or white fish and 37% black fish (with 1% unidentified), showing the importance of rivers and streams to the fishery. About 37% by weight of the fish catch comprised carnivores, 42% comprised omnivores and 21% herbivores. The diversity of the catch reflects a diversity of habitats and may indicate a resilience to fishing pressure.

- Fishing is most intense during the wet season. During this season consumption of fresh and smoked fish is also higher than during the dry season. The quantities consumed of other kinds of preserved fish as well as other meats appears to be fairly constant through the year. Most fish and OAAs are caught by households for their own consumption (74.4% on average) and the remainder is purchased.

- Households appear to regulate their day-to-day consumption by preserving catches and by buying and selling for their daily needs. Household food supply/demand balance and seasonality would be interesting subjects for further study.

- A household catch estimate of 207 kg/year can be extrapolated to a lower Songkhram River Basin (LSB) catch of 34.3 (95% cls 26.2–42.4) thousand tonnes per year. A household consumption estimate of 249 kg/year balances with the catch estimate, after allowing for aquaculture of 22 kg/household/year and imports, and is well within the precision of the data. For the entire LSB, consumption is estimated at 41.2 (95% cls 35.6–46.8) thousand tonnes per year. Extrapolation from the most recent catches (short-term recall) gave an estimate of 203 kg/household/year, remarkably similar to the estimate from long-term recall of 207 kg/household/year.

- Based on catch estimates, the yield per unit area is estimated at about 80 kg/ha of wetlands, which are mainly rice fields. This mean estimate is well within ranges for rice field/floodplain habitat reported elsewhere. The yield would vary by habitat, e.g. flooded forest may have above-average and rice fields below-average yield, but there is insufficient information to discriminate yield by habitat.

- Most village leaders believed that the fisheries situation had worsened recently. Most attributed this to increasing fishing pressure or habitat degradation. Habitat improvement or stocking of natural water bodies were the measures most supported as ways to improve fisheries, with few supporting aquaculture.

The survey showed clearly that fishing is of considerable importance for people living in the lower Songkhram River Basin, despite rice farming being the main full-time occupation. Typically, households include rice-farmers and part-time fishers, but the importance of fishing is under-recognised officially.

Despite extensive modification of the landscape, the wild capture fishery, which depends upon remnant natural habitats and the natural flood-pulse, continues to contribute most of the household intake of animal protein. The importance of the capture fishery to nutrition should be given appropriate weight in government policy on development within the LSB. The nett benefits of increasing agricultural yields from privately-owned farms are likely to be reduced if such improvements negatively impact fisheries, which are a common-property resource. In some other parts of northeast Thailand farmers appear to maintain a similar level of inland fish and OAA production and consumption to that estimated for the Songkhram. In such areas, farmers compensate for the loss of natural fishery production by building trap ponds for wild fish (which provide dry-season refuges and also increase catch efficiency) and also by engaging in aquaculture, although aquaculture appears to be relatively unproductive compared with capture fisheries.

Consumption of inland fishery products is about 25% higher in the LSB than in northeast Thailand generally (50.3 kg/person/year compared to 40.5 kg/person/year as FWAEs), but consumption of marine products (average 5.8 kg/person/year) reduces this difference to only 9%. LSB consumption of inland fishery products is about 11% higher than the LMB average of 45.5 kg/person/year.

This survey highlighted some methodological issues that should be considered in similar studies in future. Among these, censuses should seek minimal, preferably categorical information, and should be followed up with a survey of non-respondents. Survey design should include consideration of stratification (based on census data) to reduce variance in some highly skewed data, as is typical for catches and aquaculture production.

Recommendations

The following recommendations from the findings of this study are presented as suggestions to agencies with an interest in the lower Songkhram River Basin.

- The Department of Fisheries could consult with villagers regarding the specific measures that the villagers support to enhance fisheries near their villages, and also consult with water resources and other agencies on specific projects, for example to enhance aquatic habitats for fisheries.

- It would be very useful for the Department of Fisheries to monitor the effects on fisheries of any habitat enhancements or impact mitigation that are undertaken, particularly considering that there is a paucity of relevant information for the lower Mekong Basin.

- Water resources planning should take into account the importance of capture fisheries in the lower Songkhram River Basin. In particular, control of flooding and blocking of migration routes are likely to lead to negative effects on fisheries, so these should be avoided unless their benefits demonstrably outweigh their negative impacts. Mitigation

and management of impacts on fisheries should be a priority in water management planning.

- Villagers should be supported to implement fisheries regulations, such as closed seasons, conservation zones, and through co-management with the Department of Fisheries.

- Repeating key parts of this study (particularly a random household survey) at 5-year intervals would provide a very useful monitor of long-term trends in fisheries. Any future surveys should focus on improving precision by stratification and optimising sample sizes.

- Any future studies of catch and consumption should use standardised categories, and in particular should include fresh fish and OAAs, with OAAs separated into categories (see Hortle, 2007).

- Quantities that are estimated from studies based only on interviews are subject to unknown biases, so interview data should be compared to actual monitoring data wherever possible.

1. Introduction

1.1 Inland fisheries in Thailand

Thailand is one of the economically better-developed countries of southeast Asia, and inland fisheries are of considerable importance, both within the formal economy and for subsistence. Fisheries have been important for hundreds of years, but fisheries management was first formalised in 1926 when the Department of Fisheries (DoF) was founded (Pawaputanon, 2003). Inland fisheries in Thailand are based on three categories of water body:

1. reservoirs and irrigation ponds;

2. village ponds with common access;

3. natural water bodies, including rivers, swamps and canals.

The total surface area of inland aquatic habitats in Thailand is about 45,000 km^2, of which rivers and other natural water bodies constitute 41,000 km^2 and large reservoirs cover about 4,000 km^2. However, in many natural river systems, fisheries production takes place primarily on annually flooded areas (Welcomme, 1985), which are not recognised officially as aquatic habitats. Based on the MRC GIS dataset, the total area of wetlands in northeast Thailand alone is about 86,734 km^2, of which about 96% is classed as rice fields or other seasonally flooded agricultural land.

In Thailand prior to the 1960s floodplains contributed very significantly to inland fisheries production, but the majority of floodplain/wetland habitats no longer experience prolonged flooding because river flows are regulated by dams, which also block fish migration. On the other hand, much former floodplain or low-elevation forest habitat has been converted to rice fields, which are inundated in a controlled manner each year. Rice fields are managed wetlands from which many kinds of fish and other aquatic animals are harvested, but there is little accurate information on the size and value of such rice field fisheries.

Official statistics on inland capture fisheries in Thailand are based on recall by local officials and/or professional fishermen of catches over a one-year period (Coates, 2002). The number of fishers and average catch are estimated in order to calculate total annual inland catch, which in 1999 was estimated at 206,900 tonnes (Pawaputanon, 2003). The reported catches are based upon commercial fisheries in lakes and reservoirs, whereas catches from other natural water bodies (rivers, floodplains, swamps and seasonally flooded rice fields), as well as all subsistence catches are omitted, so the importance of capture fisheries is likely to be grossly underestimated.

There may be as many as 10 million people in rural areas who engage in subsistence fishing A conservative catch estimate of 20–50 kg/person/year would imply a total subsistence catch of 200,000–500,000 t/year, a very significant addition to the official statistics of between 122,314 and 318,909 tonnes caught in reservoirs in 1999 (Coates, 2002).

1.2 Location and geography of the Songkhram River Basin

The catchment of the Mekong in northeast Thailand covers about 184,000 km^2, which is 36% of the area of the country and 23% of the Mekong's total catchment. Northeast Thailand contributes around 18% of the mean annual discharge (15,060 m^3/s) of the Mekong, mostly from the Mun-Chi River system (MRC, 2003 p. 16). The Songkhram River is the second-largest system in northeast Thailand with a mean discharge of about 300 m^3/s or about 2% of the total discharge of the Mekong. The Songkhram River Basin (SRB) covers 33 districts (Amphoe) and has a total area of around 13,128 km^2.

The Songkhram River rises at an altitude of 300 masl in Sakhon Nakhon Province, then flows about 430 km eastwards through Udon Thani, Sakhon Nakhon, Nong Khai and into the Mekong River at Ban Chai Buri in Nakhon Phanom province (Figure 1). Much of the catchment comprises flat plains, 140–200 masl, typical of the Khorat Plateau. The catchment was formerly forested with tropical deciduous or monsoon forest, but most has now been cleared for agriculture; about 39% of the catchment is farmed for rice and the remainder for upland field crops, with some remnant forest land (Blake, 2006). Wetlands, including rice fields, cover about 54% of the catchment and are concentrated along the lower part of the basin (Blake, 2006; refer also to Table 1 below).

At the time of this survey, the Songkhram River was the only large river in northeast Thailand that did not have a dam along its mainstream, although it had some dams on its tributaries (Figure 1). The state of the environment and fishery along this river's lowland reaches probably indicate to some extent how conditions may have been in other Mekong tributaries if they had not been dammed. Two small dams have been built within the last five years in the middle Songkhram River (Blake, 2006), but the lower Songkhram River flows undisturbed to the Mekong. Consequently, flows still follow the natural seasonal pattern in which wet-season flows are much greater than dry-season flows (Figure 2).

Despite wide seasonal variations in flow and water quality, compared to elsewhere in northeast Thailand, the climate is wetter (rainfall is about 1700–1990 mm/year compared with about 1,200–1,300 elsewhere) and more predictable each year. Mean flow at Ban Tha Kok Daeng (which is downstream of about 36% of the catchment) is 115 m^3/s, but the average minimum flow is only 0.05 m^3/s and the average maximum flow is 533 m^3/s (MRCS/WUP-FIN, 2006); the mean flow from the entire catchment is about 300 m^3/s. In the wet season the level of the river increases until it is up to 13 m higher than in the dry season (Figure 2), primarily because of backing-up caused by Mekong River flows.

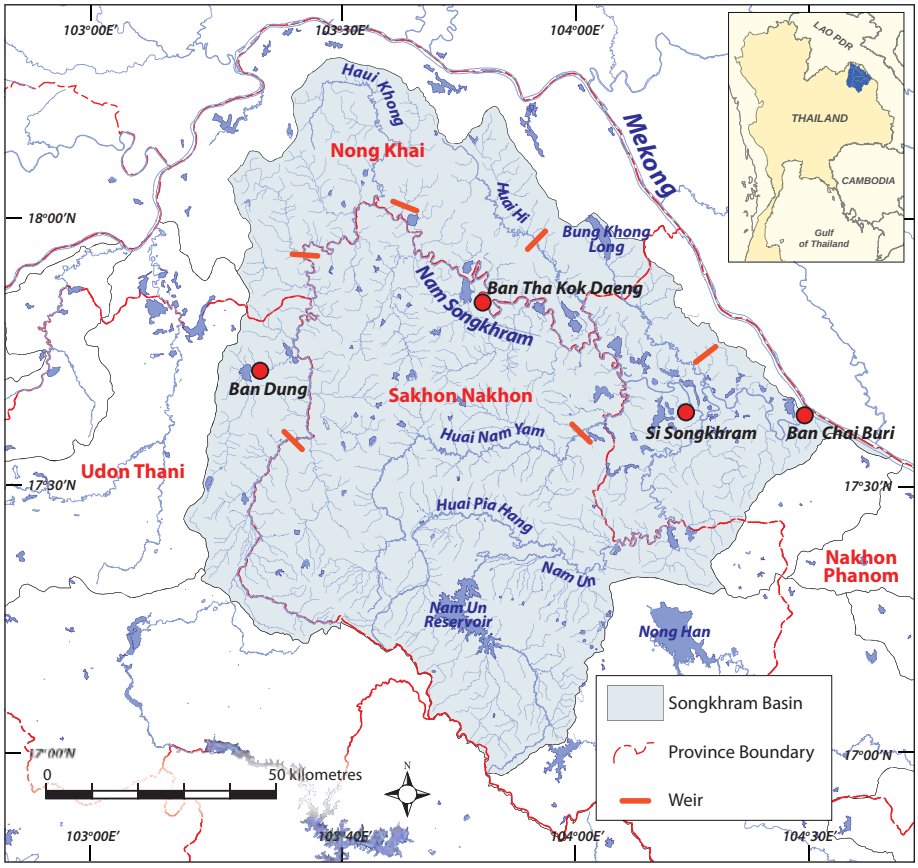

Figure 1. The Songkhram River catchment in northeast Thailand.

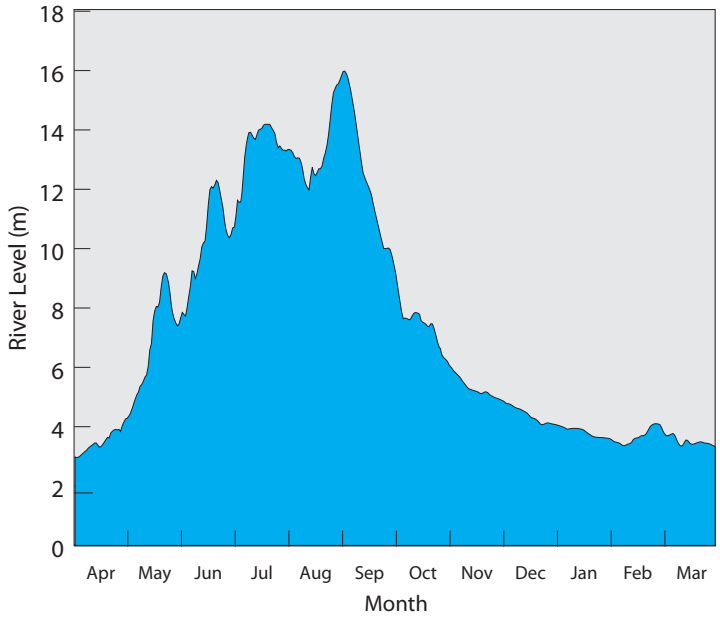

Figure 2. Daily levels of the Songkhram River in the year 2000 near the confluence with the Mekong.

This large increase in water level is a consequence of the increased flow from the river's catchment, as well as 'backing-up' by the rising Mekong River waters. In years when the rise in the Mekong's level precedes the rise in the Songkhram River (approximately one year in two) Mekong water flows into the Songkhram River as far as 126 km upstream, bringing in fertile silt that is deposited later on flooded areas (Blake, 2006). Each year the rising waters inundate about 1,000 km^2 of land on average, and up to 2,000 km^2 during a 1-in-50 year flood event (Blake, 2006).

1.3 Population and economic activities in the Songkhram River Basin

The SRB covers 33 districts of Sakhon Nakhon, Udon Thani, Nong Khai and Nakhon Phanom provinces and was home to about 1,940,572 people in 412,966 households in 2000. There are almost equal numbers of males and females in the basin. Officially, most of the local people (92%) earn their main living from agricultural activities and only 4.9% of the local people officially earn their main income from fishing (DCD, 1999). However, these statistics are misleading as they do not include secondary occupations such as fishing, which contribute significantly to family income and subsistence. Moreover, apart from the fishery, many common-property resources are officially unrecognised but are heavily utilised for food, subsistence and income. These include bamboo shoots, mushrooms, vegetables, medicinal herbs, wildlife, building materials, and even earthworms, which are a significant export from the LSB. Blake (2006) discusses in detail these resources and their dependence on the natural flood-pulse.

1.4 Fisheries in the Songkhram River Basin

The disparity between official statistics on inland fisheries and actual catch is likely to be of particular relevance to the SRB. Because the Songkhram River has no dams along the lower part of its mainstream there are large areas of natural water-bodies for fishers to exploit and the movement of fish and OAAs is not obstructed. Fishing in rivers and swamps is likely to be particularly under-recognised in the Songkhram River Basin, compared with river systems that have been dammed and now experience reduced flooding and barriers to migration.

The productivity of the Songkhram fishery has encouraged people to settle near the river and its tributaries. In an EIA for a dam in the lower Songkhram River, Khon Kaen University (1996, 1997) reported that villagers from more than 150 villages along the 10 km of the lower Songkhram River Basin were involved in fisheries all year round, with accessible fishing grounds varying according to the season. Remnant flooded forests (*paa boong-paa thaam*) are important and productive habitats. Kasetsart University (1996) reported that the total area of fishing grounds in the SRB was about 48,485–66,158 ha, comprising 43% reservoir, 52% public water body and 5% village fishing pond (there were very few fish culture ponds), but

these figures do not include the large areas of seasonally inundated land that are a major source of fisheries productivity.

Flooded areas provide habitats for spawning, feeding and growth of fish and other aquatic animals (OAAs). The fish and OAAs are within three general assemblages: floodplain species (including 'black fishes'), in which broodstock survive on the floodplain in residual water bodies or as resting stages, resident Songkhram fish and OAAs that migrate laterally (including 'grey fishes'), and fish from the Mekong that migrate in to spawn and feed in the Songkhram River system; these include many species of 'long-distance' migratory (or 'white') fishes. At the end of the rainy season (around October) fish and OAAs migrate *en masse* back to the Songkhram and Mekong Rivers (Suntornratana *et al*., 2002).

The Songkhram River is one of the most important river systems in northeast Thailand, and plans for an extensive water management scheme have been proposed for some years. The scheme would aim to improve irrigation and control floods and would include a floodgate close to the river mouth at Ban Tanpaknam. The floodgate would directly affect the Mekong species that migrate into the Songkhram River every year to breed and feed. Because the annual flood prevents some areas of fertile land in the basin from being fully cultivated it is perceived by some that there is a trade-off in maintaining the system's capture fisheries, so it is important to attempt to quantify their importance and value so that rational decisions can be made on future water resources management.

1.5 Objectives of the Study

The overall objective of this study was to obtain and disseminate accurate information on inland fisheries of the lower Songkhram River.

The main aims of the survey were:

- to test and compare census and sample survey methods for obtaining fishery data;
- to determine the importance of fisheries for food, for the local economy, and for local people's culture;
- to quantify household and individual involvement in fisheries, as well as catches and types of fishing gears used;
- to quantify the yield of capture fisheries by habitat and to estimate fisheries production of the Songkhram River Basin; and
- to prepare a summary report and database for public distribution.

Fisheries in this report covers all production of fish, as well as other aquatic animals (OAAs), which include aquatic vertebrates (amphibians, reptiles, mammals and birds) and aquatic invertebrates (e.g. crustaceans, molluscs and insects).

The results of this study have been partly reported by Sjorslev *et al*. (2001) but their preliminary report was based on an assessment of data 'as received' and provided only a partial coverage of the information obtained during the survey. This report is based on data which has been checked for omissions or inconsistencies, and provides a more accurate and complete presentation of the information derived from the survey.

2. Methods

2.1 Study area

The study aimed to cover the lower Songkhram River Basin, which has the most extensive wetlands in the basin. The Songkhram River Basin and its sub-basins and districts were mapped using GIS data from the Thailand Environment Institute (TEI) 'Thailand on a Disc' produced in 1996. The study area was delineated as the lower Songkhram River Basin, 68 sub-districts that are within about 50 km of the confluence with the Mekong (Figure 2).

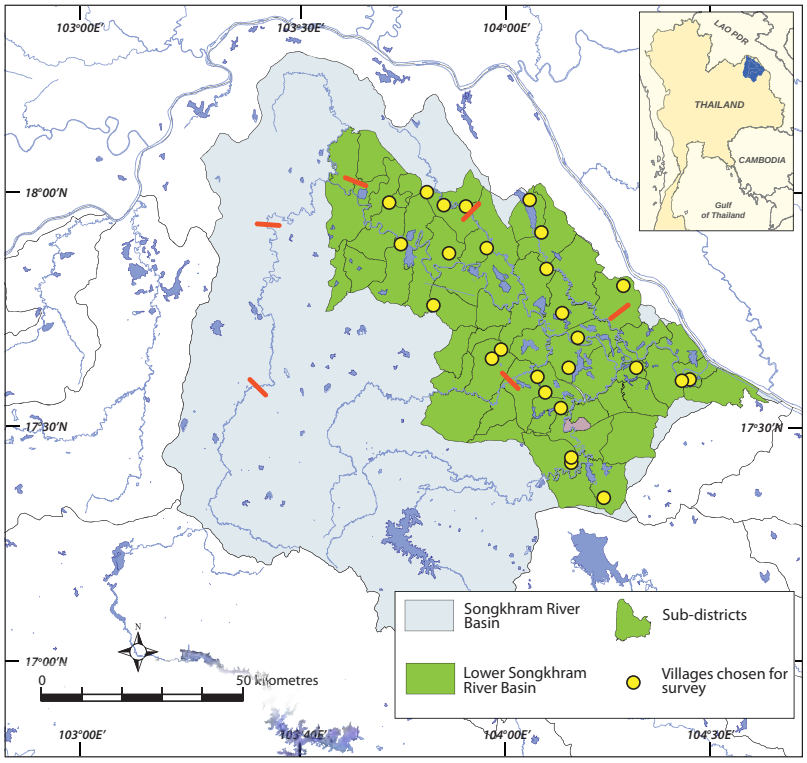

Figure 3. The study area within the Songkhram River Basin.

As it is delineated by administrative boundaries, the LSB boundary only approximately follows the boundary of the catchment of the Songkhram River. The LSB covers an area of 4,900 km^2 or about 37% of the area of the Songkhram River Basin of 13,128 km^2. The study results should not be directly extrapolated to the rest of the basin, where fisheries are likely to be somewhat less important than in the area covered by this study. According to GIS data, 88.7% of the LSB can be classed as wetlands, most of which is rice fields (Table 1).

The sample survey aimed to obtain more detailed information on all aspects of household income and livelihood, and to quantify those aspects that related to fishery activities in terms of their degree of participation. Basic information on the sample villages is provided in Appendix 1. This survey was carried out by interviewers using questionnaires, and comprised three separate surveys: village, household and individual.

- *Village sample survey*: not to be confused with the village-level census discussed above; in this survey 27 villages were randomly selected and information was obtained by face-to-face interviews with village chiefs and other village leaders, who also participated in sketching maps of fishing habitats near each village.

- *Household sample survey*: selection of households depended on the size of the village. Up to 10% of households were randomly sampled, but not more than 20 households per village. A total of 353 households were sampled. The household head or other adult household member provided information.

- *Individual sample survey*: two or three individuals over five years of age were interviewed from each of the 353 households; this interview sought detailed information about individual fishing activities. A total of 361 males and 180 females were interviewed; males dominated because all household heads were interviewed for the individual survey.

The sample survey was carried out from January to December 2000. The survey teams first visited the village leaders and explained the objectives of the study and the interview schedule. Each survey team consisted of two people, one of whom interviewed while the other filled in the form.

Data analyses

Data were stored in Microsoft Access. After checking databases against datasheets, data which showed logical errors were checked and corrected where possible, or deleted from databases prior to analyses. Data were analysed using Excel and SPSS.

For the census, the results were analysed as if representative of the total population, including non-respondents. Means and confidence intervals were calculated assuming that the villages were a random sample of all villages in the LSB. Confidence intervals for categorical data were calculated using the standard formula for binomial proportions (Snedecor and Cochrane, 1989, p.121).

For the sample survey, villages were randomly selected, so responses by village leaders were analysed as representing a simple random sample of 27 villages of the 776 in the LSB. For the household survey, the design was clustered random (i.e. 353 random households clustered within the 27 randomly selected villages), so summary data were calculated using the complex

samples module in SPSS. Complex sample analysis takes account of both the proportional weighting of samples within clusters for estimation of means, as well as the number of samples in total and the numbers within clusters for estimation of means and confidence intervals.

To extrapolate from the sampled population to the entire lower Songkhram River Basin, arithmetic means for the sampled households were multiplied by the total number of households in the LSB. To estimate precision, 95% confidence intervals of the means were calculated, with precision expressed as relative error, i.e. half of the 95% confidence interval divided by the mean. Standard symmetric confidence intervals were calculated in all cases, so for some highly skewed data (e.g. for catches) the confidence intervals should be regarded as approximate. Some authors have recently begun to address the problem of estimating accurate confidence intervals for skewed populations (Andersson, 2004), but the procedures have yet to become routine and were not applied for this study.

3. Results from village-level census

3.1 Introduction

Forms were returned from 447 or about 58% of 776 villages, a very high proportion considering that participation was voluntary. Unfortunately, forms were filled incompletely by many village leaders, and in particular questions involving numbers of households (fishing part-time, full-time and non-fishing) in many cases were either misunderstood or filled incompletely so that data did not balance. In such cases, the results were excluded from analyses. The number of villages used for each analysis is shown in summary tables and figures.

The results have been used to describe some key aspects of the fishery by assuming that the responses were representative of all villages in the study area, including non-respondents as well as those who entered incomplete or illogical responses. The assumption of representativeness should be tested in any future surveys by allowing for a random sampling of non-respondents.

3.2 Village and household size

Table 2 shows basic data on village and household size according to village leaders. Mean household size was slightly larger than the average size according to the census for the LSB.

Table 2. *Basic data on number of households per village and household size according to village leaders.*

In 240 villages that returned complete data

	Total	Mean/village	95% confidence interval	Min.	Max.
Households	32,182	134	125–143	22	411
Persons	166,500	694	643–744	95	2,417
		Mean	95% confidence interval	Min.	Max.
Persons/household		5.17	5.05–5.30	3	10

In the lower Songkhram River Basin, according to the census

Villages	776
Households	165,554
Persons	794,516
Mean/household	4.8

3.3 Importance of fisheries

Fisheries represent a supplementary livelihood in the LSB, as local people generally consider themselves to be farmers, with fishing as a part-time activity. Nevertheless, fisheries were ranked as important or very important for income by about 89% of village leaders (Figure 4) and as important or very important for food by about 99% of village leaders (Figure 5) and no village leaders ranked fisheries as unimportant for food.

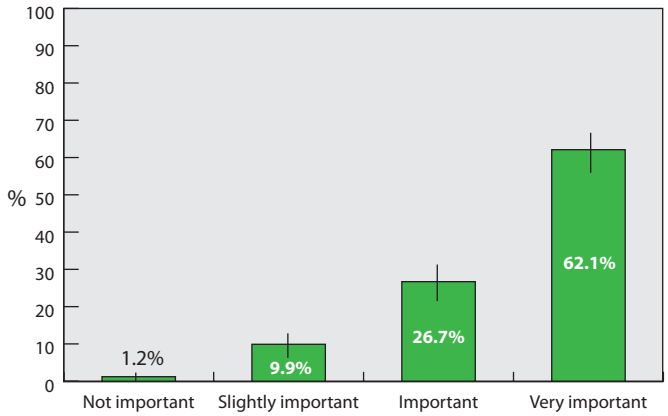

Figure 4. Village leaders' ranking of the importance of fisheries in their village for people's income. N=322. Histograms and data labels represent mean percentages and bars represent 95% confidence intervals.

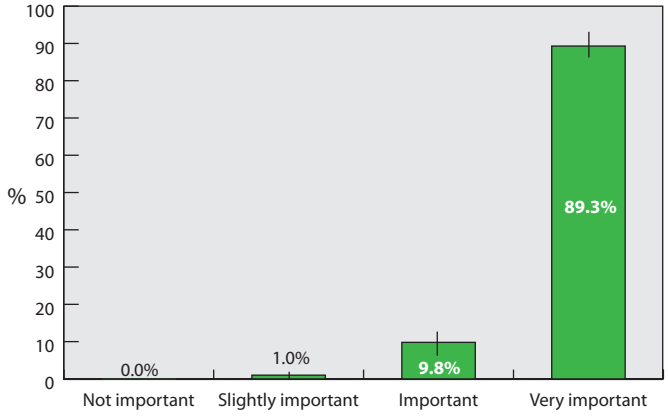

Figure 5. Village leaders' ranking of the importance of fisheries in their village for people's food. N=410. Histograms and data labels represent mean percentages and bars represent 95% confidence intervals.

Most households engage in part-time fishing; about 6% of households fish commercially for their main income and only about 19% of households do not have any members that ever go fishing (Figure 6). About 16% of households also sell fishery products part-time; although this

Table 1. *Wetland areas in the lower Songkhram River Basin.*

Category	Area (km^2)	Percent
Water bodies	119.7	2.8
Rice fields	2,899.5	66.7
Other seasonally flooded land	1,325.8	30.5
Total	4,345.0	100.0

Note: Rice fields include small areas of permanent water that are not discriminated by GIS.

2.2 Framework of the study

The survey was based on interviews conducted at two main levels:

- *a village-level census* that aimed to collect general data from all of the villages inside the study area; this approach provided a wide coverage, but with limited control on data quality; and

- *a sample survey* that aimed to collect detailed information from a sub-set of randomly-selected villages[1]; this approach used trained surveyors to produce more detailed data of better quality but with less coverage.

The village-level census was based on a four-page questionnaire distributed to all villages in the districts in which sample sub-districts (tambons) were located (Appendices 1 and 2). Survey staff explained and distributed the survey forms to village leaders at monthly meetings, which are held at sub-district level. Completed forms were returned by post from each village leader directly to the DoF office. The survey forms were given to 776 village leaders in 68 sub-districts of 11 districts.

The issues addressed by the census included:

- types and number of gears, numbers of full-time and part-time fishing households;

- importance of fisheries for subsistence and income;

- situation of the fishery over the last five years, and;

- community fisheries-based management.

The census was conducted from May to August 2000.

1 Sample selection was by Microsoft Access 1997 Strategy.

figure is perhaps an underestimate as many village leaders entered zero or a blank in this part of the questionnaire, despite noting a large number of part-time fishers in their villages.

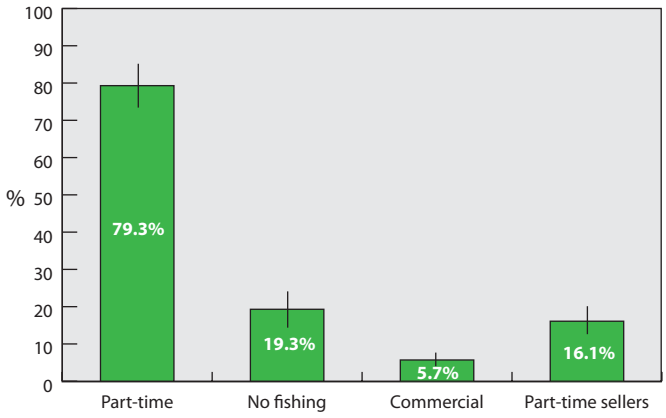

Figure 6. Mean percentage of households said by village leaders to engage in fishing and part-time selling of fishery products.
N=267. Bars are 95% confidence intervals. On average, of the 5.7% commercial fishing households, 4.3% were also recorded as having part-time fishers, so the totals sum to 104.3%.

Clearly, part-time fishing is an important supplementary activity in the LSB and commercial fishing is also of importance, providing exports from the LSB as well as providing for other households, particularly the 19% in which people do not fish.

3.4 Changes in fisheries

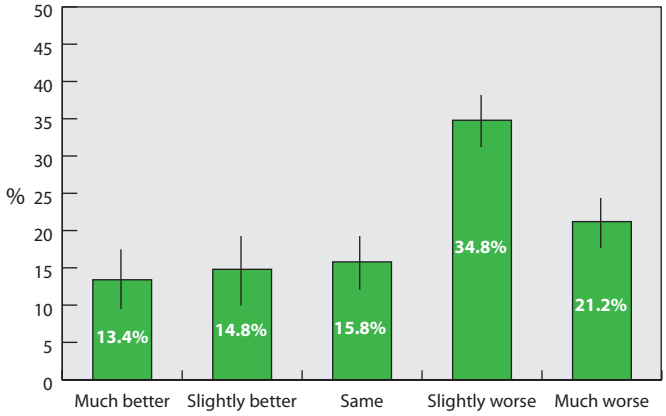

Figure 7. Village leaders' views on changes in the fishery over the last five years.
N=411.

When asked how their village fisheries had changed over the last five years, 56% of the responding village leaders reported that the situation had worsened, while only about 28% felt their fisheries were better, indicating on average a perception of worsening of the fisheries situation (Figure 7). These responses are subjective, but can probably be regarded as indicative of general trends in fisheries, at least in terms of catch per fisher.

Of 365 villages that felt the fishery had either become worse or become better over the last five years, 248 (about 68%) provided a reason under the comments section of the questionnaire; of these, 22 villages provided 2 reasons. The reasons were grouped by categories as in Table 3. Where fisheries were said to be better, the most common reason was that people were making more money; higher prices were mentioned by some respondents, but improved returns would also be consistent with more fish being caught overall in some villages. Possible reasons for higher catches would include the other quite plausible reasons mentioned, including habitat improvements, aquaculture and stocking.

Table 3. *Summary of reasons given by village leaders for changes in fisheries over the last 5 years. Most villages gave one reason (1st reason) while 22 gave two reasons.*

Fisheries became better

Summary of reason	1st reason	2nd reason	Total	% of total
Economics - prices higher or better profit	35	1	36	54.5%
Habitat improved, e.g. by dredging swamps and building dams or weirs sponsored by DoI and DoF	12		12	18.2%
Aquaculture, usually with DoF assistance	5	1	6	9.1%
Stocking by DoF	5		5	7.6%
Conservation/management of fish stocks	2	1	3	4.5%
Improved gear or methods	2	1	3	4.5%
Less fishers - migrated elsewhere for work	1		1	1.5%
Total	62	4	66	100.0%

Fisheries became worse

Summary of reason	1st reason	2nd reason	Total	% of total
Less fish and/or more fishers	116	7	123	60.3%
Habitat change, e.g. siltation and shallower water bodies	41	4	45	22.1%
Over-fishing in spawning season	8	3	11	5.4%
Illegal gear use	6	1	7	3.4%
Economics - costs rising, prices falling	5		5	2.5%
Diseases of fish seen in the wild	4	2	6	2.9%
Aquaculture production less	1		1	0.5%
Climate worse with less rain in dry season	1		1	0.5%
Dams prevent fish migration and spawning	1		1	0.5%
No money and knowledge for fishing	1		1	0.5%
Pesticides killed fish	1		1	0.5%
Pollution killed fish	1		1	0.5%
Border problem for village		1	1	0.5%
Total	186	18	204	100.0%

Most of the village leaders who reported that fisheries were worse also noted that there were less fish and/or more fishers. This ambiguous response might indicate lower catches per fisher (a logical cause of dissatisfaction) but does not preclude total catches being larger, a common situation as fishing pressure increases. Among the reasons for a reduction in fish catches, it is very interesting to note that habitat change was the most commonly cited, and problems related to fisheries management were secondary. Given that habitat improvement was also the most common measure noted to improve fisheries (where fisheries were said to have become better) there is clearly awareness by many villagers of the importance of habitat and the possibility of improving fish production by improving habitat. The villagers' perception of the importance of habitat is consistent also with their recommendations to the DoF as discussed below and summarised in Table 4.

As well as estimating the current (Year 2000) number of commercial fishing households, village leaders were also asked to estimate the number of commercial fishing households operating in their village five years ago. Excluding those villages in which there were no commercial fishing households in 2000 and also none five years previously, the mean number of commercial fishing households per village in 2000 was 27.2 and the mean for the estimates from ten years previously was 25.8, based on 124 villages. Although there was an apparent slight increase in the number of commercial fishing households, the difference was not significant (paired t-test, $p = 0.34$), so there is no basis for claiming any change in the number of commercial fishing households.

3.5 Community fisheries-based management

Many of the communities in the LSB have set up their own community-based fisheries management programmes. Fisheries regulations were reported to have been set up by 217 (48.5%) of the sample villages. Many of the other villages left this section of the form blank, so it is possible that some of these did not respond to the question and the percentage is actually higher. The main measures noted included:

- 'No fishing' or conservation areas, usually near the village in public water bodies;
- Closed season, usually specified as the beginning of the wet season when fish spawn;
- Restrictions on use of some gears, such as large trawls and seines, and illegal gears such as electrofishers, explosives and poisons.

Village leaders were also asked about their ideas for improvement of village fisheries management in an open-ended format, i.e. they could respond in any way they wished. Their responses are summarised as shown in Table 4. Most suggestions were preceded by 'the DoF should …'; because the questionnaire originated from the DoF the villagers were clearly directing their suggestions to the DoF. The majority of suggestions for improving fisheries related to wild capture fisheries, and overall most suggestions related to improving habitat or

to stocking. There were relatively few requests for support for aquaculture or training or other forms of assistance. These results should be considered carefully in the light of prevailing government policies which heavily favour aquaculture. There is also a need for the DoF to coordinate with other agencies that are directly responsible for the water and habitat. Villagers may not necessarily have the best ideas for improving fisheries, but their beliefs will certainly influence the success of any management strategies that government agencies attempt to implement.

Table 4. *Summary of suggestions by village leaders to improve fisheries.*
N=295. Up to three suggestions were made by each village so there were 384 suggestions in total.

Suggestion	First	Second	Third	Total	Percent
Improve fish habitat by improving water flow to shallow swamps, making weirs or raising existing weirs	123	3	3	129	33.6%
Stocking natural water bodies with fry	54	27	3	84	21.9%
Closed season during spawning season	25	7		32	8.3%
Set up conservation areas for wild fish	20	6	1	27	7.0%
Illegal gear control or enforcing regulations	16	15	3	34	8.9%
Control catching of fry	1			1	0.3%
Control damage to flooded forest	1			1	0.3%
Control pollution		1		1	0.3%
Investigate and control disease in wild fish	1			1	0.3%
Stop outsiders fishing	1			1	0.3%
Sub-total relating to wild fishery	242	59	10	311	81.0%
Aquaculture support including fingerlings or broodstock	32	9		41	10.7%
Make ponds for aquaculture	5	5	1	11	2.9%
Sub-total relating to aquaculture	37	14	1	52	13.5%
Set up market or provide fish trader	1	4		5	1.3%
General training in fisheries management	14			14	3.6%
Subsidise gears for catching fish	1			1	0.3%
Support for management		1		1	0.3%
Sub-total other	16	5	0	21	5.5%
Grand Total	295	78	11	384	100.0%

3.6 Fishing gear information

Village heads were asked to estimate the number of gears in their villages used by both part-time and full-time fishing households. Unfortunately some villagers entered all data on gears in either the part-time or full-time categories, so it was not possible to treat full- and part-time households separately. Moreover, some villagers reported extremely high estimates for numbers of gears that, when converted to mean gears per household, did not seem consistent with those obtained during the household survey, in which a detailed on-site check and discussion with household members is likely to have led to reasonable figures. Hence the results of the census of gears are presented in Figure 8 only as a frequency of occurrence in villages.

There were 37 kinds of fishing gear recorded, within 11 main categories. Several kinds of gear were widespread and found in most villages (Figure 8). Among these, cast nets, gill-nets and hooks are made from mostly imported components and are commonly sold throughout the region, whereas scoop-nets and small traps are locally made and are also widespread but are generally owned in smaller numbers as discussed in the household survey results. Complete data are shown in Appendix 2. Within the broad categories shown in Figure 8, large-scale fishing gears such trawls, arrow-shaped traps and big lift nets were present in relatively few villages as might be expected (Appendix 2).

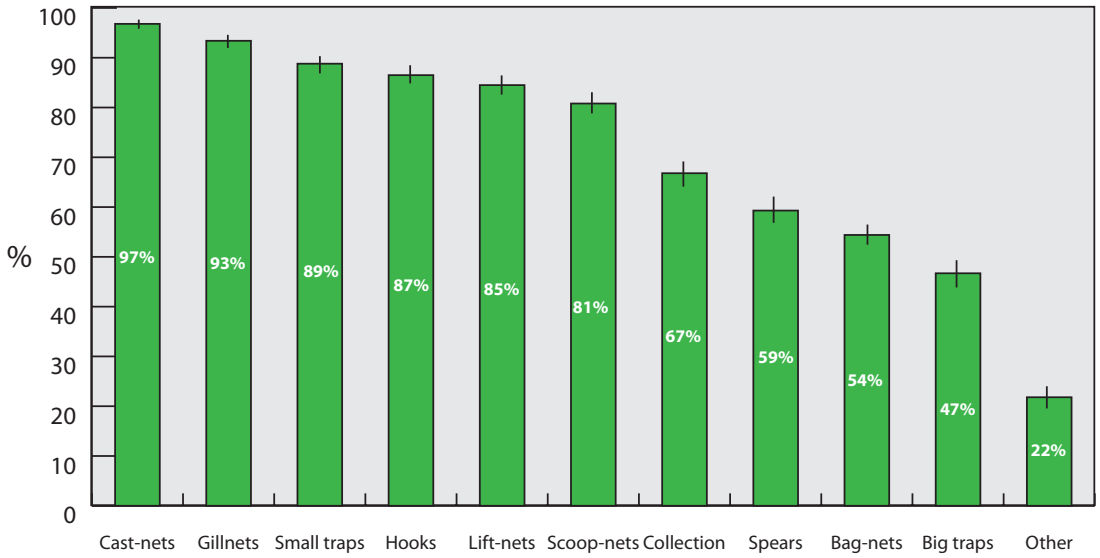

Figure 8. Gear occurrences in villages, based on the village census.
Based on data from 349 villages; the graph shows the percentage of villages in which the gear type was recorded; bars represent 95% confidence intervals. Collection includes by hand only, or aided by using traps or baskets.

Plate 1. The confluence of the Songkhram and Mekong Rivers, an important link in fish migrations.

Plate 2. Important fish habitat, remnant flooded forest along the lower Songkhram River, with boat-mounted lift nets.

Plate 3. A bag net, a large commercial-scale gear near flooded forest.

Plate 4. Fish feed and grow in seasonally flooded rice fields and are caught during the flood with traps—as in the left or during the dry season when they have migrated to permanent water bodies.

Plate 5. Traps are commonly used on small watercourses to capture fish and OAAs migrating from rice fields.

Plate 6. Villagers use hand-held lift nets to fish flooded rice fields.

Plate 7. Larger commercial-scale lift nets are operated from boats on large water bodies.

Plate 8. Monofilament nylon gill nets are now one of the most commonly used and most productive gears.

Plate 9. Traditional traps are still commonly used gears.

Plate 10. Different types of traditional traps are designed for use in particular habitats and to catch particular species.

Plate 11. Villagers have incorporated modern materials into traditional gear manufacture.

Plate 12. Gear-making is an important part-time activity.

Plate 13. Large catches are made when floodwaters are receding; excess fish are preserved or sold.

Plate 14. The importance of fishing to people can be judged from the effort put into the annual fish festival at Sri Songkhram. The floats are accurate models of local fish species.

Plate 15. Cage culture is concentrated on larger rivers, here on the lower Songkhram.

Plate 16. This watergate across the Huai Mong, a Thai Mekong tributary, prevents rising Mekong floodwaters from running into this tributary, and also blocks migrating fish and fish fry from accessing the tributary and flooded areas. Similar effects would be expected if the lower Songkhram River were to be dammed.

Plate 17. One of the two dams recently built on the middle Songkhram River to divert water for irrigation.

Plate 18. Fishery management—fish conservation zones; the signs give notification of regulations (left) and location (right).

Plate 19. Bag nets are illegal, but are commonly used to filter receding floodwaters.

4. Results from the sample survey

This section summarises the results of the sample survey of 27 villages that were sampled randomly. The results are grouped by village-level, household-level and individual responses.

4.1 Village sample survey

General information

The village leaders provided basic information as shown in Table 5, and the percentages can be used to extrapolate to the study area villages as a whole.

Table 5. *Some basic information from the 27 surveyed villages.*

Summary of question	No. of villages	Mean percentage of villages	95% confidence interval	
			lower limit	upper limit
Access				
Access to the village is by paved road	20	74.1%	56.7%	91.4%
Access to the village is by dirt road	25	92.6%	82.2%	100.0%
Access to the village is by waterways	0	0.0%	0.0%	0.0%
Water bodies				
There is a lake or large reservoir near the village	5	18.5%	3.1%	33.9%
There is a large river near the village	2	7.4%	0.0%	17.8%
There is a small lake or reservoir near the village	13	48.1%	28.4%	67.9%
There is a permanent small stream or canal near village	23	85.2%	71.1%	99.2%
There are permanent water body(ies) near village	27	100%	100%	100%
There is a water management scheme near village	11	40.7%	21.3%	60.2%
The village land is serviced by an irrigation scheme	9	33.3%	14.7%	52.0%
The village has flood protection	0	0.0%	0.0%	0.0%
Markets				
There is a market in the village	4	14.8%	0.8%	28.9%
Fish are sold at that market	3	11.1%	0.0%	23.5%
More than one middleman fish trader works in the market	3	11.1%	0.0%	23.5%
Seasonal fishers				
People leave the village to fish seasonally	3	11.1%	0.0%	23.5%
People come to the village to fish seasonally	13	48.1%	28.4%	67.9%

Some interesting features of the survey of villages included the following:

- Altitude of the villages varied from 101 – 317 masl.
- Most villages had access via paved roads and all villages had dirt road access. None relied on waterways or small tracks for access.
- All villages were in close proximity to permanent water bodies, despite the extended dry season in this region. Most villages in the LSB have developed near natural water bodies, e.g. 14 of the 27 villages had access to swamps that were not recorded officially, indicating a high level of access to productive fishery habitats. Dams and canals near most villages have increased the amount of permanent water that serves as dry-season habitat for fish.
- Less than half of the villages had access to any irrigation infrastructure for their lands, and no villages were near flood-control works.
- Fish markets were not common, being present in only 11% of villages. Over the entire study area the data suggests that about 86 villages of 776 had a fish market.
- Seasonal migration of fishers appears to be quite common. The number of villages who report seasonal emigration and immigration might be expected to balance, so either the surveyed villages have better-than-average capture fisheries, or the village leaders take more notice of outsiders fishing in their village than they do of people leaving their village to fish elsewhere.

Demographic information

The total population of the sampled villages was 21,691 in 4,175 households, with most people being either Thai Esan or Thai Yo as is typical in northeast Thailand (Figure 9). The mean number of households was 155 per village, with a confidence interval of 125 – 184, which overlaps the estimate from the village census of 134 ± 9. Similarly, the mean number of persons was 803 per village, with a confidence interval of 641 – 966, which also overlaps the estimate from the village census of 694 ± 51. Thus the sampled villages were representative in terms of numbers of households and people.

Landholdings

Figure 10 shows that the majority (about 75%) of households in the 27 surveyed villages owned between 0.96 and 9.6 ha of land, with relatively few households being landless or owning

very small plots. Given the wide confidence intervals these results should be extrapolated with caution

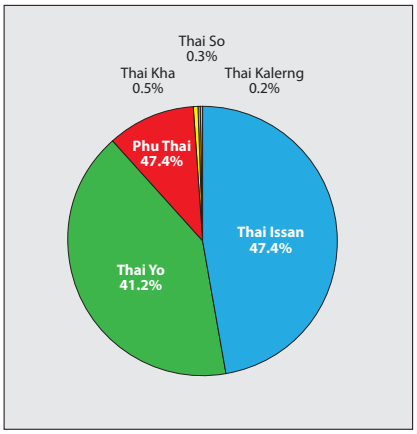

Figure 9. Ethnic proportions in the 27 surveyed villages of the LSB.
Based on 21,691 people in 27 randomly selected villages.

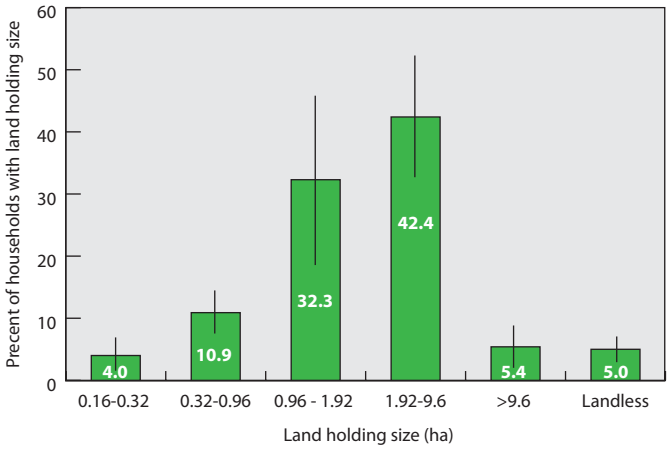

Figure 10. The percentage of households in each village owning farmland within various size intervals.
Based on a mean land holding of 154.6 ha per village. The data were converted from Thai rai, 1 rai = 0.16 ha. Histograms and data labels represent means and bars represent 95% confidence intervals.

Land use

The total area of 'land' (including surface water) used by the surveyed villages was 14,791 ha or 548 ha per village. Villagers classed about 80% of their land as agricultural, of which the majority (about 95%) was used for rice production; of this 95% was rain-fed paddy and only

5% was irrigated (Figure 11). Other farmland was used for vegetables, fruit trees, cash crops such as maize, and dry rice. Rice fields are seasonally flooded habitats that are likely to be important for fishery production, particularly because they occupy such a large proportion of the landscape.

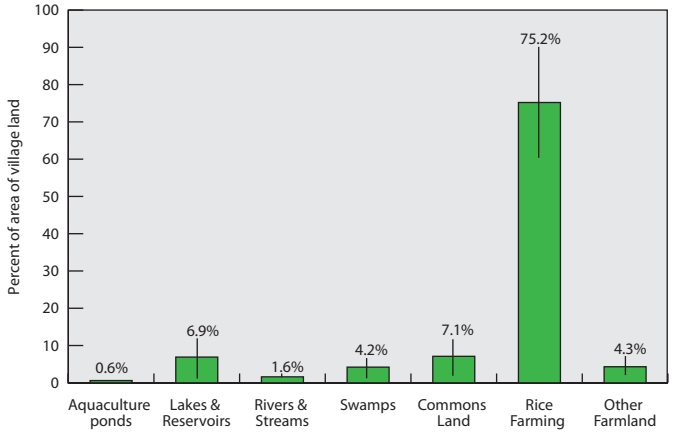

Figure 11. Land use in the 27 surveyed villages.

Based on a mean area of 548 ha per village. Histograms and labels represent means, and bars represent 95% confidence intervals.

About 13% of the village 'land' area was classed as surface water, of which about half was lakes or reservoirs. Aquaculture ponds occupied a very small area.

Flooded lands provide a good habitat for fish for spawning, feeding, and nursery grounds. All rice fields are covered with standing water for some period, so most of the land is inundated for a significant period of time each year. Village leaders were also asked to estimate the proportion of the area of land under each land-use that was flooded each year and the duration of flooding; this question was intended to relate to uncontrolled flooding.

Table 6. *Average proportions of agricultural land in the 27 surveyed villages estimated to flood each year and duration of flooding.*

Does not include routine inundation of paddies by rainwater.

	Months Flooded				
	0	1	2	3	Total
Cash crop (other than rice)	4.5%	0.0%	0.0%	0.0%	4.5%
Irrigated rice	3.4%	0.0%	0.0%	1.4%	4.8%
Orchards	0.3%	0.0%	0.0%	0.0%	0.3%
Paddy rice	48.5%	2.1%	26.7%	10.1%	89.7%
Upland/dry rice	0.3%	0.0%	0.0%	0.0%	0.3%
Vegetable garden	0.3%	0.0%	0.0%	0.0%	0.3%
Total	57.4%	2.1%	26.8%	11.5%	100.0%

The survey found that about 43% of agricultural land in the villages flooded for at least one month each year (Table 6), but only about 12% of agricultural land flooded for three months, and no land was flooded for more than three months. Seasonally flooded agricultural land is in fact the largest area of aquatic habitat, averaging 186 ha/village with all other aquatic habitats averaging only about 73 ha/village. Although the duration of flooding seems short, many fish and other aquatic animals migrate onto seasonally flooded land where they can feed and grow rapidly as there is an abundance of food, and they are caught in large quantities as floodwaters recede each year.

Aquaculture

Table 7 shows that aquaculture was of generally minor importance. For example, although ponds were present in all villages, on average only about 15% of households owned ponds, which occupied on average less than 1% of the land area, and only about 3% of households owned fish cages.

Table 7. *Summary of basic aquaculture statistics.*
Ucl/Lcl upper and lower 95% confidence limits.

Statistic	Count of villages	Mean/village	Ucl	Lcl
Ponds in village	27	29.4	37.8	21.1
Area of Ponds (ha)	27	3.3	4.4	2.1
Households that own ponds	27	23.1	29.7	16.5
Households that stock rice fields	5	0.8	1.7	0.0
Fish cages in village	4	4.1	11.7	0.0
Households that own fish cages	4	1.0	2.6	0.0
No. of households in village	27	154.6	184.0	125.3
Land area of village	27	547.8	667.7	427.9

Less than 1% of households reported stocking fish in their rice fields. Five species were being stocked: three Mekong species; *Barbonymus gonionotus* (silver barb), *Cirrhinus microlepis* (small-scaled mud carp) and *Clarias macrocephalus* (broadhead catfish), as well as two exotic species; *Cyprinus carpio* (common carp) and *Oreochromis niloticus* (Nile tilapia).

Fisheries business

In seven of the 27 survey villages there were 19 business units that were officially engaged in commercial trading of fish or fishery products; these employed 26 people and 7 labourers, as shown in Table 8. These figures probably under-estimate the level of fisheries as a business across the LSB, as informal businesses are likely to be common and a few villages which were not covered could be the centres of formal activity.

Table 8. *Breakdown of people engaged in fisheries as a business in the 27 survey villages.*

Village No	Activity	Business Units	Self-employed (people)	Hired Labour (people)
2	Trading (buy and sell)	2	2	2
5	Trading (buy and sell)	1	3	3
5	Make/sell fishing nets	1	1	1
9	Trading (buy and sell)	1	1	0
10	Trading (buy and sell)	1	1	1
18	Trading (buy and sell)	3	8	0
25	Trading (buy and sell)	10	10	0
	Total	19	26	7

Economic activities in the sample villages

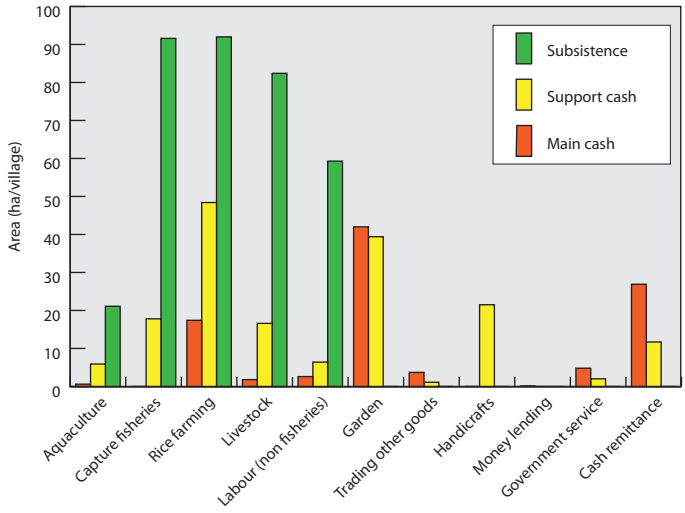

Figure 12. Economic activities importance for households for main cash income, supplementary cash income and subsistence.

Weighted means, based on responses from leaders of 27 villages.

Households were usually involved in a range of economic activities, as shown in Figure 12, and among these the most important for cash income were labouring (42% of households), cash remittance, i.e. money sent home by people working elsewhere (27%), and rice farming (17%). Many households have more than one supplementary income, among which the most important were rice farming (48%), labouring (25%) and handicrafts (22%). The most important subsistence activities were rice farming (92%), capture fisheries (92%) and livestock farming (82%). Aquaculture was relatively unimportant for income and was only practised by about 21% of households for subsistence, a figure consistent with the estimate above that about 15%

of households owned fishponds; presumably the other 6% either assist pond-owning households or are involved in cage culture or stocking of rice fields.

Overall the figures show that in the LSB villagers in 2000 relied primarily on agriculture both for income and subsistence. Fisheries were very important for subsistence, but relatively unimportant for income for most households.

Fisheries management

All villages had at least one fisheries management measure in place for capture fisheries and villages typically had two or three management measures they applied to fisheries. The most common measures were gear restrictions and seasonal closures, but community ponds and conservation zones were each adopted by about half of the villages (Figure 13). The management measures tend to duplicate those existing under Thai fisheries law, which are not well-known and not widely enforced.

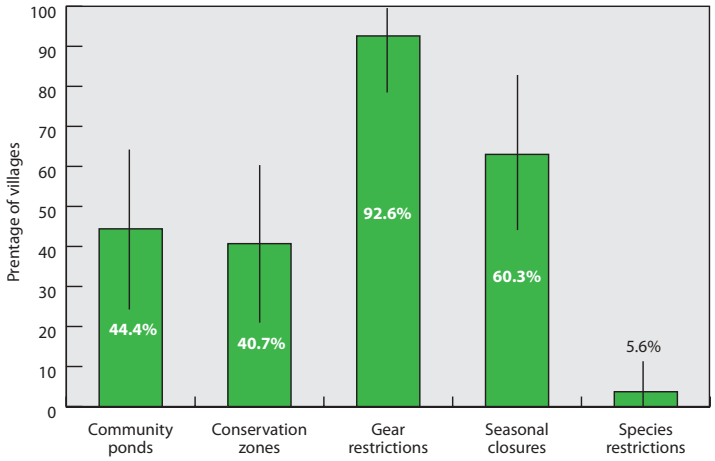

Figure 13. Fisheries management measures implemented by villages.

Histograms and data labels represent the mean percentage of villages; bars represent 95% confidence intervals. N=27.

4.2 Household Sample Survey

Demography

The sample included 353 households, representing about 9% of the total households in 27 sample villages (Table 9). A typical household consisted of a single family-unit. There were 1,743 household members, and although the mean number of females was lower than males the difference was not statistically significant.

Table 9. *Basic data on size of the households surveyed.*
N=353 in 27 villages; weighted data from complex sample analysis.

Statistic	Mean	95% Confidence Interval	
		Lower	Upper
People/household	4.95	4.74	5.17
Female	2.38	2.26	2.50
Male	2.57	2.41	2.74
Percent Female	48.0%	45.6%	50.5%
Percent Male	52.0%	48.7%	55.3%

The mean household size was very similar to that found in the village survey (5.18 persons) so in this respect the sampled households were typical of those in the surveyed villages. The mean age of people in the surveyed households was 30.1 years; most people were less than 30 years old, and the oldest person was 98 years old. There was no significant difference in male and female average age. The age distribution is shown in Figure 14.

Household status

Appendix 3 summarises data which indicate the general economic status of the sampled households. Most (76%) households occupied two-storey houses and houses were on average about 84 m^2 in floor area. Most houses were made of wood (65%) or wood and concrete (27%) with 97% of houses having corrugated iron roofs. About 96% of households owned a television but less than 1% owned a telephone. About 25% of households owned a wooden boat which was on average 5.5 m long; there were no other kinds of boat owned. About 25% of households owned a car and most of these (73%) were Kubota pick-ups (or utilities). About 36% of households owned a car or a boat and only about 7% of households owned both a car and a boat.

Economic activities of households

Full-time and part-time activities

All individuals in each of the 353 households were asked to note their full-time and part-time economic activities; i.e. activities that earned money or provided physical products to the household. The activities did not include housework or caring for children. The data can be viewed either from the aspect of the individuals or households. Relative contribution to income is discussed below.

Table 10 shows that 65.6% of all people considered they had a full-time job and 68.2% of people had either full-time or at least one part-time job, or both full- and part-time jobs, so these people could be considered as being 'within the workforce'. People not working at all (31.8%) included small children, students and elderly and handicapped people, as can be seen in Figure 14.

Table 10. *Cross-tabulation of the sample of 1,743 people working full-time and part-time.*
Note: some people (47.1%) have both 'full-time' and part-time jobs.

Category	Part-time Work	No Part-time Work	Total
Full-Time Work	47.1%	18.5%	65.6%
No Full-Time Work	2.6%	31.8%	34.4%
Total	49.7%	50.3%	100.0%

Figure 14 shows that the sample was dominated by younger people; about 45% were less than 25 years of age and about 70% were less than 41 years of age. Most children and teenagers (about 95%) were either pre-school or were full-time students. Most adults (about 93%) between 17 and 64 years of age considered that they had a full-time job as well as or apart from household work, the remainder were either unemployed (3.4%), students (3.9%) or handicapped (0.2%).

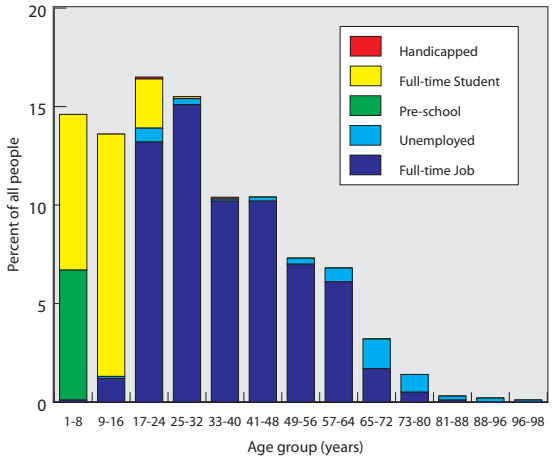

Figure 14. Age distribution and full-time employment status of the 1,743 people in the 353 surveyed households.

The level of participation in different occupations is best expressed relative to the workforce (68.2% of the sample), rather than relative to all people. Full data are shown in Appendix 4. As summarised in Figure 15, most of the workforce categorised themselves as full-time rice farmers, but about 42% of the workforce were part-time fishers. About 36% of workers were both rice-farmers and fishers. Day-labouring was a common full- and part-time occupation and other occupations were of relatively minor importance.

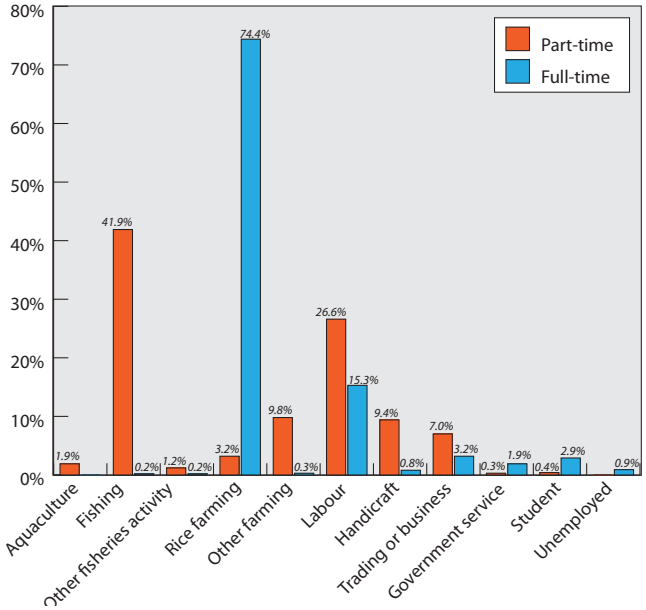

Figure 15. The percentage of the workforce employed in different occupations.

This figure only includes data from 1,182 people who had a part-time or full-time job, or both. See Appendix 4 for full summary data.

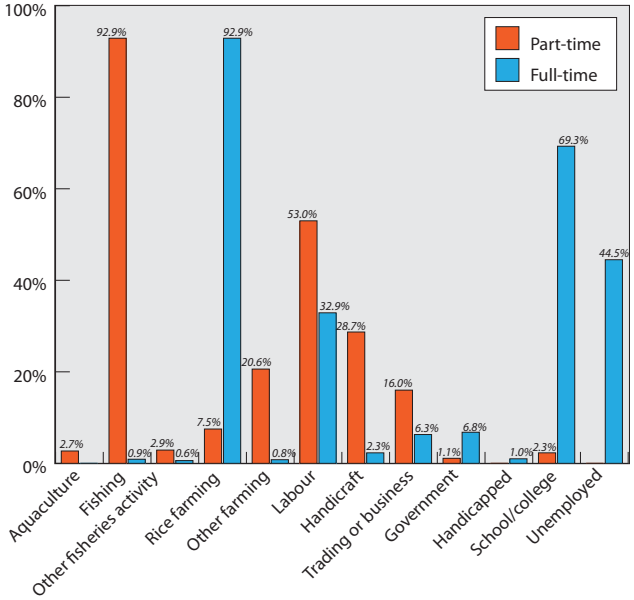

Figure 16. Important household economic activities based on data from all 1,743 individuals living in 353 households.

The graph shows the weighted mean percentage of households with one or more family member engaged in the activity. The activities may be for subsistence (household use) or for earning income. 'Other fisheries activity' includes fish processing, making gear and fish selling.

In the study area it is more appropriate to view occupations in terms of their importance to households, as there is no social security and all households comprised more than one person.

If any member of a household engages in an 'economic' activity it can be assumed that the household generally benefits, so it can be regarded as a 'household activity'. This approach is particularly relevant to fishing, where trips are often made by more than one family member, but the numbers and extent of participation by each member vary daily and may not be recalled accurately.

The most important full-time activity in the surveyed households was rice farming (92.9% of households) (Figure 16), consistent with information from village leaders (see Figure 12). Household members commonly engaged in more than one economic activity, with up to five different activities engaged in by one household. Wage-labouring was also important for about 33% of households full-time and about 52% of households part-time; such labour would also include working on other households' farms. Less than 1% of households (3) said they had full-time fishers, but fishing was an important part-time activity for about 93% of households, which is a similar figure to the estimate provided by village leaders of 92% as discussed above. Men were more involved than women in fishing, as about 74% of all people who were part-time fishers were men, as were about 71% of those involved in gear making. However about 60% of fish processors were female and the proportion of each gender engaged in fish selling were approximately equal. The largest gender imbalance was evident for handicraft workers of which about 92% were women, and for government workers of which about 89% were male. A breakdown of people's occupations by gender is shown in Appendix 5.

As would be expected from the age distribution, a significant percentage of people were either students, or young or old people classed as unemployed.

The majority of households (about 89%) were involved both in rice farming and fishing. The data are consistent with the generalisation that most LSB households rely on rice farming as the main activity for income and subsistence, but fishing is also important. People typically go to paddy fields to work on rice cultivation and also take fishing gear to use in paddies or associated habitats, or fish at times when work is not required in rice fields. Most people in the LSB depend upon rice and fish as their staples, but other foods are also grown or purchased.

Only 10 households (about 3% of the total) reported part-time involvement in aquaculture and there were no reported full-time aquaculturists in the sample population. This percentage seems inconsistent with more detailed data provided about aquaculture later in the questionnaire, in which about 23% of households reported that they owned either ponds or cages, as discussed below. This apparent discrepancy may reflect a perception that aquaculture by definition must include stocking and feeding fish; it is likely that many ponds are not actively farmed for fish, but are simply colonised by wild fish during the wet season or are stocked with fingerlings which are not fed.

Importance of activities for food supply and income

Household heads were asked to categorise the importance of activities for food supply and for income, with results as summarised in Figure 17. Interestingly, the percentages of

households differed somewhat from those shown in Figure 16, when individuals (rather than household heads) listed their main activities. For example, aquaculture appears to be more important for food supply and for income when judged from this 'whole household' perspective, perhaps indicating that individual members each spend little time on the activity, but that it is overall of some importance to a significant percentage of households.

The most important activities for household food supply were rice farming, fishing and fish processing, and the most common income-earning activities were wage labour, rice farming and other farming, but other activities, including selling fish, were also common. About 84% of households rated both fisheries and rice farming as important for food, which is consistent with the estimate of 89% from the individual responses discussed above.

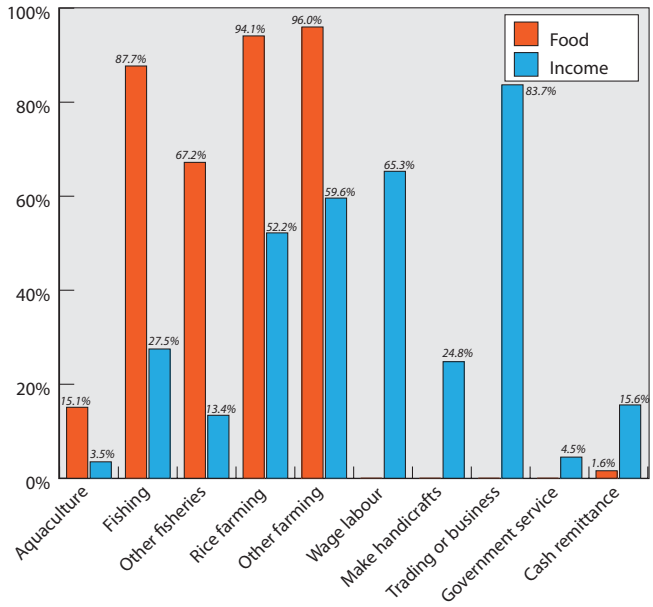

Figure 17. Importance of household economic activities for food or income.
Some categories were amalgamated. 'Other fisheries' includes fish processing, fish selling, gear making and wage labouring. See Appendix 6 for full listing with confidence limits.

The results show that the livelihoods of most households in the LSB were dependent on a range of activities, with rice farming and fishing the most common, but with several other activities usually also important for supplying food and income in each household.

Land ownership and agriculture

Each household listed the area of land it owned and also the common land it accessed, as well as holdings of livestock and poultry. Data are summarised in Appendix 7.

Mean land ownership was 2.54 ha/household and 95% of households owned rain-fed rice paddies which on average occupied about 2.13 ha per household, or about 84% of the land owned. This figure is consistent with the estimate provided by village leaders of 90% of village

land being rice paddies. People also used common land, but few households entered data on its use, so the resulting data may underestimate its importance.

About 78% of households owned livestock or poultry. Nine households owned livestock jointly with other households; in these cases a mean ownership per household was calculated Most households (67%) owned chickens (mean 10.5 per household), and ducks, cows and buffalo were also common. The ownership figures are summarised in Appendix 8.

Fishing by households

According to the data supplied on catch, in 327 households (of 353) one or more family member(s) went fishing at some time, so about 92.7% were classed as fishing households, and 26 (7.3%) were classed as non-fishing households; these did not own fishing gear and never went fishing. After weighting, fishing households comprised 93.0% and non-fishing households 7.0% of the sample.

These figures differ slightly from those provided for households that were fishing full and/or part-time (330), and households fishing for food and/or income (309). It seems that some households may have misunderstood some questions, but no adjustments could be made for these small discrepancies. There were also apparent discrepancies between total catch estimates and households' response as to whether they hosted full-time or commercial fishers, with the largest reported catches not being made by commercial or full-time fishing households.

Gear ownership

Households were asked to record the number of gears that they owned and used, classed within 10 broad types. As shown in Table 11, households had on average about 3 types of gear (range 3–7) and about 80 individual gear units. The most common gears were gill-nets, cast-nets and hooks. The frequency distributions of all gears are skewed; i.e. a few households owned many more gears than the average, so the median better represents 'typical' gear ownership.

The occurrence of gears in each village was similar to that found in the village census (Figure 4); providing some level of confidence in the responses.

Catches by each kind of gear were not estimated by households, so it is not possible to determine the proportion of total catches by each gear type.

Table 11. *Gear ownership by households.*

All data were adjusted to include the 353 households including 26 who had no gear and did not fish. For 10 fishing households that did not provide data, data were adjusted pro-rata. Means are numbers of gear per household, except for collection which is based on number of people per household who collect by hand. All statistics are weighted based on the sample frame.

Gear Type	% of villages with the gear	% of houses with the gear	Number of gears per household				
			Mean	95% Confidence Interval		Median	Maximum
				Lower	Upper		
Gill-net	100.0%	67.4%	2.54	1.49	3.59	2	200
Cast-net	100.0%	63.7%	1.19	0.91	1.47	1	6
Hooks	100.0%	54.5%	68.7	54.1	83.2	100	600
Scoop nets	88.9%	36.0%	0.456	0.322	0.590	1	5
Small traps	88.9%	23.3%	5.73	2.71	8.76	11	232
Lift nets	81.5%	19.6%	0.330	0.207	0.452	1	5
Collection	85.2%	17.0%	0.21	0.14	0.29	1	5
Spears	55.6%	12.3%	0.191	0.008	0.375	1	7
Big traps	48.1%	5.3%	0.095	0.048	0.142	2	4
Bag nets	37.0%	4.2%	0.055	0.019	0.091	1	3
Rifles	3.7%	0.2%	0.0024	0.0000	0.0076	1	1
Gear Units	100.0%	92.6%	79.5	63.2	95.8	48	666
Gear Types	100.0%	92.6%	3.04	2.71	3.36	3	7

Seasonality of fishing

The fishing households were asked to estimate the number of trips they made each month; the habitats they visited, and their total annual catch in each habitat.

Figure 18 shows that people go fishing all year, but there are three main periods: dry season, early-wet season and late-wet/recession season. Fishing is least frequent during the dry season (December to May), more frequent during the early-wet season (May to July) when fish and OAAs are migrating along watercourses and into newly flooded areas, and fishing is most intense from August to October when water levels peak and then fall rapidly. At that time aquatic animals are most abundant as they have bred and grown in the early wet season, and they become more concentrated and catchable as they migrate off flooded areas and down watercourses. November is a transitional month when fishing effort falls back to dry-season levels. Despite the variation in fishing effort, it is worth noting that mean effort only varies from about 10 to 20 trips per month.

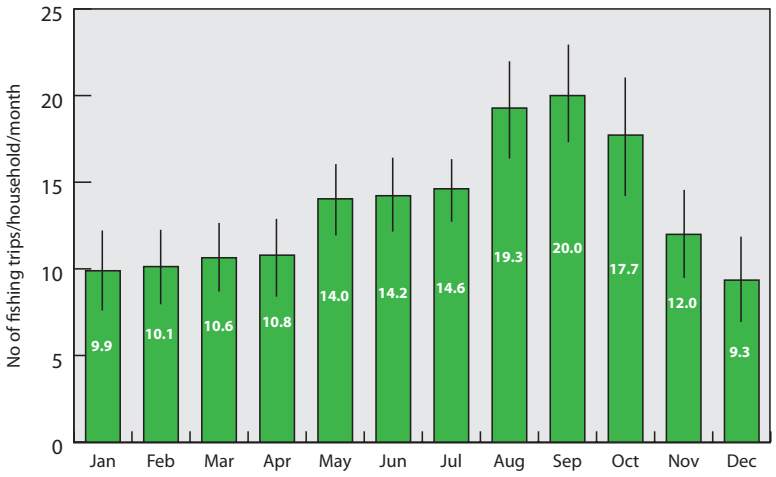

Figure 18. No. of fishing trips per month made by one or more household members.

Histograms and data labels represent means; bars represent 95% confidence limits. Based on weighted data from all 353 households.

Habitats Fished

Appendix 9 summarises information on the time taken by households to reach habitats during fishing trips. Households fished in up to five types of habitats (mean 2.3 types) and the average time taken to travel to fishing habitats was about 17 minutes. But some people travelled for up to three hours to access some habitats such as perennial rivers, presumably because these habitats are more productive and also are uncommon. The most commonly accessed habitats were wet rice-rainfed (60% of households), natural swamps (45% of households) and man-made reservoirs (30% of households).

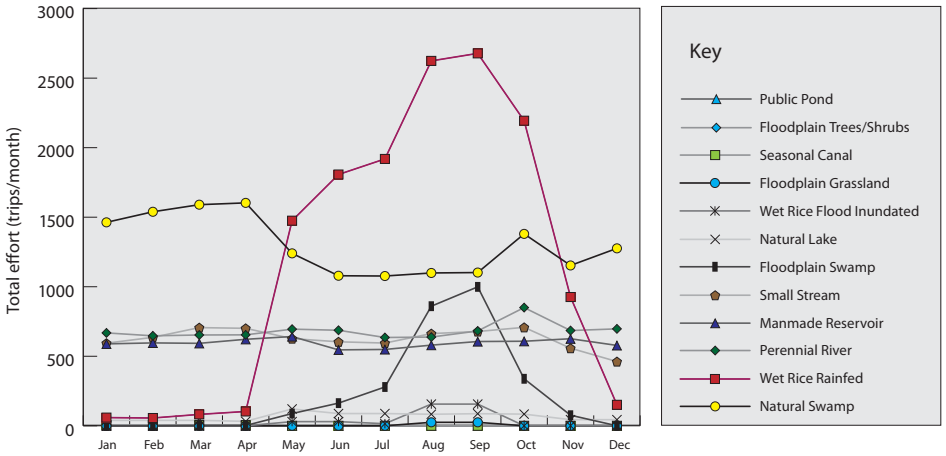

Figure 19. Seasonality of total fishing effort in each habitat.

Based on the total number of trips to each habitat by the 327 fishing households.

Figure 19 shows that many habitats were being targeted year-round by villagers, but as might be expected, there is a large increase in effort in wet rice rain-fed and floodplain swamp habitats when these areas are inundated from about April to November. The seasonal increase in fishing pressure in these habitats appears to coincide with a reduced fishing pressure in natural (permanent) swamps.

Effort and catch

Fishing households reportedly made on average 176 trips each year (which may include one or more family members) and the mean catch of the 327 fishing households was estimated at 223 kg/household/year or 207 kg/household/year as a weighted mean for all households (Table 12). The most-visited habitats were wet rice rain-fed, natural swamps and man-made reservoirs which together accounted for 66% of all trips. The highest catch rates (catch/trip) were in floodplain swamps, natural lakes and perennial rivers including the Songkhram River. The largest total catches were made in natural swamps, wet rice rain-fed and perennial rivers that together made up 64% of the total catch. Although individual households differed greatly in their fishing effort and catch, mean catch rates in each habitat only varied between 0.53 and 2.2 kg/trip. As might be expected, confidence intervals for these estimates are quite broad, as a result of high variance in the data (Appendix 10).

Table 12. *Summary of data on effort and catches by habitat.*
Statistics are based on all 353 households, including 327 fishing households. Full data with confidence intervals are shown in Appendix 10.

Habitat	% of households visiting the habitat	Mean trips (trips/household/year)	Mean catch (kg/household/year)	Mean catch (kg/trip)	Total catch (kg/year)
Natural Swamps	44.5%	43.4	51.6	1.19	18,220
Wet Rice — Rain fed	60.3%	40.1	46.8	1.17	16,507
Man-made Reservoir	30.0%	24.6	30.4	1.23	10,717
Small Stream	31.0%	22.2	23.0	1.03	8,109
Perennial River	28.7%	21.5	33.7	1.57	11,896
Floodplain Swamps	14.9%	7.66	16.9	2.20	5,950
Natural Lake	2.4%	2.06	3.97	1.92	1,400
Wet Rice Flood Inundated	2.4%	0.91	0.48	0.53	171
Floodplain Grassland	0.3%	0.13	0.12	1.00	44
Floodplain Trees/Shrubs	0.3%	0.06	0.03	0.58	12
Seasonal Canal	0.2%	0.04	0.07	1.50	23
Public Pond	0.2%	0.003	0.01	2.00	2
All habitats	93.0%	163	207	1.27	73,050
Fishing hhs only	100.0%	176	223		

The Songkhram River and four other perennial river tributaries were accessed by the surveyed households. Although these perennial rivers were not the most frequently accessed

habitats, they are undoubtedly very important for the productivity of the Songkhram River Basin, as they link habitats, as well as connecting the basin to the Mekong River. Such connectivity is necessary to allow fish and other aquatic organisms to migrate, and therefore is critical to the overall productivity of the basin. The annual migrations are also a focus of fishing effort and a source of large catches at certain times.

Table 13 combines data on the areas of habitat estimated for each of the 27 villages with effort and catch data. Rice fields occupy most of the land around the villages, but were fished relatively little relative to their area, and they also produced relatively little of the total catch compared with their area. At the other extreme, rivers and streams were fished at relatively high apparent intensities and also produced the highest catches relative to their reported area. These figures should be treated as illustrative only; some people travel away from their villages to fish so the relative areas of habitat may not be entirely representative of the areas available to fishers across the LSB. Nevertheless, the comparison shows that natural habitats are clearly of great importance for fisheries, presumably because they are crucial for fish production as well as being places where fish become more concentrated and catchable at particular times. Moreover it is likely that such natural habitats are easily accessed by villagers on foot or using motorbikes.

Table 13. *Relative effort and catch in different habitats.*
Habitat data from the survey of 27 villages (Figure 11), catch and effort data from Table 12, with some categories combined. Selectivity and catch excess are the ratios of fishing trips and catches to the percentage of the habitat.

Aquatic Habitat	Percent of this kind of habitat near villages (A)	Percent of fishing trips to this type of habitat (B)	Percent of total catch from this type of habitat (C)	Apparent selectivity of fishers for the habitat (B/A)	Apparent catch excess from the habitat (C/A)
Swamps	4.8%	31.5%	33.2%	6.6	6.9
Rice fields	85.0%	25.2%	22.8%	0.3	0.3
Lakes and reservoirs	7.8%	16.4%	16.6%	2.1	2.1
Rivers and streams	1.8%	26.9%	27.4%	15.3	15.6
Other	0.7%	0.03%	0.03%	0.04	0.1
Total	100.0%	100.0%	100.0%	1.0	1.0

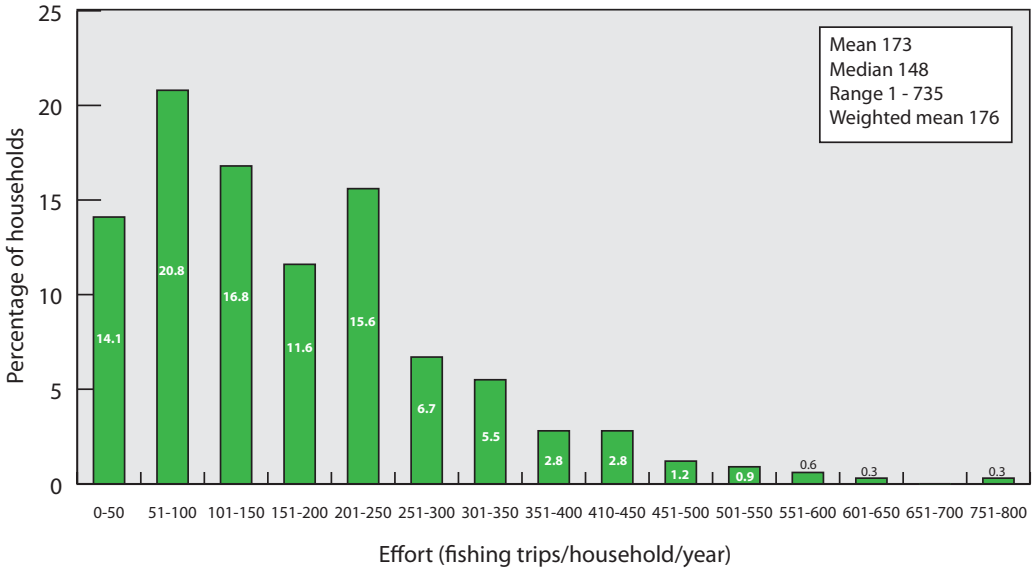

Figure 20. Distribution of fishing effort for 327 fishing households.

Each trip is one or more household member visiting one habitat for up to one day.

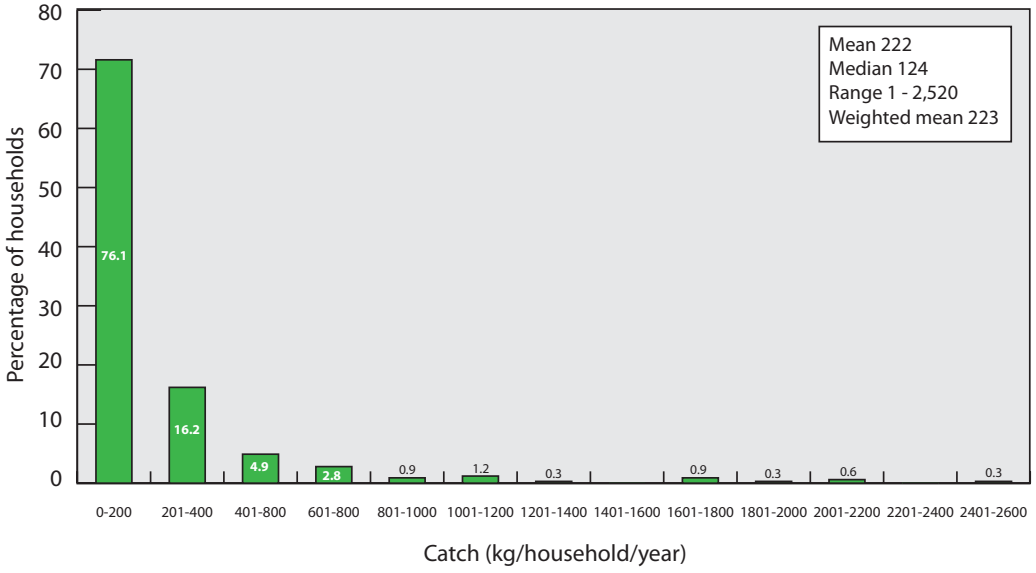

Figure 21. Distribution of annual household catches for 327 fishing households.

Catches are the sum of estimated annual catches in each kind of habitat.

Distribution of effort and catch

As shown in Figures 20 and 21, the distribution of both effort and catch are skewed to the right; and catch data were more skewed than effort data. The median is a preferable statistic if we

wish to represent a 'typical' fishing household. About half of the fishing households made more than (or less than) 148 trips per year or about 12 trips per month, so in a 'typical' household at least one family member goes fishing every second or third day on average. A typical household catches about 124 kg/year or about 10 kg/month. Most households reported catches of less than 200 kg/year; 246 households (75% of sample households) had an annual catch lower than the mean, and the highest annual catch was more than 10 times the mean catch. The 40 households with the highest catch (about 12% of the sample) caught about half of the total catch of all the households. The highest catches were from full-time fishing families, and the wide variation among other households reflects their level of effort and expertise, their opportunities to fish in favourable habitats at the best times, and the kinds of gear they use. Most households fish primarily for subsistence.

As would be expected, greater effort generally leads to larger catches, although there is considerable variation between households. For each of the six habitats commonly fished (n>10) the relationship between effort and catch was highly significant (Spearman's Rho, p<0.001). A power relationship provides the best fit for this relationship, which is to be expected from the high skewness in the data. An identical result is obtained by log-transforming the data prior to performing a standard linear regression (Figure 22).

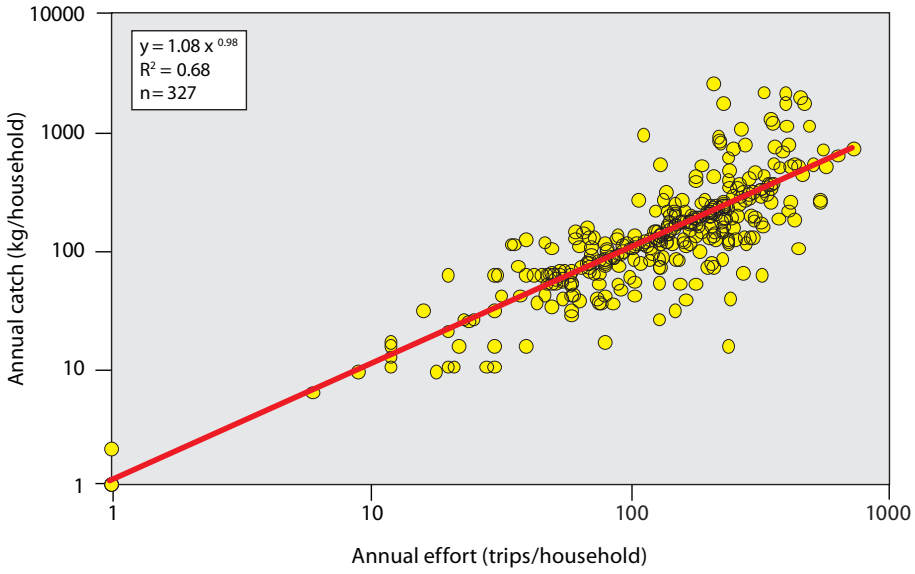

Figure 22. Regression of total catch on total effort for fishing households. N=327

Total yield of the lower Songkhram River Basin based on catch data

An estimate of the total catch for the LSB based on these data can be made as follows:

- the sample includes 353 households in total (327 are fishing households);

- the weighted mean annual catch per household (including non-fishing) is 207 kg/household, with a 95% confidence interval of 158-256 kg/household/year;

- the total catch from the 27 surveyed villages is estimated as 353*207 = 73,071 (55,774-90,368) kg/year;

- the total number of households in the lower Songkhram River Basin is 165,554, so the total catch from the LSB is approximately 165,554 * 207 = 34.3 kt/year, with a confidence interval of 26.2–42.4 kt/year; and

- this catch equates to 41.8 (31.9–51.7) kg/capita, as there are on average 4.95 people in each household.

The catch estimate has a large relative error of about ±47%, which could be reduced in future surveys by either or both of the following:

- Increasing the number of villages sampled and/or the number of households sampled to increase the effective sampling size and thereby reduce the standard error;

- Stratifying the villages and households in the LSB into low- and high-fishing groups prior to sampling to reduce variance in the data. Stratification of villages could be carried out by using census data and GIS information. Stratification of households within villages should be a key part of interviews of village leaders.

The total catch per village was estimated by multiplying the mean catch for all surveyed households within each village by the total number of households in that village, which produced a mean estimated catch of 29.0 tonnes/village/year. Although not as extreme as the skewness exhibited in household catches, the distribution of catches across villages was also skewed. The village with the highest catches had about 11% of the total catch, and seven villages caught about 48% of the total catch.

Yield per unit area in the LSB

According to GIS data, the total area of wetlands in the LSB is 4,345 km^2, as shown in Table 1. A mean estimate of yield across all wetland area is 78.9 (60.2–97.5) kg/ha, based on the catch estimate above. Virtually all of the wetland area (97%) is classed as seasonally flooded land, although a percentage of this is probably small areas of permanent water that are not resolved by the GIS software. It is probable that much of the growth of fish and OAAs occurs when they are feeding in flooded areas, despite the fact that most catches are reportedly made in permanent water bodies (see Table 12). There is insufficient information to discriminate different levels of yield between the three main categories of wetland (permanent water bodies, rice fields, and other seasonally flooded areas).

Aquaculture activity of sample HH

Aquaculture data showed some apparent inconsistencies which might have been a result of the way questions were asked or of perceptions of what constitutes aquaculture. Also, many households did not supply complete data. Among the 353 households, 112 or about 32% reported owning ponds, but only 81 (23%) reported using them for aquaculture, and of these only 37 provided annual production figures. The area of ponds, total annual production and the yield per hectare were all highly variable as shown in Table 14. The production figure (weighted mean per hectare) reported for 37 ponds was assumed to apply to all ponds, including the 44 ponds for which there were no figures, to extrapolate a total estimated production of 5,805 kg/year from these 81 households. This figure probably overestimates aquaculture production, which in many cases would include wild fish trapped in ponds as water recedes from flooded areas. Trapping of wild fish seems particularly likely in some small ponds that had very high production figures (up to 33.3 tonnes/ha/year), which is much higher than could be expected from in-situ pond aquaculture.

Table 14. *Summary of data on aquaculture production from pond-owning households. For areal production a weighted mean is shown. Includes both in-situ and trap-pond production.*

Households that supplied production values						
Statistic	n	Median	Min	Max	Sum	Mean
Pond Area (m^2)	37	800	30	16,000	64,935	1,755
Annual Production (kg/year)	37	30	1	1,000	2,687	73
Areal Production (t/ha/year)	37	0.50	0.0125	33.3		0.414
Households that did not supply production values						
Pond Area (m^2)	44	800	12	20,800	75,291	1,711
All households						
Pond Area (m^2)	81	800	12	20,800	140,226	1,731

A further 31 households reported owning ponds (total area 28,463 m^2) but did not report that they practised aquaculture, and a further four households said that aquaculture was important for food or as a part-time occupation but did not report owning ponds.

The 81 households that practised aquaculture in ponds were within 22 of the 27 villages i.e. based on the sampled households it would appear that a few villages had most of the ponds. For example, one village had 30% of the pond area and three villages together had 49% of the pond area. Two of the pond-owning households and another two households that did not report owning ponds or cages reported that they stocked rice fields (i.e. about 1% of households). Rice-fish culture is apparently uncommon in this area, probably because of the availability of wild fish.

Only two households reported owning cages for culturing fish and reported their annual production as 2,100 kg/year (1,300 plus 800 kg/year).

Total reported aquaculture production from the 27 survey villages (ponds plus cages) of 7,905 kg/year is probably an overestimate because wild fish caught in trap-ponds are included, nevertheless aquaculture production represents only about 10% of the total production from the villages, as capture fisheries account for about 73,071 tonnes/year. Even allowing for possible inaccuracies in the data it is reasonable to conclude that capture fisheries were of much greater importance than aquaculture in the LSB at the time of the survey. The aquaculture production averaged across all households is approximately 22.4 kg/household/year or 4.5 kg/person/year. For the entire LSB aquaculture production is estimated as 22.4*165,554 = 3,708 tonnes/year.

Estimates of aquaculture production from the LSB could be greatly improved by stratifying villages into groups based on the extent of pond area and obtaining more details to separate in-situ from trap-pond production. Cages are likely to be concentrated in a few areas in large rivers, so production should be estimated after a census of cage operations.

The survey did not produce useful data on the monetary value of aquaculture production. Of 14 households that said aquaculture was important for income, only one provided an estimate of annual income. Of 81 households that used ponds for aquaculture, only 21 provided estimates of their income from aquaculture. It seems likely that, as might be expected, households did not want to report income or found it difficult to estimate.

Household consumption

In this part of the survey the main objective was to estimate the intake of animal foods by people in the LSB; i.e. all terrestrial and aquatic animals, including fish and other aquatic animals. The study also aimed to compare the intake of fish and OAAs with meat from terrestrial animals. Households were asked to estimate their weekly intake of foods within various categories in the wet and dry seasons. The results were summed by categories and by broader groupings for each household.

Fresh fish and OAAs was a single dietary category that was expressed as FWAEs (fresh whole animal equivalent weights), i.e. the weight prior to cleaning or cooking. The proportion of fish within this category was estimated as 71.3%, from the results of a survey in Champassak Province in Lao PDR where fish and various kinds of OAAs were separately itemised (Hortle, 2007). Weight as ‘actual consumption’ was estimated for fresh fish by multiplying FWAE weights by 0.8 (i.e. approximately 80% of the fresh weight of fish was assumed to be eaten) and for OAAs by multiplying by 0.49 (i.e. approximately 49% of the weight of OAAs was assumed to be eaten). These conversion factors are based on generic LMB data reviewed in Hortle (2007). Future surveys should separately itemise fresh fish and the main kinds of OAA as well as estimating site-specific conversion factors for the various kinds of foods.

In contrast to fresh fish and OAAs, the various types of preserved fish and the other types of meat were separately itemised in questionnaires and were expressed by households as 'actual consumption'. These were converted to 'fresh whole animal equivalents' and to protein units by multiplying by the factors in Table 15. Table 16 shows the factors used to convert other kinds of foods to protein units.

Table 15. *Generic factors used to convert preserved fish products to fresh whole animal equivalents (FWAEs) weight.*
Based on lower Mekong Basin data reviewed in Hortle (2007).

Product	Conversion Factor FWAE-processed	Protein content of final product	Edible Protein as % of FWAE weight
Salted/Dried Fish	2.82	50.6%	17.9%
Smoked Fish	2.50	39.8%	15.9%
Fish Paste	0.88	14.0%	15.9%
Fish Sauce	0.50	8.0%	15.9%
Fermented Fish	0.75	12.0%	15.9%

Table 16. *Generic factors used for conversion of actual quantities consumed to protein units.*
Based on lower Mekong Basin data reviewed in Hortle (2007).

Category	% protein
Poultry	19.0
Eggs	12.9
Pork	21.8
Beef	21.2
Wildlife	15.0
Insects	15.0
Goat/sheep	21.2
Fresh fish	19.9
Other Aquatic Animals (not fish)	16.3

Households were also asked to estimate the percentages of the consumption of each kind of aquatic food which originated from capture, aquaculture, purchases or gifts for each individual category in both wet and dry seasons. These percentages were converted to weights for each household prior to calculating statistics.

Summary statistics were calculated over all households and converted to units of kg/household/year. These data were then converted to units of kg/capita/year by dividing by the average household size. Converting to units of kg/capita/year prior to calculating summary statistics would produce incorrectly weighted values, as larger households tend to have smaller per capita consumption. It should be noted that actual per capita consumption was not measured, but the units are converted in this way to allow comparisons because household size varies. Animal foods may also be converted to units of protein actually consumed, as shown in Table 16.

Table 17 shows that reported consumption as FWAEs averaged 50.3 kg/capita/year, of which about 40% was fresh fish, 16% was other aquatic animals, and 45% was preserved fish. Dried/salted fish made up the largest share (41%) of preserved fish.

Table 17. *Summary of reported consumption of fish and OAAs by 351 households in 27 villages as fresh whole animal equivalents (FWAEs) kg/capita/year.*
Statistics were weighted based on the sample frame. A single value for fresh fish plus OAAs was reported, and 'Fresh fish' and 'OAA' quantities were estimated as proportions—see text. Preserved fish were reported as consumed and were converted to FWAEs for each household and then summarised for this table.

Category	Mean	95% Confidence Interval		% of households	Median	Min..	Max
		Lower	Upper				
Fresh Fish and OAAs	27.9	23.4	32.3	100.0%	21.1	1.1	121.2
Fresh Fish est.	19.9	16.7	23.0	100.0%	15.0	0.8	86.4
OAA est.	8.0	6.7	9.3	100.0%	6.0	0.3	34.8
Fish Paste	0.3	0.2	0.5	21.9%	0.0	0.0	8.8
Other Fermented Fish	4.8	4.3	5.3	98.9%	4.0	0.0	23.7
Fish Sauce	2.8	2.6	3.0	98.5%	2.0	0.0	11.9
Smoked Fish	5.4	4.4	6.3	48.0%	0.0	0.0	131.7
Dried/salted Fish	9.2	6.5	11.9	66.9%	3.7	0.0	148.5
All Preserved Fish	22.5	18.9	26.0	99.7%	15.4	0.0	287.4
All Fish (Fresh and Preserved)	42.3	36.6	48.1	100.0%	33.4	6.1	298.7
All fish and OAAs	50.3	43.5	57.1	100.0%	40.5	6.4	303.2

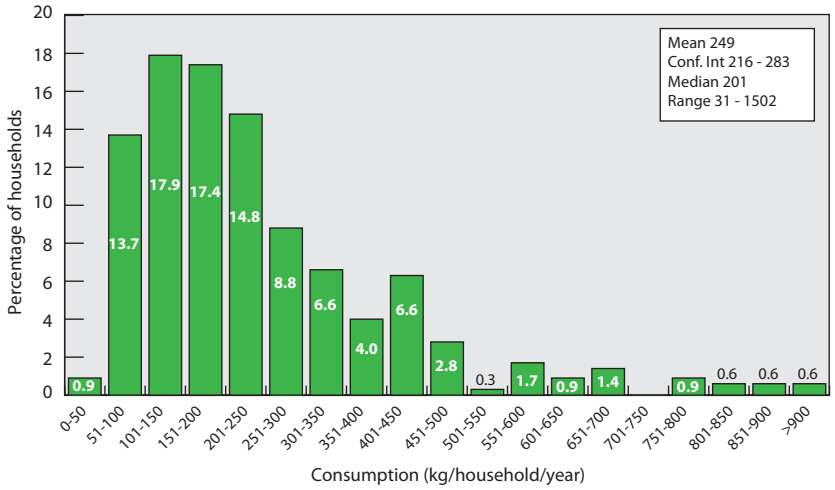

Figure 23. Distribution of consumption of all fish (fresh and preserved) and other aquatic animals by 351 households in the LSB, expressed as kg fresh whole animal equivalents (FWAEs).
Summary statistics are weighted by the sample frame.

Figure 23 shows that the distribution of household consumption of all fish and other aquatic animals is somewhat skewed, but less extremely than the distribution of household catches. Median consumption of 201 kg/household/year equates to about 41 kg/capita/year as a 'typical' consumption, or about 32 kg/capita/year as actual consumption (Table 18). Mean consumption of 249 kg/household/year is less than the estimated catch of 207 kg/household/year, but the difference is likely made up by aquaculture production of 22 kg/household/year as well as imports of fish. Considering the level of precision in the data, the production and consumption figures balance well.

Consumption in the entire lower Songkhram River Basin can be estimated by multiplying mean household consumption by number of households (165,554), which produces an estimate of 41.2 (35.6–46.8) kt/year as FWAEs.

Table 18. *Summary of reported consumption of fish and OAAs and other meat foods by 351 households in 27 villages as actual consumption in kg/capita/year.*
Statistics were weighted based on the sample frame. Fresh fish and OAAs was reported and 'Fresh fish' and 'OAA' quantities were estimated as proportions (see text) then were converted to actual weights to allow for losses during processing (see text). Preserved fish were reported as consumed as shown in this table. Eggs were estimated to weigh 50 grams each and converted to kg.

Category	Mean	95% Confidence Interval		% of households	Median	Min	Max.	Mean as Protein
		Lower	Upper					
Fresh Fish est.	15.9	13.4	18.4	100.0%	12.0	0.6	69.1	2.66
OAA est.	3.9	3.3	4.5	100.0%	3.0	0.1	17.0	0.54
Fresh Fish and OAAs	19.8	16.7	23.0	100.0%	15.0	0.7	86.1	3.20
Fish Paste	0.4	0.2	0.5	21.9%	0.0	0.0	10.0	0.03
Fermented Fish	6.4	5.7	7.1	98.9%	5.3	0.0	31.6	0.68
Fish Sauce	5.6	5.1	6.1	98.5%	4.0	0.0	23.7	0.41
Smoked Fish	2.1	1.8	2.5	48.0%	0.0	0.0	52.7	0.70
Dried/salted Fish	3.3	2.3	4.2	66.9%	1.3	0.0	52.7	1.17
All Preserved Fish	17.7	16.0	19.5	99.7%	15.3	0.0	115.1	3.00
All Fish (Fresh and Preserved)	33.6	29.8	37.4	100.0%	29.1	7.2	126.0	5.66
All fish and OAAs	37.6	33.2	41.9	100.0%	31.8	7.6	137.9	6.20
Poultry	7.2	5.4	9.1	90.6%	5.3	0.0	110.6	1.03
Eggs	6.9	6.2	7.6	93.3%	5.3	0.0	31.6	0.80
Pork	5.5	4.5	6.6	91.2%	3.2	0.0	52.7	0.97
Beef	3.9	3.1	4.7	80.9%	2.1	0.0	42.1	0.67
Wildlife	0.8	0.2	1.4	14.2%	0.0	0.0	26.3	0.03
Insects	0.7	0.3	1.1	20.5%	0.0	0.0	36.9	0.05
Goat/sheep	0.01	0.00	0.04	0.4%	0.0	0.0	3.2	0.00
Terrestrial Animals	25.1	19.8	30.5	99.7%	15.8	0.0	284.4	3.56
All Meats and Fish and OAAs	62.7	55.8	69.6	100.0%	55.1	11.2	242.7	9.76

In terms of actual consumption, as shown in Table 18, fish and other aquatic foods made up about 60% of the weight of all meat and fish foods, while terrestrial meats comprised about 40%. Poultry and eggs were the most important terrestrial meats, together making up over half of the total. Protein intake from all meat sources averaged 9.8 kg/capita/year, of which roughly equal proportions were derived from fresh fish and OAAs, preserved fish, and terrestrial animals (33%, 31% and 36% respectively). These actual intake figures show the dominant contribution of aquatic foods to overall animal-derived protein intake, and by extension, the importance of the wild capture fishery to people's health.

In the questionnaire, participants were asked to itemise the proportion of each category of fish and OAAs from capture, culture, purchase or a gift. For each household these proportions were converted to actual weights prior to calculating statistics, which were then re-converted to percentages. As shown in Figure 24, most (74%) of all fish and aquatic animals were reported to be derived from capture by each household, and virtually all of the remainder was purchased.

The proportion of preserved fish that was purchased was higher than the proportion of fresh fish (27% compared with 21%) but the difference (while possibly real) was not statistically significant because of high variance in the data.

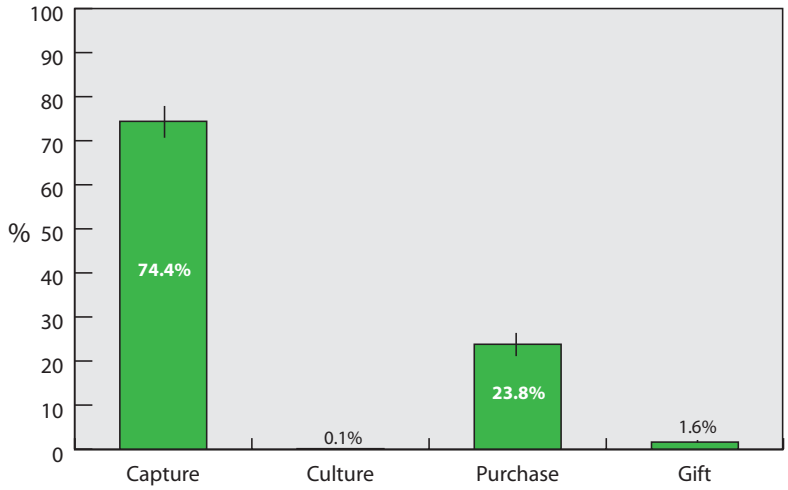

Figure 24. Sources of fish (including all preserved fish) and other aquatic animals in 351 households, based on consumption as kg/household/year as FWAEs.

In the LSB catches vary seasonally, so not surprisingly fresh fish and OAAs are eaten in significantly greater quantities during the wet season than during the dry season, when mean consumption was reported as about 32 and 24 kg/capita/year as FWAEs respectively (t-test, $p<0.01$). Mean per capita consumption of preserved fish (all categories combined) during the wet season was higher than during the dry (19 and 16 kg/capita/year as FWAEs respectively), but this difference was not statistically significant. Consumption of four of the five main kinds of preserved fish was not significantly different between the wet and dry seasons, but smoked fish was eaten in greater quantities during the wet season. These results suggest that people

eat rather constant quantities of preserved fish all year, but many households preserve fish by smoking in the wet season and eat them shortly thereafter. Consumption in the wet season is therefore greater than in the dry season both because more fresh fish/OAAs are eaten and also because more smoked fish are eaten shortly after smoking them.

It might be expected that lower consumption of fish/OAAs in the dry season would lead to increased consumption of other animals, especially domestic stock and poultry. There was a slight seasonal difference apparent in consumption of terrestrial animals (26 and 24 kg/capita/year in the dry and wet seasons respectively), but the difference was not statistically significant, nor was there any significant (nor apparent) seasonal difference for the seven groups of terrestrial animal foods.

Seasonality in food intake should be further investigated, for several reasons:

- questionnaires might be unreliable for this comparison as people often simply enter the same quantities for both seasons;
- the study was carried out during the dry season, which might have influenced people's recall of relative quantities; and
- high variance in the data and low effective sample size lead to limited power of tests to detect differences; i.e. more samples are required to reduce the chance of Type II errors.

It seems likely that households that catch more fish and OAAs would also eat more of these aquatic foods, but interestingly, there was no correlation between household catch and household consumption (r^2=0.051) and a wide scatter in the data. Households may have a certain desired level of consumption and simply purchase food to make up any daily deficit, or preserve or sell food to reduce any daily surpluses. Daily and seasonal supply/demand balance is clearly of considerable interest and relevance to development so should be investigated further, and it may be fruitful to examine some representative households' situation in detail rather than to collect more broadly based data.

4.3 Individual Sample Survey

During the household survey it was found that 499 people in total went fishing part-time. A total of 541 randomly selected people were then interviewed, and of these 428 people went fishing, so about 86% of all fishers were interviewed. The intention of interviewing individual fishers was to get better and more detailed information on catches per fisher with different gears and by habitat. However, the data were difficult to interpret because each fisher did not always fish alone, but with variable numbers of other people (up to 10 people per trip), including both other fishers from the same household and possibly from other households, with the catch divided. Moreover, some data on catches were incomplete. Individual data were therefore not used to estimate total catches, and the approach of using 'household catches' as followed above is recommended for future studies in the LMB where household fishing is the norm.

A useful result from the interviews of individual fishers was obtained from questioning about recall of their most recent fishing trip, which provided information about fishing and catches at the time of the survey, which was carried out during the dry season of January to May in the year 2000.

Table 19. *Summary of responses from 295 individual fishers about their most recent fishing trip, expressed as values (above) and percentages (below).*
Note that some fishers managed more than one 'operation' each trip and/or used more than one kind of gear within each gear type. Typical catch is the catch that they believed was typical for the gear and habitat being fished.

Gear Type	Operations	People	Units in use	Total Catch (kg)	Sum of Estimated Typical Catches (kg)
Bag-nets	2	7	3	2.0	1.3
Big traps	2	6	2	13.0	4.0
Cast-nets	138	196	141	156.8	276.6
Collection	20	23	20	17.6	22.4
Gill-nets	93	133	237	120.4	170.4
Hooks	15	20	1382	18.7	42.6
Lift-nets	19	30	20	22.1	39.2
Scoop-nets	33	50	33	23.2	22.0
Small traps	23	38	715	33.3	52.0
Spears	2	2	2	0.7	1.2
Total	347	505	2555	407.8	631.6

Gear Type	Operations	People	Units in use	Total Catch (kg)	Sum of Estimated Typical Catches (kg)
Bag-nets	0.6%	1.4%	0.1%	0.5%	0.2%
Big traps	0.6%	1.2%	0.1%	3.2%	0.6%
Cast-nets	39.8%	38.8%	5.5%	38.5%	43.8%
Collection	5.8%	4.6%	0.8%	4.3%	3.5%
Gill-nets	26.8%	26.3%	9.3%	29.5%	27.0%
Hooks	4.3%	4.0%	54.1%	4.6%	6.7%
Lift-nets	5.5%	5.9%	0.8%	5.4%	6.2%
Scoop-nets	9.5%	9.9%	1.3%	5.7%	3.5%
Small traps	6.6%	7.5%	28.0%	8.2%	8.2%
Spears	0.6%	0.4%	0.1%	0.2%	0.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 19 shows that the fishers caught a total of about 408 kg of fish and other aquatic animals during their most recent trip. Although only 295 fishers responded to this question, their answers represented 505 people, i.e. themselves as well as 210 others who fished with them during their most recent trip. The total number of fishers present during the most recent trip (505) closely approximates the total estimated number of fishers in the surveyed households (499), so the responses can be assumed to represent a snapshot of total 'recent trip'

fishing activity across the 353 surveyed households. Because there were on average 176 trips/year/household, an estimate for total catch from all households based on these data is 176 x 407.8 = 71,773 kg, or 203 kg/household/year (over all 353 households), an estimate which is remarkably similar to the estimate of 207 kg/household/year based on long-term recall. Short-term recall (usually of the previous 24 hours) is often considered to produce the most accurate estimates in interviews, so this concordance of results supports the catch estimate obtained in the household survey. Interestingly, the fishers judged that their catches overall were about 65% of their usual (i.e. typical) catches, which might be expected given the timing of the survey during the dry season, so perhaps using their most recent catches actually leads to an underestimate for total annual catches.

Fishers used 10 main kinds of gear (Table 20 and 21) and 27 types within these main categories. Although fishers used up to four types of gear, most fishers (275 or 93.2%) used only one type of gear in the previous 24 hours, but some used more than one sub-type of a gear within the main type. For example, one fisher used six different kinds of small traps and five fishers used both drifting and stationary gill-nets; because each sub-type was treated as a separate 'operation' the total number of 'operations' was 347.

Most fishing operations were in swamps or small streams, consistent with the data from long-term recall in the household survey. Gillnets and cast-nets were the most commonly used gears and caught the most fish. Table 20 shows that many gears were being used across a range of habitats, but there was some selective use of gears in certain habitats; e.g. cast-nets were used disproportionately in swamps and small streams.

Table 20. *The percentage of the total operations (347) in each habitat using each type of gear for the most recent fishing trip.*

Habitat	Bag nets	Big traps	Cast nets	Coll.	Gill-nets	Hooks	Lift nets	Scoop nets	Small traps	Spears	Sum
Man-made Reservoir			1.7%	0.3%	3.4%	0.6%	0.9%		0.3%		7.1%
Natural Lake					0.6%			0.3%	0.3%		1.1%
Natural Swamp		0.3%	20.3%	2.6%	8.0%	0.9%	1.1%	4.0%	4.0%	0.6%	41.7%
Perennial River	0.3%		2.0%		6.3%	1.1%	0.3%				10.0%
Pond			2.6%	0.3%	1.1%		0.3%				4.3%
Seasonal Canal			0.6%								0.6%
Small Stream	0.3%		10.6%	0.9%	6.6%	1.4%	2.3%	1.7%	0.6%		24.3%
Wet Rice Flood Inundated		0.3%		0.6%	0.3%				0.6%		1.7%
Wet Rice Irrigated				0.3%							0.3%
Wet Rice Rain fed			2.3%	0.9%	0.6%	0.3%	0.6%	3.4%	0.9%		8.9%
Total Nos.	0.6%	0.6%	40.0%	5.7%	26.9%	4.3%	5.4%	9.4%	6.6%	0.6%	100.0%

Table 21. *The percentage of the total catch of 407.8 kg caught by each type of gear in each kind of habitat in recent fishing trip catches.*

Habitat	Bag nets	Big traps	Cast nets	Coll,	Gill-nets	Hooks	Lift nets	Scoop nets	Small traps	Spears	Grand Total
Man made Reservoir			0.6%	0.1%	6.0%	0.5%	0.4%		0.2%		7.8%
Natural Lake					1.1%			0.1%	0.7%		2.0%
Natural Swamp		2.9%	17.8%	1.8%	9.5%	0.7%	0.7%	3.6%	5.3%	0.2%	42.5%
Perennial River	0.2%		1.6%		5.8%	1.0%	0.7%				9.3%
Seasonal Canal			0.2%								0.2%
Small Stream	0.2%		13.2%	0.7%	5.7%	1.3%	2.3%	0.7%	0.5%		24.6%
Wet Rice Flood Inundated		0.2%		0.2%	0.2%				0.5%		1.2%
Wet Rice Irrigated				0.2%							0.2%
Wet Rice Rain fed			1.6%	0.2%	0.4%	1.1%	1.0%	1.3%	0.9%		6.5%
Pond			3.5%	1.0%	0.9%		0.2%				5.6%
Sum	0.5%	3.2%	38.5%	4.3%	29.5%	4.6%	5.4%	5.7%	8.2%	0.2%	100.0%

Table 21 shows that the most productive habitat-gear combinations in terms of total catches were cast-nets used in swamps and small streams, with gillnets and small traps also producing high catches when used in swamps. These data confirm the importance of these habitats and gears as interpreted from the household data.

Fishers were asked to itemise the weight of their most recent catch and the proportion of the catch made up of the five most abundant species. These percentages were converted to weights and the total weights of each species caught by each gear in each habitat were calculated. The catch records included 872 individual records of species. Data are summarised by species in Appendix 11. Fishers itemised 56 species of fish and 8 taxa of other aquatic animals (OAAs). Fish made up about 93% of the total weight of the catch, but OAAs are likely to be under-represented in these catches during the dry season, as most OAAs (amphibians, snails, aquatic insects and rice field crabs) are found in greatest abundance in flooded rice fields. Only two species of exotic fishes were identified, Nile tilapia and common carp, comprising only 2.4% and 0.05% of the catch by weight, so the fauna is almost entirely (97.5%) indigenous.

Figure 25 shows that eight species made up about 76% of the catch of fish, and these included three widespread 'black fish' taxa: (*Channa striata*, *Clarias macrocephalus* and *Anabas testudineus*), air-breathing fish that live their entire lives in still or slow-flowing water bodies. These eight species were similarly dominant in terms of occurrence in catches, making up 69% of individual species-catch records.

Figure 26 shows the relative importance of black fish and white or grey fish[1] ; of the black

1 Black fish are air-breathing fish that can spend their entire lives on floodplain habitats and are well-defined morphologically and behaviourally. Grey and white fish migrate short and long distances respectively from rivers and streams onto flood plains to feed; they are intolerant of anoxia and generally require dry-season refuges in well-oxygenated water, typically deep pools. There are insufficient data to classify many Mekong system fishes as grey or white, so they are combined in one group here.

fish most (50%) were snakeheads (Channidae), 35% were walking catfish (Clariidae), and 11% were climbing perch (Anabantidae). Of the white or grey fish, 76% were cyprinids, 15% were bagrid catfish and 4% were featherbacks (Notopteridae).

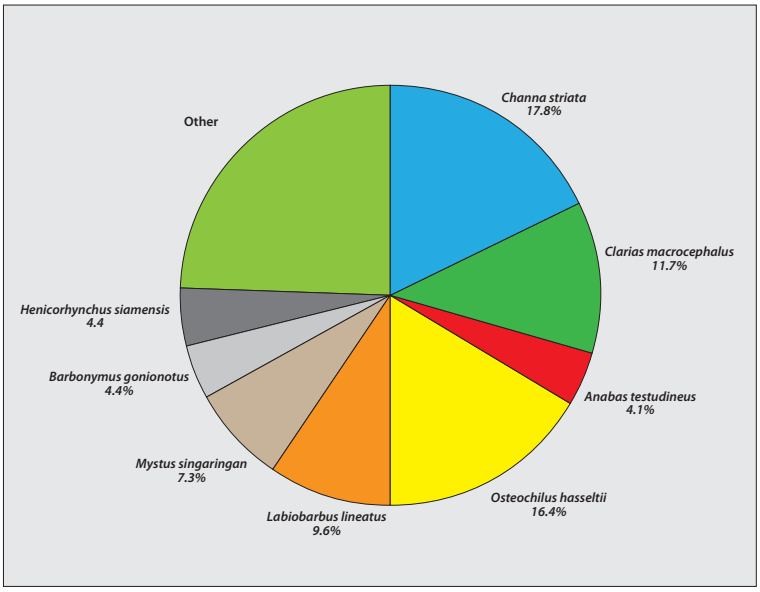

Figure 25. The percentage of the eight most abundant species of fish in the most recent catches of 298 responding fishers.

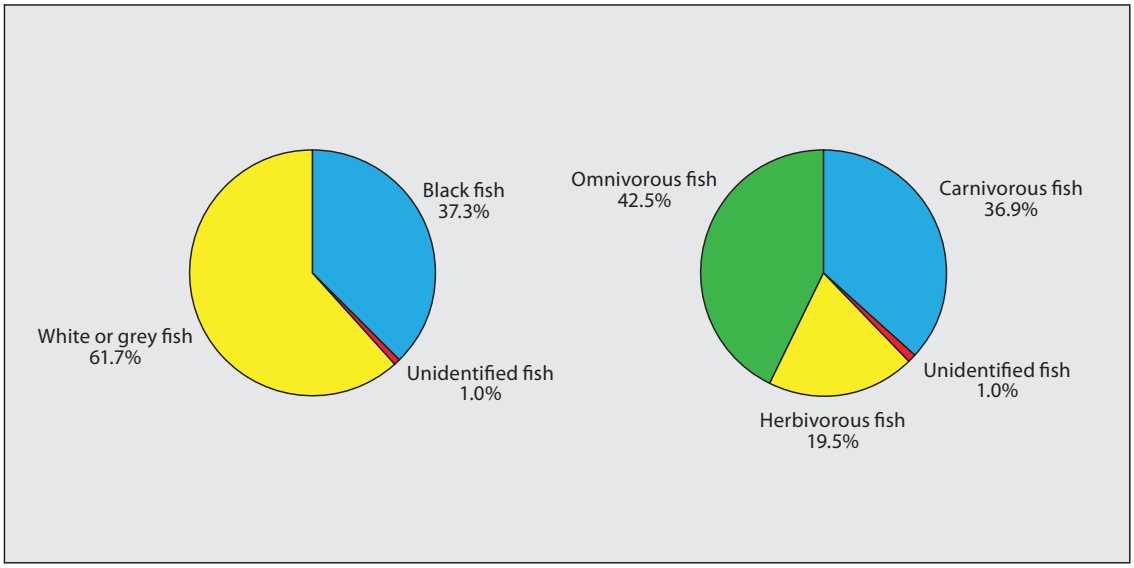

Figure 26. The proportion by weight of black and white or grey fish in recent fish catches (left) and the proportion of fish categorised by trophic group (right).
Fish species and categories are shown in Appendix 11.

Despite the extent of rice fields and other floodplain habitats favoured by black fish, white or grey fish (those that live in flowing waters for most of their lives) made up most of the total catch of indigenous fish, as shown in Figure 26, confirming the importance of streams and rivers to which white and grey fishes must return in the dry season, as they are intolerant of anoxia and the extreme conditions in residual floodplain habitats.

Overall, the fish catch comprised mainly omnivores and carnivores, with herbivores of less importance. Within the black fish group, carnivores were dominant, comprising 85% of the weight of catches, with the remaining 15% comprising omnivores. Black fish live in rice fields and swamps, where insects, frogs, crabs and small fish are seasonally abundant and can support a carnivore assemblage. Within the white/grey fish group, about 60% of the catch comprised omnivores, 32% herbivores, and only 9% comprised carnivores. The relatively low proportion of carnivores in the white/grey fish catch may reflect some degree of 'fishing-down' of the larger species found in rivers and streams, an expected effect of fishing pressure, which appears to be high. Nevertheless, it is likely that the fish assemblage is quite resilient and adapted to fishing pressure, as is considered a typical characteristic of floodplain fisheries (Welcomme, 2001).

5. Conclusions and recommendations

This study has produced useful quantitative information on a large and representative sample of villages and households in the lower Songkhram River Basin. The main findings from the study can be summarised as follows.

The census of 776 village leaders produced a very high proportion of returns, but many returns did not provide reliable data for quantities (such as gears). While the preparation and training for the survey were adequate, it was somewhat over-ambitious to ask too many questions of anonymous respondents, especially where numerical estimates were involved. In future, more explanation should accompany census forms, questions requiring numerical estimates should be minimised, and the survey plan should include following-up on incomplete or incorrect forms by visiting village leaders and/or returning their forms with explanations and requests for corrected information. The most useful information resulted from categorical questions (such as rating the current status of fisheries) so future censuses should focus on such questions. The village census has been interpreted assuming that respondents were representative, as seems realistic based on the similarity of some results to the sample survey, but any future surveys should test this assumption.

Some key findings of the village census were:

- Fisheries are important or very important for income in about 89% of villages and for food in about 99% of villages.

- About 80% of households fish part-time and about 6% fish commercially, about 19% of households do not fish.

- Most village leaders (56%) believed that the fisheries situation had worsened over the previous five years and only 28% felt that fisheries were better.

- The main reasons given for fisheries being worse was less fish, more fishers or both, but habitat change and over-fishing were also significant. Where fisheries were considered to have become better the main reason was improved prices or profit, but habitat improvement was considered the most significant factor improving catches.

- About half of the villages reported they had set up community-based fisheries management strategies which aimed to implement such measures as ‘no-fishing’ or conservation areas, closed seasons and gear restrictions.

- When asked how the government could improve fisheries, village leaders most commonly requested improving habitat for wild fish and stocking natural water bodies

with fry, and there was apparently relatively little support for aquaculture. These results should be very useful in informing government efforts to improve fisheries.

- The village census showed that modern gears such as cast nets, gillnets and hooks, as well as some traditional gears such as small traps are widespread and found in almost all villages, but the census did not produce accurate estimates of gear numbers.

The sample survey of 353 households within 27 randomly sampled villages produced more reliable quantitative data than the census, because surveyors 'on-the-ground' could verify and check numerical values, but could not obtain the broad coverage of the census. The clustered-random design resulted in smaller effective sample sizes than would result from a simple random sample of households, which then caused lower precision than desirable for the mean estimates for some variables. Consideration should be given to stratifying villages and households prior to surveying, particularly for catch and aquaculture production, as these variables are particularly skewed by some high-catch fishing households or by aquaculture households which are likely to be concentrated in certain areas. Increasing the number of villages (and sampling fewer households per village) may also lead to more precise estimates for some variables.

The main findings of the sample survey of the 27 village leaders were as follows:

- Information was collected and summarised on the general socioeconomic situation of the households, which are considered typical of those within the lower Songkhram River Basin.

- Most village land (80%) is agricultural and most (95%) of this is rice paddies.

- About 43% of the land floods for at least one month per year, providing extensive habitat for wild fish production.

- Aquaculture was of limited importance in the surveyed villages; only 15% of households owned ponds and most were not being actively managed for aquaculture and only 3% of households owned fish cages.

- The most important economic activities for households were labour (non-fisheries), cash remittance (i.e. sent to the household by family members working elsewhere) and rice farming, for 42%, 27% and 17% of households respectively.

- The most important activities for subsistence were rice-farming, capture fisheries and livestock farming, practised by 92%, 92% and 82% of household respectively.

The main findings of the sample survey of 353 households were as follows.

- Households comprised between 1 and 10 people, with an average of 4.95 people/ household.

- About 68% of all people were in the workforce, i.e. they had a full- or part-time job. There were very few full-time fishers, only about 0.2% of the workforce, but 42% of the workforce classed themselves as part-time fishers. Other fisheries activities or aquaculture were of very minor importance. Most of the workforce (75%) classed themselves as full-time rice farmers, but 36% were both rice-farmers and fishers.

- About 93% of households had at least one full-time rice farmer, and about 93% of households had at least one part-time fisher so were classed as part-time fishing households, a similar percentage to that estimated by village leaders. These occupations dominated household economic activities, and about 89% were both rice-farming and fishing households.

- Farming and fishing were overwhelmingly the most important activities for household food supply, while farming, various kinds of trading or businesses and wage labour were the main sources of income. Fisheries were relatively unimportant for income: about 28% of households sold wild fish, about 4% sold aquaculture-products, and about 13% made money from other fisheries-related activities.

- Males and females both engaged in a range of occupations. Gender differences include: about 74% of part-time fishers were male, about 60% of fish processors were women, about 92% of handicraft workers were women and about 89% of government workers were male.

- The most important activities for household food supply were rice farming, fishing and fish processing, and the most common income-earning activities were wage labour, rice farming and other farming, but other activities, including selling fish, were also common. About 84% of households rated both fisheries and rice farming as important for food.

- Households owned on average 2.5 ha of land, of which most was rice paddies, and most households also owned livestock or poultry.

- About 93% of households owned gear and went fishing; households owned on average three kinds of gear, the most common being gillnets, cast nets and hooks.

- Fishing effort varies about two-fold during the year and is least intense during the dry season (November–April), intermediate intensity during the early wet (May–July), and most intense during the wet season (August–October).

- Households accessed up to five kinds of habitats and travelled up to three hours to fish, but the average travel time was 17 minutes. The most-fished habitats were natural swamps, wet rice-rainfed paddies, reservoirs, small streams, and perennial rivers. The highest catches/trip were in natural habitats, such as swamps, lakes, small streams and perennial rivers. Compared to their area, these natural habitats were disproportionately targeted by fishers compared for example to rice paddies which cover most of the landscape.

- Fishing households fished on average for 127 days per year to catch 222 kg of fish and other aquatic animals; averaged over all households the annual catch was 207 kg/household/year. Over the entire lower Songkhram River Basin the catch estimate is about 34.3 (26.2–42.4) kt/year.

- About 32% of households owned ponds, but only 23% used them for aquaculture and only two households had fish cages. Total aquaculture production was about 22 kg/household/year, but much of this may have been wild fish trapped in ponds during the flood recession. From the entire LSB, aquaculture production is estimated as about 3,708 tonnes, or approximately 10% of the entire fishery production including both capture and culture fisheries.

- Consumption of all fish and other aquatic animals as FWAEs was about 50.3 kg/person/year, or about 249 kg/household/year, which balances with the catch estimates allowing for aquaculture and imports as well as the level of precision in the data. For the entire LSB consumption is estimated at 41.2 (35.6–46.8) kt/year.

- Fish and other aquatic foods made up about 60% of the weight of all animal protein actually consumed. The most important terrestrial meats were poultry and eggs. Fresh fish and OAAs, preserved fish, and terrestrial meats contributed about 33%, 31% and 37% respectively of animal protein intake in people's diets.

- Most fish and OAAs are caught by households for their own consumption (74.4% on average) and the remainder is purchased. Households eat more fresh fish and OAAs during the wet than during the dry season, but similar amounts of most types of preserved fish in each season, with the exception that more smoked fish is apparently eaten during the wet season. Smoking fish may be a short-term way of preservation. There was no apparent difference in seasonal consumption of other meats.

- Households that catch more do not appear to eat more fish and OAAs. It seems probable that households regulate their day-to-day consumption by preserving catches and by buying and selling for their daily needs. Household food supply/demand balance and seasonality would be interesting subjects for further study.

The main findings from interviews of 428 individual fishers about their most recent catches were:

- The most commonly used gears were cast-nets, gillnets and various kinds of traps, and most effort and catches were in swamps and small streams, as might be expected because the interviews were carried out during the dry season.

- Extrapolation from the most recent catches (short-term recall) gave a total catch over all households of 203 kg/household/year (41.0 kg/person/year), remarkably similar to the estimate from long-term recall of 207 kg/household/year (41.8 kg/person/year).

- The fauna is largely indigenous. Fishers caught about 56 species of fish and 8 taxa of OAAs, of which only two species (of fish) were exotic and both were caught made up a small proportion of catches. About 93% of these dry season catches comprised fish and 7% comprised OAAs.

- The fish catch comprised about 37% black fish and 62% white/grey fish, with 1% unidentified, showing the importance of rivers and streams to the fishery.

- About 37% by weight of the fish catch comprised carnivores, 42% comprised omnivores and 21% herbivores. Most of the black fish catch comprised carnivores whereas most of the white/grey fish catch was omnivores or herbivores. Trophic diversity is partly a consequence of a diversity of habitats and may result in some level of resilience to fishing pressure.

Overall, the study showed that in the year 2000 fishing was of considerable importance for people living in the lower Songkhram River Basin. Typically, households include rice-farmers and part-time fishers, but the importance of fishing is under-recognised officially. Despite extensive modification of the landscape, the wild capture fishery, dependent on remnant natural habitats and the natural flood-pulse, contributed on average about two thirds of the household intake of animal protein. The importance of the capture fishery to nutrition should be given appropriate weight in government policy on development within the LSB. Most villagers perceived that the fishery situation was getting worse because of increasing fishing pressure and habitat degradation, but there is also a strong perception that government can improve the situation by improving habitat and enforcing fisheries regulations. There was relatively little development of aquaculture within the LSB and relatively little support for government aid to aquaculture compared to support for the capture fishery.

Comparisons with other studies

The lower Songkhram River Basin is the last system in northeast Thailand which still floods in a natural pattern each year and which is still connected to the Mekong. It seems reasonable to assume that other large tributaries in this region, for example the Mun-Chi system, would have supported similar floodplain fisheries prior to their alteration by water management schemes. However, there are no quantitative baseline data that could be usefully used to test this assumption.

Saengrut (1998) interviewed a representative sample of 180 households spread through the lower Chi valley, an area where rivers and streams have been modified by dams and where the landscape is largely deforested and intensively farmed, and where most farmers believe the wild fishery has seriously declined in productivity. Nevertheless, 81.1% of respondents went fishing each year, commonly in swamps, wetlands and rice fields, a similar percentage to that recorded in this study. Cast-nets, gillnets and lift nets were the most commonly used gears and 53 species of fish were recorded, compared with 56 in this study. About 68% of households

had trap ponds compared with only 32% in this study. The total wild fish catch was about 36.4 kg/person/year, of which 54% was from trap ponds and 46% was from fishing[1] . This catch estimate is about 87% of the estimate for catches of fish plus OAAs (41.8 kg/person/year) from the lower Songkhram River Basin, and if OAAs had been included in Saengrut's study (see comparative estimates in Table 24 below) it is likely that the per capita fisheries production from the lower Chi area would in fact be very similar to or possibly even higher that from the lower Songkhram River. Therefore, the wild fishery continues to be very important in the lower Chi, an area where most people believe it has seriously declined, because farmers can compensate to some extent for the loss of natural aquatic resources by building trap ponds which provide dry-season refuges as well as improving the efficiency of capture. Aquaculture in the lower Chi study was only being practised by about 22% of households (similar to 23% in this survey) and aquaculture production added only 1.4 kg/person/year, or about 4% of the total production. Despite a significant effort on extension and the availability of government-supplied fry, most farmers in the lower Chi (as in the lower Songkhram River Basin) were not interested in aquaculture for a range of reasons, including technical problems, lack of capital and theft. The wild fishery clearly shows more promise, particularly for poor or landless people, but suffers from its status as a common-property resource. Trap ponds provide some degree of protection for the wild fishery, reasonable security of ownership of most of the fish for farmers, are relatively low-tech and also can support other uses. It is therefore not surprising that trap ponds are becoming increasingly common throughout northeast Thailand.

The number of species recorded by fishers in this study (56) is much less than the total number of 146 listed for the Songkhram River Basin by Yingcharoen and Virapat (1998), probably because of limited coverage of habitats and because only dry-season catches were recorded in this study. Fishers may also have combined some similar species under one name.

Based on the comparative data in Table 22, the estimated yield per unit area from the LSB wetlands of 78.9 (60.2 – 97.5) kg/ha appears to be well within the range which would be expected from a system which comprises mainly seasonally flooded rice fields and remnant forest and swamp. Hence it would be incorrect to conclude that the Songkhram River is unusually productive for the region, rather it is likely that when seasonal flooding is maintained or if it were to be restored in other lowland parts of the basin, similar yields can be expected.

The consumption figures recorded in this study can be compared with those found during other household studies in northeast Thailand and in Lao PDR (Table 23).

The the consumption values from the LSB are quite similar to the estimates from other studies in northeast Thailand. Given possible errors in the data, (for example the other studies probably under-estimated preserved fish as they did not include all categories), there is little basis for suggesting any difference in total per capita consumption of fish and OAAs in different parts of northeast Thailand.

1 The trap pond production seems reasonable because yield per unit area can be high. For example, Middendorp (1992) reported an average yield of 209 kg/ha (based on the area of ricefields) of wild fish from trap ponds in one area of northeast Thailand.

Table 22. *Comparative data for yield per unit area.*

Mekong System - Floodplains

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Mekong Delta Floodplain, deepwater flooded areas	Rice fields, blackwater area	42–63	Fish 46.9% OAAs 53.1%	Intensive monitoring at one site	de Graaf and Chinh (2000)
Mekong Delta Floodplain, deepwater flooded areas	Rice fields, non-acid area	80–119	Fish 88.9%, OAAs 11.1%	Intensive monitoring at one site	
Battambong, near Great Lake, Cambodia	Rice fields, single crop rain fed	66–165, mean 119	Fish 76.5%, OAAs 23.4%	Yields from 10 plots of 25 ha each, monitoring of all catches	Troeung *et al*. (2005)
Northeast Thailand	Rice fields, wild fish	25-125	Fish	Range from one study in Khu Khat	Little *et al*. (1996)
	Rice fields, wild and stocked	56–303		Range from two sites	
Uplands, Lao PDR	Rice fields, stocked with fry	31–640 per crop	Fish, mostly exotic	Range from several studies, approximate	Funge Smith (1999b)
Prey Veng, Cambodia	Rice fields, single-crop, former forest	55	Fish	Includes only large and middle-scale fisheries catches in fishing lots, does not include artisanal catch	Troeung *et al*. (2003)
Prey Veng, Cambodia	Degraded forest 31% cover and rice fields, single crop	92	Fish		
Battambong, near Great Lake, Cambodia	Flooded forest	95	Fish		

Other rivers - Floodplains - wild fish

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Africa, South America, Asia	Tropical floodplain rivers	typically 40–60, range 7–143	Fish?	Review of data	Welcomme (1985) p. 214 and Table 7.13
Bangladesh	Unregulated Floodplains 8 studies	51–215	Fish	Intensively fished	Ali (1997) Table 31
Bangladesh	Floodplain enclosed by levees	77–102	Fish	Intensively fished	Ali (1997) Table 33 - non-stocked yield only
Bangladesh	Open floodplain	423–574	Fish	Intensively fished	Ali (1997) Table 33 - non-stocked yield only
Bangladesh	Floodplain low-lying areas with permanent water bodies	165	Fish	Intensively fished	de Graaf *et al*. (2001)
Bangladesh	Floodplain seasonally inundated	83	Fish	Intensively fished	
Bangladesh	Rivers and riparian land	102–157	Fish	Intensively fished	
Bangladesh	Floodplain — Natural	104–130	Fish	Intensively fished	Halls *et al*. (1999)
	Floodplain — Modified	51–81	Fish	Intensively fished	
Malaysia	Rice fields, wild fish	68–140	Fish	Double rice cropping, artisanal fishery	Tan *et al*. (1973), cited in Fernando (1993) Table 3

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

Study Area	Habitats	Yield (kg/ha/year)	Composition	Comment	Source
Tonle Sap system	Floodplain, total	230	Fish?	Crude estimate.	Baran, van Zalinge, Ngor, Baird, and Coates (2001)
Tonle Sap floodplain	Floodplain, total for 1995–99	139–190	Fish?	Crude estimate.	Lieng and van Zalinge (2001)
Prey Veng, single rice rain fed, low-moderate yield	Rice fields	50–100	Fish?	Estimates based on catches, villages may not be representative, approximate area	Guttman (1999)

Table 23. *Comparison of consumption results from this study with other studies in northeast Thailand and Lao PDR. All units are kg/capita/year as FWAEs (fresh whole animal equivalent weights). Note that in this study and in Luang Phabang inland fresh fish and OAAs were recorded as a single category which was then apportioned to fish and OAAs based on the proportions recorded in Champassak.*

Study area	Northeast Thailand			Lao PDR	
Category	Five Provinces	Khon Kaen & Nakhon Ratchasima	Lower Songkhram River Basin	Champassak, southern Lao PDR	Luang Phabang, northern Lao PDR
Fresh Fish	21.3	30.1	19.9	25.6	11.36
Fermented Fish	4.0		4.8	5.1	2.0
Fish Paste			0.3	0.0	0.3
Fish Sauce			2.8	0.0	0.5
Smoked Fish			5.4	0.1	0.9
Salted Dried Fish		6.4	9.2	6.4	12.4
Preserved Fish	4.0	6.4	22.5	11.6	16.2
Total Inland Fish	25.3	36.5	42.3	37.2	27.5
Total OAAs	7.8		8.0	10.3	4.6
Inland Fish + OAAs	33.1		50.3	47.5	32.1
Canned fish marine	5.9	1.4		0.5	0.5
Total Fish	39.0	37.9	42.3	37.7	28.0
Data sources	Prapertchob *et al.* (1989)	Piumsomboun (2001)	This study	Hortle (2007)	Sjorslev (2000)

Compared with the LSB, in other parts of northeast Thailand there is probably less consumption of wild-capture fish from natural habitats (especially as preserved fish), but to compensate people eat more fish caught from trap ponds as well as eating fish grown in aquaculture and marine products. The LSB results also appear very similar to those for Champassak Province, where data were weighted to reflect that 92% of the population live on the floodplain or along the river system and are still largely dependent on fisheries for subsistence, as they are in the lower Songkhram River Basin. In northern Lao PDR, people consume somewhat less aquatic foods, as might be expected in a more mountainous terrain with limited seasonally inundated areas.

The LSB figures can also be compared with consumption estimates for the entire LSB, based on the review of Hortle (2007) as shown in Table 24. The estimates for the lower Songkhram River Basin are above-average for total inland fish and OAAs, and higher than country averages for all countries except Cambodia, which has large fisheries around the Tonle Sap—Mekong floodplains. The LSB has a much higher proportion of preserved fish than country averages, which seems consistent with extreme seasonality and reliance on capture fisheries in the LSB. The consumption lower Songkhram River Basin of all aquatic animal foods is identical to that estimated for the lower Mekong Basin mean; elsewhere in northeast Thailand and also in Viet Nam marine products compensate for lower consumption of inland fishery products.

Table 24. *Comparison of estimates of mean consumption in lower Songkhram River Basin with those from countries in the LMB.*

OAA (other aquatic animals), fresh whole animal equivalent weights (FWAEs). Country estimates from Hortle (2007).

Categories	Estimated consumption in the LMB (kg/capita/year as FWAEs)					
	Cambodia	Lao PDR	Thailand	Viet Nam	LMB Weighted Average	Lower Songkhram River Basin
Inland Fresh Fish	27.4	17.5	21.3	27.4	24.1	19.9
Inland Preserved Fish	14.8	17.1	10.7	12.2	12.5	22.5
Total Inland Fish	42.2	34.6	32.0	39.5	36.6	42.3
Inland OAAs	9.2	8.4	8.5	9.2	8.8	8.0
Inland Fish plus OAAs	51.4	43.0	40.5	48.7	45.5	50.3
Marine Products	1.0	0.5	5.8	7.4	4.9	0.0
Total Fish and OAAs	52.4	43.5	46.2	56.1	50.3	50.3

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Appendix 1 Summary information on the sampling frame for the 27 villages, showing weightings used for analysing the household data

Village Code	Province	District	Sub-district	Village name	No. of inhabitants	No. of households (N)	Sample HHs (S)	% sampled in the village	Individual HH weighting (N/S/4,175)*353
THA01	Nakhon Phanom	Tha-Utain	Chaiburi	Kaeo Pad Pong	919	198	21	10.61%	0.797
THA02	Nakhon Phanom	Tha-Utain	Phanom	Had Kuan	1,200	157	15	9.55%	0.885
THA03	Nakhon Phanom	Ban Phaeng	Nong Waeng	Don Klang	542	83	9	10.84%	0.780
THA04	Nakhon Phanom	Srisongkram	Sri Songkhram	Nong Ba Tao	897	167	16	9.58%	0.883
THA05	Nakhon Phanom	Srisongkram	Sam Phong	Sam Phong	418	108	10	9.26%	0.913
THA06	Nakhon Phanom	Srisongkram	Ban Kha	Ban Kha	738	169	12	7.10%	1.191
THA07	Nakhon Phanom	Nawa	Na Ngua	Na Kra Thum	207	47	6	12.77%	0.662
THA08	Nakhon Phanom	Nawa	Na Ngua	Non Sa-ad	222	58	4	6.90%	1.226
THA09	Nakhon Phanom	Nawa	Ban Sieo	Don Pra Thay	644	150	14	9.33%	0.906
THA10	Nakhon Phanom	Nawa	Lao-phatthana	Don Por	1,100	178	19	10.67%	0.792
THA11	Nakhon Phanom	Nawa	Lao-phatthana	Na Noi	1,600	253	17	6.72%	1.258
THA12	Nakhon Phanom	Nawa	Lao-phatthana	Don Por	1,027	191	19	9.95%	0.850
THA13	Nakhon Phanom	Na Thom	Na Thom	Lao Som Poy	758	145	15	10.34%	0.817
THA14	Nakhon Phanom	Na Thom	Don Toei	Don Toei Nua	528	148	18	12.16%	0.695
THA15	Sakonnakhon	Kusuman	Na Phiang	Kung Sri	695	121	11	9.09%	0.930
THA16	Sakonnakhon	Akat Amnuai	Phon Ngam	Phon Ngam	1,374	406	20	4.93%	1.716
THA17	Sakonnakhon	Akat Amnuai	Wa Yai	Kud Jok Yai	431	105	10	9.52%	0.888
THA18	Sakonnakhon	Kam Ta Kla	Na Tae	Don Kam	673	136	10	7.35%	1.150
THA19	Sakonnakhon	Kam Ta Kla	Phaet	Dong Bang	1,113	239	13	5.44%	1.554
THA20	Nong Khai	SeKa	Sang	Nong Yang	500	97	9	9.28%	0.911
THA21	Nong Khai	SeKa	Tha Kok Daen	Nong Bua Daeng	560	100	11	11.00%	0.769
THA22	Nong Khai	SeKa	Pong Hai	Tha Chang	971	240	18	7.50%	1.127
THA23	Nong Khai	SeKa	Pong Hai	Non Ta Pha	290	58	6	10.34%	0.817
THA24	Nong Khai	SeKa	Nam Chan	Tha Muang	970	191	14	7.33%	1.154
THA25	Nong Khai	Phon Charoen	Sri Chomphu	Ban Non	940	176	14	7.95%	1.063
THA26	Nong Khai	Bung Khong Long	Bung Khong Long	Sok Phok	460	109	10	9.17%	0.922
THA27	Nong Khai	Bung Khong Long	Pho Mak Khaeng	Dong Sawang	1,914	145	12	8.28%	1.022
Totals	3 provinces	11 districts	23 sub-districts	27 villages	21,691	4,175	353		

Appendix 2 Village census. Frequency of gear types reported per village, based on returns from 349 villages

Gear Type	Gear Name	No. of Villages with gear	% with gear	95 per	LCL	UCL
Bag-nets	Total	190	54.4%	2.7%	57.1%	51.8%
	Beach seine	1	0.3%	0.3%	0.6%	0.0%
	Small Barrage	181	51.9%	2.7%	54.5%	49.2%
	Trawl	43	12.3%	1.8%	14.1%	10.6%
Big traps	Total	163	46.7%	2.7%	49.4%	44.0%
	Arrow shaped trap	15	4.3%	1.1%	5.4%	3.2%
	Barrages	38	10.9%	1.7%	12.6%	9.2%
	Lee trap	127	36.4%	2.6%	39.0%	33.8%
	Pond trap	35	10.0%	1.6%	11.6%	8.4%
Collection	Total	233	66.8%	2.5%	69.3%	64.2%
	Collection by coop-like trap	190	54.4%	2.7%	57.1%	51.8%
	Collection by hand	1	0.3%	0.3%	0.6%	0.0%
	Collection with scoop basket	165	47.3%	2.7%	50.0%	44.6%
Cast nets	Total	338	96.8%	0.9%	97.8%	95.9%
Gill-nets	Total	326	93.4%	1.3%	94.7%	92.1%
	Drifting, at bottom	3	0.9%	0.5%	1.4%	0.4%
	Drifting, at surface	133	38.1%	2.6%	40.7%	35.5%
	Stationary	305	87.4%	1.8%	89.2%	85.6%
Hooks	Total	302	86.5%	1.8%	88.4%	84.7%
	Long line, bottom set	160	45.8%	2.7%	48.5%	43.2%
	Pole with single hook and line	290	83.1%	2.0%	85.1%	81.1%
	Set hook with float	123	35.2%	2.6%	37.8%	32.7%
Lift-nets	Total	295	84.5%	1.9%	86.5%	82.6%
	Big lift-net on raft	48	13.8%	1.8%	15.6%	11.9%
	Big lift-net on shore	35	10.0%	1.6%	11.6%	8.4%
	Small lift-net	278	79.7%	2.2%	81.8%	77.5%
Other	Total	76	21.8%	2.2%	24.0%	19.6%
	Electricity	24	6.9%	1.4%	8.2%	5.5%
	Rifles or shotguns	59	16.9%	2.0%	18.9%	14.9%
	Unspecified	14	4.0%	1.1%	5.1%	3.0%
Scoop-nets	Total	282	80.8%	2.1%	82.9%	78.7%
	Large scoop net	56	16.0%	2.0%	18.0%	14.1%
	Small scoop net	259	74.2%	2.3%	76.6%	71.9%
	Small trawl	122	35.0%	2.6%	37.5%	32.4%
Small traps	Total	310	88.8%	1.7%	90.5%	87.1%
	Attractant Basket	107	30.7%	2.5%	33.1%	28.2%
	Bamboo Tube Eel Trap	133	38.1%	2.6%	40.7%	35.5%
	Barbed Rattan Cone	201	57.6%	2.7%	60.2%	54.9%
	Basket Eel Trap	211	60.5%	2.6%	63.1%	57.8%
	Basket Frog Trap	235	67.3%	2.5%	69.8%	64.8%
	General fish traps	267	76.5%	2.3%	78.8%	74.2%
	Two funnel trap	24	6.9%	1.4%	8.2%	5.5%
	Upright Basket Trap	139	39.8%	2.6%	42.4%	37.2%
	Wedge Cone Trap	122	35.0%	2.6%	37.5%	32.4%
Spears	Total	207	59.3%	2.6%	61.9%	56.7%
	Bow and arrow	1	0.3%	0.3%	0.6%	0.0%
	Harpoon	200	57.3%	2.7%	60.0%	54.7%
	Spear	8	2.3%	0.8%	3.1%	1.5%

Note: Statistics are weighted based on the sampling frame. N=349.

Appendix 3 Household ownership of economically important items

Item	Unit	Mean	95% Confidence Interval	
			Lower	Upper
1-storey house	%	20.6%	16.1%	25.0%
2-storey house	%	75.8%	71.1%	80.4%
Shop house	%	3.7%	1.7%	5.6%
House Size	m^2	83.9	76.6	91.1
Bricks	%	0.3%	-0.3%	0.8%
Concrete-Wood	%	26.8%	22.1%	31.5%
Concrete	%	6.8%	3.9%	9.6%
Leaves-Grass	%	0.5%	-0.2%	1.2%
Ply-wood	%	0.3%	-0.3%	0.8%
Wood	%	65.4%	60.3%	70.5%
Roof Asbestos	%	1.5%	0.3%	2.7%
Roof Ceramic Tile	%	1.1%	0.0%	2.2%
Roof Corrugated Iron	%	96.9%	95.1%	98.7%
Roof Grass-Leaves	%	0.5%	-0.2%	1.2%
Wood Boat	%	24.5%	19.9%	29.2%
Boat Length	m	5.5	5.2	5.9
Car	%	24.7%	20.1%	29.4%
Kubota car	%	18.0%	13.9%	22.2%
Pick-up	%	6.0%	3.4%	8.6%
Saloon	%	0.2%	-0.2%	0.7%
Truck	%	0.5%	-0.2%	1.2%
Telephone	%	0.7%	-0.1%	1.6%
Television	%	95.9%	93.9%	98.0%

Note: Statistics are weighted based on the sampling frame. Most are shown as proportions of the total sample. N=353.

Appendix 4 Summary of household engagement in economic activities

Activity	Full-time			Part-time		
		95% Confidence Interval			95% Confidence Interval	
	Mean	Lower	Upper	Mean	Lower	Upper
Aquaculture	0.0%	0.0%	0.0%	2.7%	0.9%	4.5%
Fishing	0.9%	-0.2%	1.9%	92.9%	89.7%	96.2%
Fish processing	0.0%	0.0%	0.0%	0.6%	-0.3%	1.6%
Fish selling	0.2%	-0.2%	0.6%	1.4%	0.0%	2.8%
Gear making	0.4%	-0.2%	1.0%	1.0%	0.0%	2.1%
Combined group Other fisheries activity	0.6%	-0.3%	1.6%	2.9%	1.1%	4.7%
Rice Farmer	92.9%	90.1%	95.7%	7.5%	4.7%	10.3%
Other farming	0.8%	-0.1%	1.7%	20.6%	14.7%	26.6%
Daily labour	32.9%	28.6%	37.2%	53.0%	46.5%	59.6%
Handicraft	2.3%	0.4%	4.2%	28.7%	18.8%	38.7%
Business	1.0%	-0.2%	2.1%	5.7%	2.7%	8.7%
Miller	0.0%	0.0%	0.0%	0.3%	-0.3%	0.8%
Petty trading/shop	4.0%	2.1%	5.9%	7.6%	3.9%	11.4%
Repair shop	0.8%	-0.1%	1.8%	2.1%	0.4%	3.7%
Transport service	1.3%	0.0%	2.6%	1.9%	0.5%	3.3%
Combined group Trading or business	6.3%	3.2%	9.3%	16.0%	10.6%	21.3%
Government service	6.8%	4.6%	9.0%	1.1%	-0.1%	2.3%
Handicapped	1.0%	-0.9%	2.9%	0.0%	0.0%	0.0%
School/college	69.3%	64.8%	73.8%	2.3%	0.2%	4.3%
Unemployed	44.5%	39.0%	49.9%	0.0%	0.0%	0.0%

Notes: Statistics are weighted based on the sampling frame. Shown as % of 353 households. Highlighted groups were combined for graphs. Note component activities do not sum to group totals because some households engaged in more than one activity within the group.

Appendix 5 Breakdown of the economic activities of people in each household by gender

Breakdown by numbers (n=1,741, no response=2)

Activity	Female			Male			Grand Total
	Full-Time	Part-Time	Total	Full-Time	Part-Time	Total	
Business	1	12	13	2	14	16	29
Daily labour	77	102	179	98	207	305	484
Fish culture		8	8		12	12	20
Fish processing		3	3		2	2	5
Fish selling		5	5	1	4	5	10
Fishing	1	128	129	2	367	369	498
Gear making		2	2	2	3	5	7
Government service	3		3	20	4	24	27
Handicapped				2		2	2
Handicraft	9	107	116	2	8	10	126
Miller					1	1	1
Other farming	3	51	54	1	71	72	126
Petty trading/shop	18	25	43	10	23	33	76
Repair shop				3	10	13	13
Rice Farmer	414	15	429	463	27	490	919
School/college	188	4	192	209	2	211	403
Transport service		1	1	5	5	10	11
Unemployed	121		121	86		86	207
Grand Total	835	463		906	760		1,741

Breakdown by percentage

Activity	Female			Male			Grand Total
	Full-Time	Part-Time	Total	Full-Time	Part-Time	Total	
Business	3.4%	41.4%	44.8%	6.9%	48.3%	55.2%	1.7%
Daily labour	15.9%	21.1%	37.0%	20.2%	42.8%	63.0%	27.8%
Fish culture	0.0%	40.0%	40.0%	0.0%	60.0%	60.0%	1.1%
Fish processing	0.0%	60.0%	60.0%	0.0%	40.0%	40.0%	0.3%
Fish selling	0.0%	50.0%	50.0%	10.0%	40.0%	50.0%	0.6%
Fishing	0.2%	25.7%	25.9%	0.4%	73.7%	74.1%	28.6%
Gear making	0.0%	28.6%	28.6%	28.6%	42.9%	71.4%	0.4%
Government service	11.1%	0.0%	11.1%	74.1%	14.8%	88.9%	1.6%
Handicapped	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.1%
Handicraft	7.1%	84.9%	92.1%	1.6%	6.3%	7.9%	7.2%
Miller	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.1%
Other farming	2.4%	40.5%	42.9%	0.8%	56.3%	57.1%	7.2%
Petty trading/shop	23.7%	32.9%	56.6%	13.2%	30.3%	43.4%	4.4%
Repair shop	0.0%	0.0%	0.0%	23.1%	76.9%	100.0%	0.7%
Rice Farmer	45.0%	1.6%	46.7%	50.4%	2.9%	53.3%	52.8%
School/college	46.7%	1.0%	47.6%	51.9%	0.5%	52.4%	23.1%
Transport service	0.0%	9.1%	9.1%	45.5%	45.5%	90.9%	0.6%
Unemployed	58.5%	0.0%	58.5%	41.5%	0.0%	41.5%	11.9%
Grand Total	48.0%	26.6%		52.0%	43.7%		100.0%

Note: Statistics are weighted based on the sampling frame.

Appendix 6 Importance of household activities for food supply and income

Activity	Food Supply			Income		
	Mean	95% Confidence Interval		Mean	95% Confidence Interval	
		Lower	Upper		Lower	Upper
Aquaculture	15.1%	10.6%	19.6%	3.5%	1.2%	5.8%
Fishing	86.8%	80.6%	93.0%	25.2%	17.4%	33.0%
Professional fishing	1.0%	-0.1%	2.1%	2.2%	0.1%	4.2%
All fishing	**87.7%**	**81.9%**	**93.5%**	**27.5%**	**19.0%**	**36.1%**
Making, selling or repairing fishing gear	0.8%	-0.1%	1.8%	1.0%	0.0%	2.0%
Processing aquatic animals	67.2%	59.7%	74.7%	5.1%	2.6%	7.5%
Sale of aquatic animals	0.0%	0.0%	0.0%	1.6%	0.1%	3.1%
Wage labour (fishery related)	0.0%	0.0%	0.0%	6.5%	3.9%	9.1%
All other fishing acts	**67.2%**	**59.7%**	**74.7%**	**13.4%**	**9.5%**	**17.4%**
Rice farming	**94.1%**	**91.3%**	**96.9%**	**52.2%**	**41.9%**	**62.5%**
Grow vegetables	35.2%	28.9%	41.5%	5.0%	1.9%	8.1%
Looking after livestock	41.7%	35.9%	47.5%	20.9%	15.0%	26.7%
Tend an orchard	7.7%	4.2%	11.3%	2.9%	1.2%	4.6%
Other Farming	**96.0%**	**94.0%**	**98.0%**	**59.6%**	**50.1%**	**69.1%**
Wage labour (not fishery related)	0.0%	0.0%	0.0%	65.3%	58.6%	72.1%
Make Handicrafts	0.0%	0.0%	0.0%	24.8%	14.7%	34.9%
Barber	0.0%	0.0%	0.0%	0.8%	-0.3%	1.9%
Miller	0.0%	0.0%	0.0%	0.3%	-0.3%	1.0%
Trading (not fish related)	0.0%	0.0%	0.0%	15.3%	11.0%	19.6%
Transport service (land or water)	0.0%	0.0%	0.0%	4.9%	3.0%	6.7%
Trading or business	**0.0%**	**0.0%**	**0.0%**	**83.7%**	**78.5%**	**88.8%**
Government service	0.0%	0.0%	0.0%	4.5%	2.2%	6.8%
Cash Remittance	1.6%	-1.1%	4.3%	15.6%	9.4%	21.7%
Rice Farming and Fishing	83.8%	77.6%	90.1%	15.6%	9.2%	22.1%

Note: Statistics are weighted based on the sampling frame. Shown as % of 353 households. Highlighted groups were combined for graphs, note component activities do not sum to group totals because some households engaged in more than one activity within the group.

Appendix 7 Land ownership by households and access to commons land

Land-use	% of households with land-use	Area (ha) mean	95% Confidence Interval		Percent of total of owned land
			Lower	Upper	
Aquaculture ponds	27.6%	0.042	0.018	0.066	1.7%
Cash crops other than rice	8.6%	0.135	-0.012	0.282	5.3%
Floating rice	1.4%	0.018	-0.008	0.044	0.7%
Home-stead	93.8%	0.077	0.063	0.091	3.0%
Irrigated rice	4.6%	0.038	0.003	0.073	1.5%
Orchards	12.7%	0.048	0.019	0.078	1.9%
Paddy rice	95.0%	2.132	1.802	2.463	84.0%
Upland/Dry rice	3.1%	0.037	-0.006	0.080	1.5%
Vegetable garden	42.6%	0.012	0.004	0.020	0.5%
Total without commons		**2.540**	**2.000**	**2.877**	**100.0%**
Commons access forest/scrub	5.0%	0.249	-0.010	0.508	
Commons access grassland/grazing	1.3%	0.002	-0.001	0.006	
Total including commons		**2.791**	**2.535**	**3.047**	

Note: Statistics are weighted based on the sampling frame. N=353, Area (ha/household).

Appendix 8 Livestock and poultry ownership by households

Breed	wtd % of hhs	Mean No. of animals/hh	95% Confidence Interval	
			Lower	Upper
Chicken	67.1%	10.48	7.44	13.51
Duck	30.4%	3.34	2.48	4.20
Cow	15.7%	0.76	0.38	1.15
Buffalo	15.4%	0.60	0.36	0.84
Other fowl	7.7%	0.58	0.23	0.93
Pig	6.3%	0.35	0.02	0.69
Others	0.3%	0.04	-0.04	0.11
Sheep and goats	0.3%	0.02	-0.02	0.05

Note: Statistics are weighted based on the sampling frame. N=353

Appendix 9 Habitats fished and distances travelled.

Habitats fished/ household	Mean	95% Confidence Interval		N	% of households	Min.	Max.
		Lower	Upper				
No. of habitats fished	2.3	2.1	2.5	327	100%	1	5
Distance to habitats (minutes)	Mean	95% Confidence Interval		N	% of households	Min.	Max.
		Lower	Upper				
Floodplain Grassland	20	20	20	1	0.30%	20	20
Floodplain Swamp/ Marsh	10.9	7	14.9	55	14.90%	2	30
Floodplain Trees/ Shrubs	5	5	5	1	0.30%	5	5
Man made Reservoir	15.7	9.2	22.3	91	30.00%	3	60
Natural Lake	16.6	0	129.3	9	2.40%	5	60
Natural Swamp/Marsh	20.7	17.8	23.7	158	44.50%	1	90
Perennial River	23.4	14.7	32.1	104	28.70%	3	180
Public Pond	15	15	15	1	0.20%	15	15
Seasonal Canal	20	20	20	1	0.20%	20	20
Small Stream	13.5	11.1	15.9	105	31.00%	2	40
Wet Rice Flood Inundated	38	0	93	10	2.40%	5	155
Wet Rice Rain fed	15.1	11.8	18.4	210	60.30%	1	120
Average Distance for each household	16.7	15.2	18.3	327	100%	4	93

Note: Statistics are weighted based on the sampling frame. N=327.

Appendix 10 Summary information on catch and effort data by habitat

	Habitat	Mean	95% Confidence Interval	
			Lower	Upper
Frequency (HHs)	Floodplain Grassland	0.3%	-0.3%	0.8%
% of 353 hhs visiting the habitat	Floodplain Swamp/Marsh	14.9%	9.0%	20.9%
	Floodplain Trees/Shrubs	0.3%	-0.3%	0.8%
	Public Pond	0.2%	-0.2%	0.7%
	Manmade Reservoir	30.0%	12.9%	47.2%
	Natural Lake	2.4%	-1.6%	6.4%
	Natural Swamp/Marsh	44.5%	28.5%	60.6%
	Perennial River	28.7%	16.5%	40.9%
	Seasonal Canal	0.2%	-0.2%	0.7%
	Small Stream	31.0%	16.0%	45.9%
	Wet Rice Flood Inundated	2.4%	-0.6%	5.4%
	Wet Rice Rainfed	60.3%	50.0%	70.7%
	All habitats	**93.0%**	**89.5%**	**96.5%**
Habitats visited	**No. of Habitats/Household**	**2.15**	**1.93**	**2.38**
Trips/household/year to the habitat	Floodplain Grassland	0.13	-0.13	0.38
	Floodplain Swamp/Marsh	7.66	4.39	10.92
	Floodplain Trees/Shrubs	0.06	-0.06	0.18
	Public Pond	0.00	0.00	0.01
	Manmade Reservoir	24.63	6.36	42.89
	Natural Lake	2.06	-2.17	6.29
	Natural Swamp/Marsh	43.37	21.63	65.11
	Perennial River	21.51	8.40	34.61
	Seasonal Canal	0.04	-0.05	0.13
	Small Stream	22.21	8.41	36.01
	Wet Rice Flood Inundated	0.91	-0.33	2.15
	Wet Rice Rainfed	40.09	30.75	49.43
Total trips/hh/year	Total	162.67	136.77	188.57
Trip catch	Floodplain Grassland	1.00	1.00	1.00
kg/household/trip	Floodplain Swamp/Marsh	1.84	1.15	2.52
	Floodplain Trees/Shrubs	0.58	0.58	0.58
	Manmade Aquaculture Pond	2.00	2.00	2.00
	Manmade Reservoir	1.56	0.98	2.14
	Natural Lake	2.02	-3.34	7.38
	Natural Swamp/Marsh	1.71	1.42	2.01
	Perennial River	1.48	0.85	2.10
	Seasonal Canal	1.50	1.50	1.50
	Small Stream	1.18	0.95	1.41
	Wet Rice Flood Inundated	0.72	-0.09	1.52
	Wet Rice Rainfed	1.10	0.97	1.24
Annual catch	Floodplain Grassland	0.13	-0.13	0.38
kg/household/year	Floodplain Swamp/Marsh	16.85	7.92	25.79
	Floodplain Trees/Shrubs	0.04	-0.04	0.11
	Public Pond	0.00	0.00	0.01
	Manmade Reservoir	30.36	6.89	53.83
	Natural Lake	3.97	-4.25	12.18
	Natural Swamp/Marsh	51.62	24.57	78.66
	Perennial River	33.70	4.36	63.04
	Seasonal Canal	0.07	-0.07	0.20
	Small Stream	22.97	6.43	39.51
	Wet Rice Flood Inundated	0.48	-0.08	1.05
	Wet Rice Rainfed	46.76	27.10	66.42
Total catch (kg/hh/year)	**Total**	**206.94**	**157.96**	**255.93**

Notes: Statistics are weighted based on the sampling frame. N=353, includes 26 non-fishing households.

Appendix 11 Summary of the most recent catches from interviews of 295 fishers during the dry season in 2000

Group	Family	Species	Total Catch	No. of Fisher Records	Fish OAA	English Name	Thai Name	Black/White	Feeding Category
INDIGENOUS FISH	Anabantidae	*Anabas testudineus*	15.56	57	Fish	Climbing perch	*mhor, kheng*	Black	Omnivorous
	Ariidae	*Hemiarius stormii*	0.20	1	Fish	Armoured sea catfish	*kod ta-lay*	White/Grey	Omnivorous
	Bagridae	*Hemibagrus nemurus*	5.64	15	Fish	Bronze catfish	*kung*	White/Grey	Carnivorous
	Bagridae	*Hemibagrus wyckioides*	0.80	2	Fish	Asian redtail catfish	*kod keaw, kerng*	White/Grey	Carnivorous
	Bagridae	*Mystus bocourti*	0.05	1	Fish	Bocourt's mystus	*ka yhang tong, kun tong*	White/Grey	Carnivorous
	Bagridae	*Mystus singaringan*	27.53	34	Fish		*ka yhang bai, khao, ka yang bai khao*	White/Grey	Omnivorous
	Belonidae	*Xenentodon cancila*	0.60	2	Fish	Freshwater garfish	*ka tung heio, sob tong*	White/Grey	Carnivorous
	Channidae	*Channa gachua*	0.60	3	Fish	Walking snakehead	*kang*	Black	Carnivorous
	Channidae	*Channa lucius*	1.00	2	Fish	Spotted snakehead	*ka song, ka jon*	Black	Carnivorous
	Channidae	*Channa striata*	67.67	127	Fish	Striped snakehead	*chon, kor*	Black	Carnivorous
	Clariidae	*Clarias batrachus*	4.00	15	Fish	Philippine catfish	*duk dan*	Black	Omnivorous
	Clariidae	*Clarias macrocephalus*	44.34	104	Fish	Broad-headed catfish	*duk oui*	Black	Carnivorous
	Cyprinidae	*Barbonymus altus*	1.20	1	Fish	Red tailed tinfoil	*tapien thong, lian fi*	White/Grey	Omnivorous
	Cyprinidae	*Barbonymus gonionotus*	16.86	27	Fish	Java barb	*ta pien khao, pak*	White/Grey	Omnivorous
	Cyprinidae	*Barbonymus schwanenfeldii*	6.60	12	Fish	Goldfoil barb	*lien fai*	White/Grey	Omnivorous
	Cyprinidae	*Cirrhinus microlepis*	0.70	2	Fish	Small-scaled mud carp	*nuan chan, pon*	White/Grey	Omnivorous
	Cyprinidae	*Cirrhinus molitorella*	0.60	2	Fish	Mud carp	*gang*	White/Grey	Herbivorous
	Cyprinidae	*Cyclocheilichthys armatus*	1.40	3	Fish		*sai ton ta khao*	White/Grey	Omnivorous

Note: Information on feeding and status as black or white/grey fish was obtained from MRC (2003) and Froese and Pauly (2007)

Group	Family	Species	Total Catch	No. of Fisher Records	Fish OAA	English Name	Thai Name	Black/White	Feeding Category
	Cyprinidae	*Hampala dispar*	2.82	11	Fish	Spotted barb	*kra sube jud, sude*	White/Grey	Carnivorous
	Cyprinidae	*Hampala macrolepidota*	0.40	1	Fish	Hampala barb	*kra suub kheed*	White/Grey	Omnivorous
	Cyprinidae	*Henicorhynchus lobatus*	0.60	1	Fish	Mud carp	*soi lord*	White/Grey	Herbivorous
	Cyprinidae	*Henicorhynchus siamensis*	16.73	39	Fish	Jullien's mud carp	*peek dang*	White/Grey	Omnivorous
	Cyprinidae	*Labeo chrysophekadion*	1.16	2	Fish	Black sharkminnow	*ka dum, e-tuu*	White/Grey	Herbivorous
	Cyprinidae	*Labiobarbus lineatus*	36.49	50	Fish		*kui rham*	White/Grey	Omnivorous
	Cyprinidae	*Lobocheilos melanotaenia*	0.60	1	Fish	Black stripe minnow	*soi dok yang*	White/Grey	Herbivorous
	Cyprinidae	*Mystacoleucus marginatus*	4.50	3	Fish		*nham lung*	White/Grey	Herbivorous
	Cyprinidae	*Osteochilus hasseltii*	62.26	118	Fish	Nilem carp	*khao e-thai*	White/Grey	Herbivorous
	Cyprinidae	*Osteochilus lini*	0.40	1	Fish		*soi nok khao nah mhong*	White/Grey	Herbivorous
	Cyprinidae	*Osteochilus schlegelii*	0.90	2	Fish		*soi bua*	White/Grey	Herbivorous
	Cyprinidae	*Poropuntius deauratus*	0.40	2	Fish			White/Grey	Omnivorous
	Cyprinidae	*Puntioplites proctozysron*	0.02	1	Fish		*ka mung*	White/Grey	Omnivorous
	Cyprinidae	*Puntius binotatus*	0.60	1	Fish		*ta pien nam tok*	White/Grey	Omnivorous
	Cyprinidae	*Puntius orphoides*	5.15	4	Fish	Javan barb	*gam chum*	White/Grey	Omnivorous
	Cyprinidae	*Rasbora borapetensis*	5.14	25	Fish	Blackline rasbora	*sue hang dang*	White/Grey	Omnivorous
	Cyprinidae	*Rasbora trilineata*	4.86	11	Fish	Three-lined rasbora	*sue hang gungai*	White/Grey	Omnivorous
	Cyprinidae	*Thynnichthys thynnoides*	1.20	1	Fish		*soy kled tee, kum*	White/Grey	Herbivorous
	Eleotridae	*Oxyeleotris marmorata*	0.30	2	Fish	Marble goby	*bu trai*	White/Grey	Carnivorous
	Mastacembelidae	*Macrognathus siamensis*	2.31	9	Fish	Peacock eel	*lod na*	White/Grey	Carnivorous
	Mastacembelidae	*Mastacembelus armatus*	0.10	1	Fish	Tiretrack eel	*lod dum, lard*	Black	Omnivorous
	Nandidae	*Pristolepis fasciata*	4.52	12	Fish	Malayan leaffish	*mhor chang yieb, kar*	White/Grey	Omnivorous
	Notopteridae	*Chitala lopis*	0.16	1	Fish	Indonesian featherback	*sa tue*	White/Grey	Carnivorous

Group	Family	Species	Total Catch	No. of Fisher Records	Fish OAA	English Name	Thai Name	Black/White	Feeding Category
	Notopteridae	*Chitala ornata*	1.30	4	Fish	Clown featherback	*krai, tong krai*	White/Grey	Carnivorous
	Notopteridae	*Notopterus notopterus*	6.75	10	Fish	Bronze featherback	*sa-lard, tong*	White/Grey	Omnivorous
	Osphronemidae	*Trichogaster pectoralis*	1.20	3	Fish	Snakeskin gourami	*sa lid*	Black	Omnivorous
	Osphronemidae	*Trichogaster trichopterus*	0.37	4	Fish	Three spot gourami	*kra dee mor, kra derd*	Black	Carnivorous
	Osphronemidae	*Trichopsis vittata*	3.13	19	Fish	Croaking gourami		Black	Carnivorous
	Sciaenidae	*Boesemania microlepis*	0.90	2	Fish	Boeseman croaker	*mah, kueng*	White/Grey	Omnivorous
	Siluridae	*Hemisilurus mekongensis*	0.40	1	Fish	Mekong sheatfish	*dung dang*	White/Grey	Carnivorous
	Siluridae	*Micronema apogon*	0.85	1	Fish	Sheatfish	*nam ngern, nang*	White/Grey	Carnivorous
	Siluridae	*Micronema bleekeri*	0.90	1	Fish	Bleeker's sheatfish	*nang, nang dang*	White/Grey	Carnivorous
	Siluridae	*Ompok urbaini*	2.35	14	Fish	Butter catfish	*sa yhum porn, suam*	White/Grey	Carnivorous
	Siluridae	*Wallago attu*	0.05	1	Fish	Great white sheatfish	*kao khao, kao*	White/Grey	Carnivorous
	Siluridae	*Wallago leerii*	1.00	1	Fish		*koon*	White/Grey	Carnivorous
	Synbranchidae	*Monopterus albus*	0.08	1	Fish	Swamp eel	*lhai na, eian*	Black	Omnivorous
	Unidentified	*Unidentified fish species*	3.65	19	Fish	Unidentified fish species		Unid	nd
INTRODUCED FISH	Cyprinidae	*Cyprinus carpio*	0.20	1	Fish	Common carp	*nai*	White/Grey	Omnivorous
	Cichlidae	*Oreochromis niloticus*	9.20	11	Fish	Nile tilapia	*nin*	White/Grey	Herbivorous
OTHER AQUATIC ANIMALS	Several	*Aquatic insects*	0.45	2	OAA	Aquatic insects			MIXED
	Several	*Amphibians*	3.94	11	OAA-Amphibian	Adult frogs and toads	*khead*		Carnivorous
	Several	*Tadpoles*	1.30	6	OAA-Amphibian	Tadpoles			Herbivorous
	Several	*Molluscs*	0.21	2	OAA-Clam	Mussels			Omnivorous
	Somanniathelphusidae	*Rice field crabs*	0.11	2	OAA-Crab	Crabs			Omnivorous
	Palaeomonidae/ Atyidae	*Shrimps*	19.42	45	OAA-Shrimp	Shrimps			Omnivorous
	Several	*Molluscs*	2.25	2	OAA-Snail	Snails			Herbivorous

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