New approaches

for the improvement of
inland capture fishery statistics
in the Mekong Basin

Ad-hoc expert consultation
Udon Thani, Thailand
2 to 5 September 2002

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RAP Publication 2003/01

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Food and Agriculture Organization of the United Nations
Mekong River Commission
Government of Thailand
Government of the Netherlands

DISCLAIMER

PREPARATION OF THIS DOCUMENT

This document contains the papers presented at the Ad Hoc Expert Consultation, held in Udon Thani from 2 to 5 September, 2002. The papers were compiled, edited and designed by Terry Clayton under the supervision of Simon Funge-Smith (FAO RAP), Devin Bartley (FAO Rome) and Chris Barlow (MRC Phnom Penh).

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Printed by Erewan Press, Bangkok, Thailand

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Opening Address

Governor of Udon Thani,
Distinguished Participants,
Ladies and Gentlemen,

It is my great pleasure to be among all of you who are attending the FAO, MRC, Government of Thailand and Government of the Netherlands "Expert Consultation on New Approaches for the Improvement of Inland Capture Fishery Statistics in the Mekong Basin". I sincerely hope that all of you had a pleasant journey and that you enjoy your stay in Udon Thani.

Inland capture fisheries make a valuable contribution to food security in many parts of the developing world and especially in the Mekong Basin. However, the contribution that inland fishery resources make to rural livelihoods is often unknown or underestimated due to a lack of basic production and consumption information. As a result, inland capture fisheries are often ignored or undervalued by decision-makers and development agencies.

On behalf of the Department of Fisheries, Thailand, I wish to express our heartfelt thanks to FAO, the Government of Netherlands and MRC for supporting this consultation to improve the state of knowledge on inland capture fisheries in the LMB.

Finally, I would like to wish this consultation every success, and hope that during your four days of deliberations you will come up with new and innovative ideas and approaches for building inland fisheries management systems and through this provide an impetus for the better management of inland fisheries so that its benefits can be shared among all peoples.

I now declare the consultation officially open. Thank you.

Oopatham Pawaputanon
Deputy Director-General
Department of Fisheries
Udon Thani, Thailand

Abstract

Inland capture fisheries provide a valuable contribution to food security in the Mekong Basin. However, official national estimates of this contribution have consistently been lower than estimates derived from more focused and localized fishery surveys. Thus, inland capture fisheries are undervalued by decision makers and development agencies. The poor state of knowledge on inland fisheries arises from the diverse nature of inland fisheries, that fisheries are often small-scale and dispersed over large areas, that inland fishers have inadequate political power, the misconception that inland fisheries are not valuable, the local consumption or bartering of inland fisheries harvest, and the excessive power of certain stakeholders that do not want the actual value known.

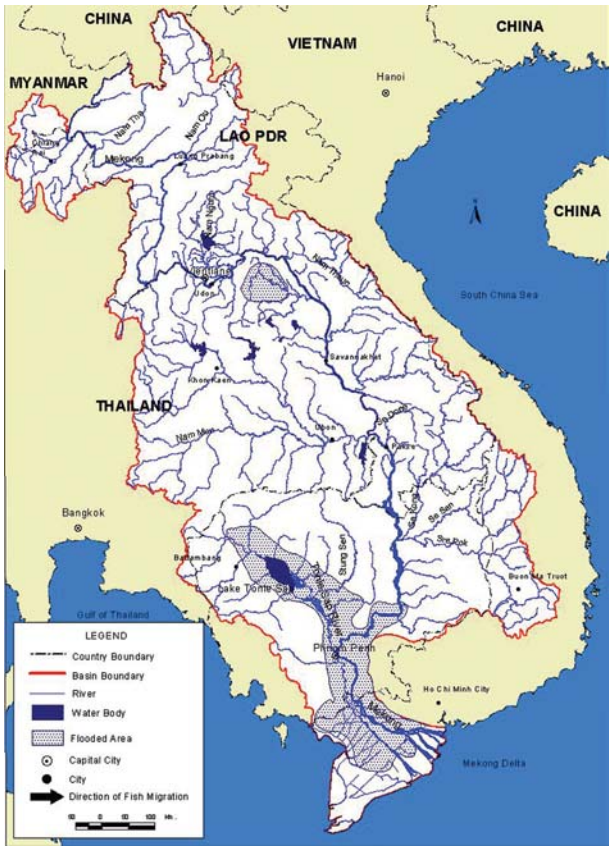
Development activities may then inappropriately focus on other sectors at the expense of rural communities that depend on inland fisheries. Accurate information on the contribution of inland fisheries is essential for responsible development. Key uses of accurate information identified at the Expert Consultation were: i) to determine the status and trends of the fishery and the environment, ii) to assess correctly the value of inland fisheries, iii) to allocate appropriate resources to the inland fishery sector, and iv) to fulfill international obligations.

In general, information collection in the Mekong is based on figures collected from government fishery officers assessing catch and effort data. These methods are best suited to formal, large-scale fisheries, but are inappropriate for many of the small-scale, informal fisheries of the Mekong Basin. Alternative approaches are being developed and evaluated that include individual fishers, household and communities, and proxy measures of fishery yield. Besides the traditional catch and effort surveys, approaches to improve information on inland fisheries were identified to include agriculture surveys, consumption studies (including household surveys), market surveys, geo-referenced information, habitat classification and measurement, and establishment of co-management or fishery user groups.

In the lower Mekong Basin, the primary information need was yield. The informal and formal fishery sectors must be treated differently to obtain accurate information on both. The results from focused studies on particular habits or fisheries can be extrapolated to provide information on a wider area within the basin. There is a strong seasonal component to the fisheries that must be considered and the capacity and status of local fishery officers must be increased in order to facilitate accurate reporting. Useful information already exists in project reports, with NGOs and IGOs, and in government offices that should be analyzed, and stakeholders in inland fisheries should form partnerships with other users of inland water resources.

"Inland capture fisheries are often under valued by decision-makers and development agencies."

Report of the Meeting



Inland capture fisheries provide a valuable contribution to food security in many parts of the developing world including the Mekong Basin. National production estimates have consistently underestimated fisheries production compared to recent figures derived from focused fisheries surveys. The actual contribution that inland fisheries resources make to rural livelihoods is often unknown or underestimated due to a lack of basic production and consumption information. More focused studies report 60 million people inhabiting the Mekong Basin, a yield of 2.3 million tonnes and a per capita fish consumption of 39 kg/year. Many of the 60 million inhabitants engage in small-scale fishing or fish only part-time and represent some of the least empowered and poorest people in society.

As a result, inland capture fisheries are often under-valued by decision-makers and development agencies. Development activities may then inappropriately focus on other sectors, such as agriculture, aquaculture, water extraction, hydroelectric development, navigation and land conversion at the expense of inland capture fisheries and rural communities. This results in a vicious circle that continues to impact on the poorest people.

An accurate understanding of the size, value and overall importance of inland fisheries is essential for managers making decisions on appropriate use of the resources on which the fisheries depend. Importance includes issues such as income generation, employment, food security and the role of fishing in rural societies. At the fishery resource level, fisheries managers and development agencies need to know what the objectives of management programmes are, what information is needed to manage and monitor the fisheries and then how that information can be systematically collected and interpreted.

The Food and Agriculture Organization of the United Nations (FAO) is an official repository for government statistics on inland capture fisheries production. The Mekong River Commission (MRC) in collaboration with other agencies has made significant progress in

improving the quality of information collected on inland capture fisheries through studies focused on specific areas or fisheries. The information demonstrates that officially reported production from the Mekong Basin is vastly underestimated. An accurate understanding of the size, value and overall importance of inland fisheries is essential for managers making decisions on appropriate use of the resources on which the fisheries depend. FAO is continually striving to improve the reliability of fishery information through increasing the capacity of FAO Members to collect good quality data in a cost-effective manner. FAO convened a Technical Consultation in March 2002 from which developed a draft Strategy on Improving Information on Status and Trends of Capture Fisheries. The outputs of this meeting will be considered by the FAO Committee on Fisheries in 2003.

Ad Hoc Expert Consultation

To address the concerns for better data, an *Ad-hoc* Expert Consultation on New Approaches for the Improvement of Inland Capture Fishery Statistics in the Mekong Basin was held in the Charoensri Grand Royal Hotel in Udon Thani, Thailand, from 2 to 5 September 2002. The consultation was convened with financial support from FAO, MRC, Government of Thailand and the Government of the Netherlands.

Objectives

The overall objective of the consultation was to improve the state of knowledge on inland capture fisheries in the sub-region.

Specific objectives were to:

- Raise awareness of the value of inland capture fisheries
- Provide guidance on collection of appropriate information on inland capture fisheries
- Assess and develop methodologies for rapid data collection
- Evaluate and identify the use and utility of inland fishery statistics
- Establish minimum data requirements for national and regional inland fishery management

Process

The programme of the consultation consisted of a presentation of country reports, thematic studies and case studies, followed by general discussion in plenary and further elaboration in working groups. The meeting was opened by Oopatham Pawaputanon, Deputy Director-General of the Department of Fisheries of Thailand, who welcomed the participants to Udon Thani. In his address, Dr. Pawaputanon stressed the importance and relevance of the Expert Consultation to the Mekong countries. Further opening remarks were delivered by the Governor of Udon Thani, Simon Funge-Smith (FAO) and Jeanineke Dahl Kristensen (MRC). Over 50 people attended the Expert Consultation including delegates from Cambodia, China, Lao PDR, Thailand and Viet Nam and invited experts and resources persons from the Asian Institute of Technology (AIT), The World Conservation Union (IUCN), the Southeast Asian Fisheries Development Center (SEAFDEC), The Mekong River Commission (MRC) and the Food and Agriculture Organization (FAO).

Output of the Ad Hoc Expert Consultation

Information needs

The types of information needed will depend on the intended uses of that information. There are several possible objectives of inland fishery management that can be generally classified into social, economic and conservation categories. The consultation identified the following priority objectives for collecting information on inland fisheries:

- To fulfil international obligations
- To ensure proper valuation of the fisheries
- To justify the requests for appropriate allocation of funding and other resources to the sector
- To obtain status and trend information on the fisheries and the environment for the

formulation and assessment of management interventions concerning the fishery

Whereas the simultaneous fulfilment of some objectives such as use and conservation may lead to conflict, most are not mutually exclusive and some fishery data may be appropriate for multiple objectives. The consultation further noted that there are layers of information needs: i) to establish baseline information, ii) for trend analysis, i.e. monitoring the resource and impacts of management decisions and iii) for specific objectives.

Status and trends of fishery and environment

Information on baseline conditions of the fishery and environment is a first step in managing a fishery for the benefit of the people who depend on inland water resources. Information on trends and how the resources respond to management interventions, development activities and environmental change will also be needed.

Yield of inland capture fisheries was cited as the priority information need. However, national statistics are inaccurate due to missing data, errors and exclusion of some fisheries. Some information does exist in project reports, but these reports have limited use for trend analysis as the data are not collected on a routine basis.

Other types of information include catch by species, length-frequency data, geographical distribution of fisheries and landing sites, effort and gear, price, fish export markets and consumption rates.

Habitat quality and quantity and, in particular, water quality and quantity (including water levels) were judged to be additional important information needs. The distribution and density of human population in the Mekong Basin were also considered significant factors.

Valuation of inland fisheries

In addition to data on the status of and trends within the fishery and monetary value of yield, information is needed on:

- market prices
- post harvesting activities
- per capita fish consumption
- employment along the chain of production
- flow-on effects along the chain of production
- nutritional value of fishery products in peoples' diets
- conversion factors from fresh to processed fish products
- the amount of fish products consumed at home by fishers
- the number, age and gender of people participating in the fishery
- the degree of dependence of rural households on fishery resources
- value of import/export and the balance of the two (includes national and foreign trade)

Accurate information on other sectors such as the value of crop or livestock production, number and types of people benefiting from hydroelectric development and tourism will be required to assess the comparative value of inland fisheries in relation to other uses for inland water resources.

Appropriate allocation of resources to inland fishery sector

With a comprehensive valuation in hand, inland fishery managers and policy makers need to convince national governments, donors and the international community to commit adequate financial and human resources to the sector. Therefore, information on the cost of fishery management, i.e. the operations, interventions and training, is needed before national governments can estimate budget requirements.

Fulfilment of international obligations

Countries of the Mekong Basin are signatories to several international agreements, codes and conventions that call for the sustainable use and conservation of biological diversity, the equitable sharing of benefits derived from such use, the protection of cultural heritage and the protection of important inland water habitats. Some of these international instruments are legally binding, such as the Convention on Biological Diversity,

while others are voluntary (the FAO Code of Conduct for Responsible Fisheries). In general, the participants were unfamiliar with the precise obligations of these instruments. Thus, a significant information need that emerged was to identify the requirements of international instruments in regards to inland fisheries. However, it does appear that information on the status of endangered species and historically, culturally or biologically important wetlands is important for fulfilling a number of international obligations.

Approaches to improve information

The consultation confirmed that inland fisheries in the Mekong Basin were extremely important, but that poor information on the status of the fisheries and the role they play in the economy of the region were preventing an accurate and comprehensive valuation of the sector. The poor state of knowledge on these fisheries arises from:

- The diverse nature of inland capture fisheries
- The fisheries are often small-scale and diffused over large areas
- Inadequate political power of many rural communities that rely on inland fishery resources
- The misconception that inland capture fisheries are of low value and not worth monitoring
- Much of the harvest is bartered or consumed locally and is not registered as part of the formal economy of a region
- Excessive power of certain stakeholders or sectors that do not want the true value of the resource known for personal or political reasons

In addition, official statistics are often estimates that may not be based on actual data. Major sources of error in these officially reported statistics are:

- Deliberate mis-reporting
- Lack of attention to small-scale fishing activities
- Lack of status, capacity or training of local fishery officers
- Errors in catch reporting (often field data is collected based on recall)
- Difficulty in accessing sources of information (women, children and other fishers far from population centres)
- A reluctance to report catches because this is linked, in most countries, to licence fees or other forms of taxation

In general, information collection methods in the Mekong are based on the application of traditional methods of government fishery officers assessing catch and effort data. These methods are best suited for formal, large-scale fisheries and are inadequate or inappropriate for the many informal, small-scale fisheries of the Mekong Basin. Thus, alternative approaches are being developed and evaluated that attempt to include individual fishers, households and communities. Additionally, indicators and proxy measures of fishery yield are being developed.

The consultation noted that data alone are not always enough to manage a fishery or develop fishery policy. Data must be analysed and transformed into meaningful information and this information delivered in an appropriate form to the people who are actually making decisions that affect the fisheries.

There are two general means to obtain information on inland fisheries: i) direct measurement of the fishery through frame surveys, catch assessment surveys, census at landing sites, creel census, counting number of fishers, gear, boats, etc. and ii) indirect measurements such as yield per type of habitat and extrapolation, GIS and remote sensing, post-harvest surveys such as consumption, financial, trade and household surveys. Direct measurement is not appropriate for the fisheries of the Mekong due to the variety of gear used; the scale of operations from subsistence to commercial; the geographic spread of the fisheries and the lack of centralized landing sites; the seasonality of fishing; and the number of species commercially exploited. For many of the indirect strategies, participatory approaches that involve the stakeholders will be necessary

to promote cooperation, information sharing and compliance with fishery management regulations.

The participants identified several priority activities for data collection. However, they also stressed that focusing on 'priorities' may hinder data collection if the wrong priority was chosen and if the information collection system became too rigid. There are already rigid, inflexible data collection systems in some areas and it would do little good to replace one for another.

The main alternative approaches were agricultural surveys, household surveys, consumption surveys, use of geo-referenced data coupled with habitat productivity information and fishery co-management. Each approach has strengths and weaknesses. Regardless of the approach used, training in survey techniques, participatory techniques and gender issues will be necessary to improve the quality of data collected.

Traditional catch and effort surveys

These direct measurement methods are most appropriate for large-scale fisheries or where fishers must be licensed. Although difficult in the Mekong Basin as a whole, specific areas, species or fisheries could be targeted to obtain accurate information on a specific aspect of a fishery. Census of a fishery landing was judged to be most feasible for large lakes and reservoirs. Tax and license systems can be used to provide information from certain fisheries, but this has not proved successful in some regions of the Mekong where licensing family and other small-scale informal fisheries is impractical. Problems in accessing accurate data may arise when fishers become too powerful or fisheries become too valuable which could lead to deliberate mis-reporting to avoid taxes or licensing fees.

Agriculture surveys

National censuses are being used to provide structural data and other economic and social information on the agriculture sector. With the inclusion of appropriate fishery-related questions they could also be used to generate similar information on inland fisheries, especially on their subsistence component. These censuses could also generate comprehensive listings of households engaged in fishing that could be used in sampling surveys. Currently, the structure, questions and terminology in many of the agricultural censuses lead to inaccuracies in regards to the fishery sector. Modifications will be necessary to provide useful inland fishery information. Generally it was considered that national surveys could be an effective tool to obtain information about particular aspects of fisheries.

An accurate understanding of the size, value and overall importance of inland fisheries is essential for managers making decisions on appropriate use of the resources on which the fisheries depend.

Some countries are adapting these surveys to meet the needs of the fishery sector. Lao PDR noted that the inclusion of one question on household expenditure revealed the important contribution of fish to overall consumption and corroborated the results of more detailed studies being undertaken in local areas. Viet Nam modified the household income expenditure survey to include the 'source of income' and discovered that nearly 70% of households engaged in some fishery and aquaculture activities. Thailand reported that questions on fisheries would not be included in the upcoming agriculture census due to the quinquennial Fishery Census due in 2003. Although the potential use of censuses for collection of data and information on inland fisheries was recognized as useful, they are large-scale exercises. Processing the data often takes considerable time resulting in long delays in getting the information to resource managers.

Consumption studies, including household surveys

Household consumption studies are increasingly used to estimate regional or national consumption

of fisheries products. More than 15 socio-economic surveys incorporating consumption estimates were undertaken in the Lower Mekong Basin in the late 1990s. Synthesis of the information is currently being undertaken and is providing good first estimates of consumption and, by extrapolation, the yield of various fisheries. Generally speaking, household consumption surveys were considered to be the most effective means of obtaining basin-wide estimates of the fishery in a large and varied region such as the Mekong Basin.

It is clear that to obtain accurate information, good planning and control of survey design is essential. Specifically, effective consumption surveys require that surveys are designed to include appropriate geographic factors (*e.g.* marginal or transient communities), demographic factors (*e.g.* contributions from women, children and ethnic minorities) and that quality control of the data is incorporated into the design. Extrapolation of the consumption data to indicate fisheries yield in a particular area requires that import and export of fisheries products are also taken into account.

These indirect measures are extremely useful for small-scale, informal fisheries. However, there are several potential sources of error including problems of recall, accessing appropriate information from women, children and other less empowered minorities and the problem of double counting data from market surveys that could affect accuracy.

Market surveys

For major fisheries, landing sites may be equivalent to markets. They are usually well known, not too remote and can be surveyed. Problems of double counting may occur as noted in the section on consumption studies since the same fish may be sold in numerous markets. Market studies can involve different aspects of fishery production, such as trade, export/import, food items, fish seed, quantity and value of fishery products. Market surveys may be useful for small-scale and widely dispersed fisheries. However, substantial quantities of fishery products are traded before going to market 17% from reservoirs).

Geo-referenced information

Geographic information systems (GIS) and remote sensing information (RS) are used increasingly in fishery and ecosystems management. There is the impression, however, that these techniques are still expensive and difficult to implement locally. GIS are useful in predicting fishery potential but not actual yields. They are also useful planning tools for creating models and "what if" scenarios, for example, "what would be the change in production if flooded forests were converted to rice-paddy"? It is also possible to find proxy measures for fishery production such as in China where plant coverage can be assessed by GIS and RS and then related to fishery yield. Validation of the accuracy of the predictions from such models will be necessary, as will training and capacity building.

Habitat classification and measurement

These approaches involve establishing fishery production values for specific habitats based on results of focused studies. They are useful to establish a range of production values and potential, but not for routine monitoring. The consultation identified problems with accuracy in estimating production from habitat classification. These techniques are especially useful when coupled with GIS/RS models. Focused studies on particular habitats are needed, plus demographic data.

Co-management or fishery user groups

These techniques attempt to include the users in the data collection and fishery management process. The *in situ* management structure of some habitats/fisheries can provide the means to collect information. In China, fishing companies have been established that manage lake and reservoir fisheries and provide data to government resource officers. Related to market studies, intermediate buyers and sellers of fishery products also provide an entry point to access

information on a fishery. Lake Victoria in East Africa provides an example of a co-management system that has improved the quality of information on a lake fishery. Such co-management and fishing associations promote cooperation between community and government regulators and provide a good means for communities to collect and collate information. Family logbooks can be incorporated into fishery co-management.

Key outcomes and conclusions

The Consultation reconfirmed that basic information is needed to manage and develop the sector, but the quality of the information needs to be improved. Given the nature of the fisheries and the ecological and human environments in the Mekong Basin, it is understandable why accurate information is difficult to obtain.

In view of the large number of people directly involved in fishing or in flow-on activities such as processing, marketing and sales, small errors multiplied by the numerous people involved lead to gross errors in estimating overall production. The acceptable level of accuracy in estimating production and value of inland fisheries will depend on what is being analyzed. For global estimates, less accuracy will be required than for local planning and fishery management.

Countries in the Mekong Basin are encouraged to submit data on inland fishery yield, species, effort and consumption to FAO. However, the primary reason for countries collecting fishery data is to help in the development of national fishery management and wetland policy. It is apparent that much of the information reported to FAO is not actually being used for these purposes and that the reason for collecting information on inland fisheries is unclear to national fishery resource officers, fishers or the local communities that rely on inland fisheries.

The objectives for collecting information on inland fisheries needs to be specified and conveyed to users along with the benefits of having accurate information.

The primary data need was identified as yield. There are direct methods to measure yield but these are difficult to apply to the entire Mekong Basin. Therefore, alternative approaches will be required to supplement direct measures of fishery yield.

The fisheries within the Mekong Basin are extremely diverse and composed of both formal and informal sectors that must be treated differently. Methodologies that work in one area may be inappropriate for other sections of the basin. A certain amount of standardization of terminology, approaches and methods will be essential for basin-wide planning and information exchange. The diversity of situations in the basin will require a diversity of approaches. Given limited human and financial resources to manage inland fisheries, it was acknowledged that you cannot measure everything needed in all areas. Thus, focused studies can provide information on particular fisheries or habitats and these results can then be extrapolated to a wider area. An ongoing and sustainable data collection programme needs to be based on activities that can be done well with a limited amount of financial and human resources.

With a comprehensive valuation in hand, inland fishery managers and policy makers need to convince national governments, donors and the international community to commit adequate financial and human resources to the sector.

Fisheries and fishing activity in the basin have a strong seasonal component based primarily on the flood cycle of the Mekong River. Data collection and interpretation must take into account how habitats, production and human activity change in response to the changing environmental conditions in the basin.

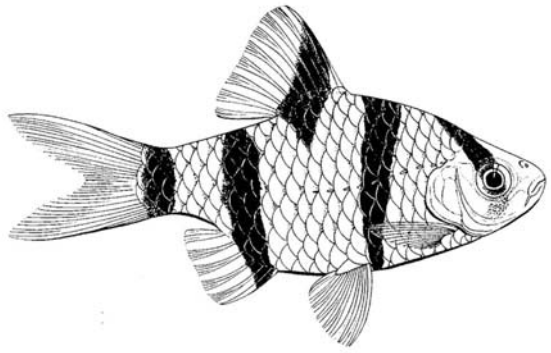
The capacity of local fishery resource officers needs to be increased. Training in standard and new data collection, fish identification and community participation techniques will be required. The status of government fishery officers is often very low and leads to lack of motivation, which results in poor performance of duties. Once the importance of inland fisheries is fully appreciated, the status of the officers responsible for managing the resource should improve.

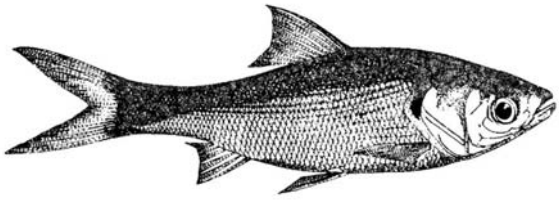
There are data collection systems in place. Significant progress can be made by working with information that is already available in project reports, government offices, NGOs and IGOs. Modification of existing mechanisms is needed to make them more flexible, to ensure they do not bias results in regards to inland fisheries and to ensure that they access all available information. Such modifications can be expected to greatly improve the quality of information needed for fishery management.

Inland fisheries do not exist in isolation of other sectors and there are many other users of inland water resources. Inland waters are most strongly impacted by events occurring outside the inland fishery sector. Therefore, it will be crucial for policy makers and managers of the inland fishery sector to form partnerships with stakeholders in other sectors. The fishery departments in the countries of the Mekong Basin have good relations with some of the sectors using inland waters, e.g. ministries controlling hydrology, water resource management and hydroelectric development. Often government departments can help form links to other sectors where fishers have difficulty in establishing relations. The private sector must also be involved in the partnership, for example access to traders and brokers could improve information on commercial (formal) fisheries.

Countries of the Mekong Basin have limited financial resources and have acknowledged that external assistance will be needed to improve their data collection and fishery management capacities. Training is needed on a variety of subjects and should include local communities and training-of-trainers. Donor support in improving information for fishery management is well-justified given the productivity of the inland fisheries, the large number of people dependent on them and the wealth of biological and cultural diversity of the Mekong Basin.

The international community is becoming more aware of the importance of inland fisheries to food security and poverty alleviation. This awareness is reflected in the development of several projects in the region by FAO, MRC, MRAG and IUCN. It will be important for these projects to build on the conclusions and outcomes of processes such as the present Ad Hoc Expert Consultation. The participants stressed the importance of information exchange, communication and participatory processes in improving information on inland fisheries and viewed the Ad Hoc Expert Consultation as significantly contributing to this objective.





"Available information has shown that economic activities of rural Cambodians are almost fully dependent on natural resources such as agriculture, forestry and fisheries."

Improving Inland Capture Fishery Statistics in Cambodia

SAM Nouv
LIENG Sopha
THOR Sensereivorth
Department of Fisheries
Cambodia

Inland fisheries in Cambodia play a more important role than the marine fisheries sector and contribute 90% of the total fish production. Fisheries information and statistics is important for planning the development and management of the fisheries and understanding fisheries contribution to the national GDP. Information on the economic value of the fisheries will attract the attention of managers, government officers, NGOs and other stakeholders and help persuade them to maintain the status of resources and to protect the interests of resource users. Given the significant contribution of fisheries resources to food security, there is an urgent need to maintain sustainable management of these resources through policy and program decision-making.

Available information has shown that economic activities of rural Cambodians are almost fully dependent on natural resources such as agriculture, forestry and fisheries. The inland fisheries support a thriving industry of great economic and social importance (Van Zalinge *et al.* 2000a). However, lack of understanding has resulted in neglect and some development activities have caused Cambodians to suffer from seasonal water shortages and lower domestic water quality from livestock and human waste, fertilizers and pesticides used in agriculture production and waste discharged from industry.

These and other changes have put considerable stress on water resources and the aquatic ecosystem (Jady, 2001). In addition, the construction of dams, navigation channels, irrigation, river canalization and diversions and burned and bunded road networks have caused a reduction in fish production by altering fish habitats, changes in nutrient levels and blocked fish migration routes between feeding, breeding and nursing grounds (Jady, 2001).

This paper will discuss the development of a new approach to improving inland fisheries information, which will further our understanding of the current status and trends in inland and capture fisheries.

Importance of inland fisheries in Cambodia

Fish in Cambodia is essential for providing food security to the people. Fish and fisheries products are part of the daily diet. Fish are smoked, fermented, dried, salted, made into fish sauce or served fresh. Fish can be found almost everywhere in Cambodia and provide high nutrition in the diet and are easily digested.

The fisheries also provide employment. About 85% of Cambodian people are rural farmers and most of them are full or part-time fishers. At least 2.3 million people are engaged in fisheries-related activities. The fisheries provide direct job opportunities to fishers and other related activities such as fish marketing, netting, making fishing gears, fish processing and so on.

The fisheries provide revenue to the government and income generation to the people. The government collects fishing fees from large and medium-scale fisheries. The estimated value from all types of fisheries could be US$ 200-250 million for the estimated fish catch range from 290 000 tonnes to 400 000 tonnes. Under the government policy to reduce poverty, free fishing rights have recently been given to medium-scale fishers.

Status of inland capture fisheries

The administrative structure

The responsible body for collection and compiling fisheries data and information is the statistical section of the Department of Fisheries.

The statistics so far have been taken from provincial fisheries offices ranging from aquaculture, inland and marine fisheries (Fig. 1). The provincial fisheries offices also compile reports from their own fisheries districts through logbook recordings. Lack of funds, skills and techniques have been obstacles for statistical data collection and analysis. The available statistics so far are not reliable and need to be improved.

Since the beginning of the DoF/MRC Capture Fisheries Project between the Department of Fisheries and the Mekong River Commission in 1994, data and information on fisheries has improved and is more reliable. The Department of Fisheries has a better understanding of the status of the inland fisheries both on biological and ecological aspects.

Part of the overall activity of the DoF/MRC Capture Fisheries Project was the assessment of fish catch and value from fisheries. The project applied a stratified sampling scheme. The estimate was the fish catch by month, by gear, by season, by district, by province, price and value for large and medium-scale fisheries. The administrative structure of the project for data collection and analysis is shown in Fig. 2. The first comprehensive socio-economic survey on small- and medium-scale fisheries was carried out in 1995/96. The estimate covered mainly the central part of Cambodia. This system of operation ended when the project was phased out. However, Provincial Fisheries Office staff were trained by the Capture Fisheries Project and have the field level skills.

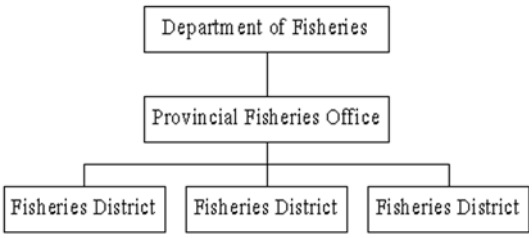


Fig. 1. Old system of data collection and compilation

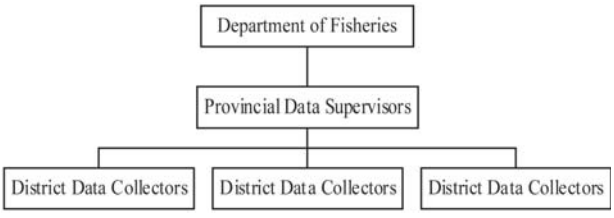


Fig. 2. Project system of data collection/compilation

Habitat types and water resources

Cambodia comprises a wide range of habitat types including marshes/swamps, flooded grasslands, flooded forests, flooded shrub lands and rice fields. All of these habitats are situated in the central floodplain of Cambodia, which is the main fishing ground. The flooded forests cover the largest areas after rice fields and it is believed that they make a large contribution to fish production (Table 1).

Table 1: Land and water resources in Cambodia
Source: Mekong Secretariat 1995
* Water surface refers to dry season levels. Wet season central floodplains cover an area of 23 400 square kilometers.

Types of Land and Water Resources	Area (Km^2)	%
Water surfaces	4 111*	18.3
Marshes/swamps	29	0.1
Flooded grasslands	849	3.8
Flooded forest	3 707	16.5
Shrub land	13 501	60.0
Receding rice fields	293	1.3
Total	**22 490**	**100**

The availability of fish habitats in Cambodia is influenced by the flood regime of the Mekong River. The flood regime influences the changes in the extent of the floodplain area (Fig. 3). The total area of water bodies is much smaller in the dry season. Understanding the types of water resources and the area they cover may provide clues for the estimation of fish yield and production in relation to these habitat types.

Fish species and the fisheries

Cambodia is rich in fish species. About 100 fish species are commonly caught every year in the Tonle Sap floodplain (Van Zalinge *et al.* 2000b). About 500 fish species have been identified. The variety of fish species is due to the wide range of fish habitats, the complex ecosystem and the geological characteristics of the system which provides a rich supply of food and breeding grounds. The zone has high biological productivity and provides important nurseries for fish breeding. Many fishing gear types and fishing methods have been developed to catch the many different species of fish. Gears range from stationary to fixed gear in flowing water and stagnant water

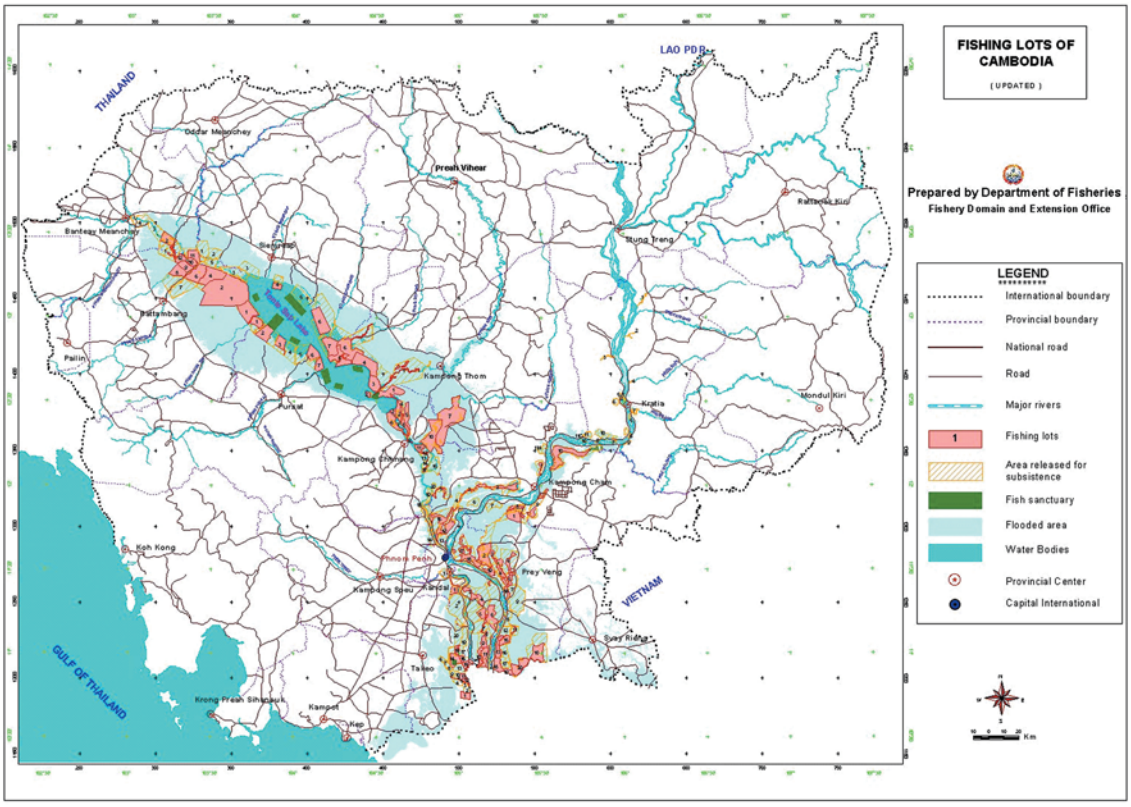


Fig. 3. Extent of floodplain in Cambodia

bodies. Fishing takes place in two seasons: open (October-May) and closed (June-September). These fisheries can be categorized into three levels:

1) Large-scale (industrial) fisheries: can operate in limited access areas. There are two types of large-scale or industrial fisheries: fishing lots and bagnet fisheries. The fishing lot or barrage fisheries sell fishing rights through an auction system. There are currently 164 fishing lots consisting of 82 riverine and lacustrine fishing lots, 60 bagnet (dai), 8 dai trey linh bagnet fisheries catching *Thynnichthys thynnoides*, 13 shrimp fishing lots, and 10 beach fishing lot. There are 13 fish sanctuaries.

2) Middle-scale (artisanal) fisheries: operate in open access areas only during the open season. About 200 types of fishing gear have been identified and about 40 gear types are used in most fishing grounds. Ten fishing gears are most commonly used.

3) Family (subsistence) fisheries: operate in open access areas year round and in limited access areas during closed fishing season and in flooded rice fields.

These artisanal and family fisheries have rapidly increased in the past two decades leading to over-fishing.

Fish production

The estimated fish production in Cambodia varies. One factor is the extent to which estimates of fish production include all varieties of gear types at all times and in all areas. Not all the fish caught pass through markets and are not recorded. Rural people who catch fish in small amounts for family consumption were previously not considered. There was no statistical monitoring system for these household fisheries and therefore information on capture fisheries may not reflect the actual production.

The most recent and most reliable fish statistics in Cambodia come from the collaborative MRC and Fisheries Department project. These reasonably accurate statistics point to the significant contribution of the fisheries sector to the rural economy and the social requirements of rural people (Van Zalinge *et al.* 2000a). These statistics are increasingly important for decision-making on options for the development of the national economy.

The most comprehensive data and information are from the MRC/DoF socio-economic and catch assessment surveys conducted in parts of the country (Ahmed *et al.* 1998, Van Zalinge *et al.* 2000b). These surveys indicate that:

- Cambodia's freshwater capture fisheries production is over 400 000 tonnes/year.
- Estimated value at landing site is around US$ 200 million. The estimated retail value is about US$ 300 million. Exports are underestimated, but exceed 50 000 tonnes/year (Van Zalinge *et al.* 2001). Countrywide fish consumption is around 30-40 kg/person per year.

The average per capita fish consumption in central Cambodia is 67 kg.

The Department of Fisheries has adopted a level of fish production slightly lower than the capture fisheries project estimate. This is twice or triple past estimates. This may be a result of underestimation of the fishing effort and an increase in the gear used in the past two decades (Fig. 4).

Suggestions for the improvement of fisheries statistics

As a majority of the population lives under the poverty line, the government focus is on poverty alleviation. Fisheries information is important for identifying key strategies for sustainable development and management, but is given low priority. Up to the present there are insufficient government funds allocated for fisheries research and information purposes. Therefore, support to fisheries information has so far come from international sources.

The local staff working in the field of data collection and handling still have insufficient capacity. With assistance from DANIDA through

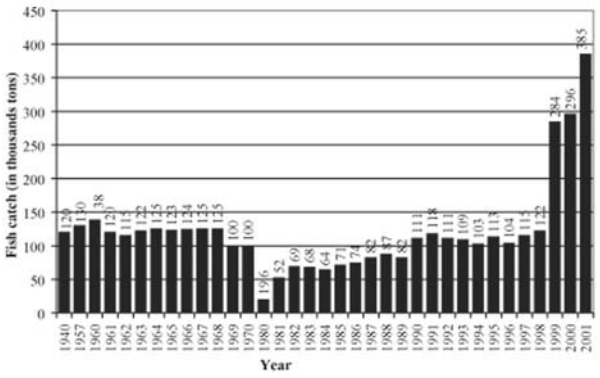


Fig. 4. Estimated inland capture fish production from 1940 to 2001

the Mekong River Commission, the capacity of local staff has improved and progress on improvement of data collection and information has been made. There is more available fisheries information at present compared to the past but it still does not satisfy the requirement. To ensure the sustainability of continuous and reliable data and information, DoF needs continuous international assistance and special techniques to gather information.

Among the current fisheries issues, research activities need to be formulated to serve the following purposes:

- To prevent the use of destructive fishing methods and harmful use of pesticides
- To establish suitable fish sanctuaries and dry season refuges
- To increase ecological knowledge, particularly fish habitats such as deep pools and spawning and feeding grounds to formulate habitat protection measures (conservation zones or fish sanctuaries) and maintain aquatic ecosystems
- To assess the status of fish stocks so that measures can be taken to ensure sustainability
- To promote understanding of biology of fishes in Cambodian ecosystems, in particular information on fish migration to maintain and restore fish migration routes
- To serve the need for information for formulating management and strategic planning

To meet the above needs for fishery information with limited funds for operation, there should be a focus on:

- CPUE
- Potential fish species, their status and species under threat
- Catch and value
- Fish consumption
- Fish yield
- Ecological information
- Fishing effort (number of gears, days, gear types, number of fishers
- Quantity of export of fish and fishery products

Catch assessment should be considered to obtain this information. Catch assessment can be estimated based on groups of gear types instead of by individual gear types and groups of species (local species name instead of individual species name). This may be done once every three to five years to reduce costs and coud be conducted according to ecological characteristics such as:

- Tonle Sap area (Kampong Chnang, Pursat, Battambang, Kampong Thom and Siem Reap)
- Highland area (Kratie, Stung Treng, Ratanakiri and Mondulkiri)
- Southeast of Phnom Penh
- Southwest of Phnom Penh
- Northeast of Phnom Penh
- Flood plain area south of Phnom Penh

The estimation of fish capture can also be based on fish consumption surveys in these areas in fishing communities, provincial capitals, distances from water bodies plus export of fish and fisheries products.

The catch can also be assessed based on habitat types. When the fish yield for each habitat type and the area is known then total catch can be estimated (Table 1).

CPUE is also an important indicator for estimating the status of fish stocks. This may be

done once every three years representing each sub-catchment area.

Fish species surveys also need to be carried out focusing on identifying new species and those with export potential. At the same time, there is also the need to identify species under threat for conservation and management purposes.

To facilitate statistical compilation, responsibility should go to a body with technical knowledge of data collection and compilation of fisheries statistics, hopefully, the Inland Fisheries Research Institute of Cambodia (IFRIC) at the Department of Fisheries.

Other information such as number of gears, ecological knowledge of fish habitats, fish migration, and spawning grounds are also important for formulating study projects.

General recommendations for improvement of information on the status and trends in the inland capture fisheries:

1 Train involved personnel in statistical data and information handling techniques

2 Further strengthen communication and cooperation between FAO and the Department of Fisheries for exchanging information

3 Use cost effective methods to get data and information to fulfill necessary requirements

4 Build awareness among fishers to cooperate in providing more accurate data and information

5 Set up an information gathering network as a coordination mechanism for the compilation of fisheries information

6 Provide the necessary facilities, equipment and budget needed for data and information collection and analysis

7 Seek international technical and financial support for the fisheries information operation

8 Establish good cooperation and communication with all relevant agencies and institutions for information exchange

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COUNTRY REVIEW

"Inland fisheries play an important role in providing food and jobs. It is estimated that about 20 million people rely on fisheries in China."

Inland Fisheries Statistics in China

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China has a history of more than 3000 years of inland fisheries. In recent decades, the inland fishery, especially aquaculture, has been well developed. Since 1981, the production from inland aquaculture increased rapidly while the production from capture fisheries increased only slightly (Fig. 1). In 1999, the total fishery production in China was 41 million tonnes. Of the 16.5 million tonnes from inland fisheries, 2.28 million tonnes came from the capture fishery and 14.2 from aquaculture. From the data in 1999, about 30% of inland aquaculture area was ponds, 28% paddy fields and 22% reservoirs (Fig. 2). Figure 3 shows that 92% of inland fishery production was fish with the remaining 8% consisted of shrimp, crab, molluscs and other aquatic animals. More than 78% of total inland fishery production was carps (Fig. 4) and most of these were from ponds (Fig. 5).

Most fisheries are operated as fish farms. Fish farmers rent the ponds and pay yearly rental. Licenses are given only for lake capture and reservoir capture fisheries and license fees are paid annually.

The statistical collection system[1]

China has a very powerful system of inland fishery data collection implemented at provincial and district levels. The Department of Fisheries under the Ministry of Agriculture is the top governmental administrative office and is responsible for policy development, protecting and developing fishery resources, foreign affairs related to fisheries, management of marine and inland fisheries, organisation of far-sea fisheries, conservation of water environments for fisheries, guiding the processing of aquatic products, standardizing fishery equipment, supervising the management of international fishery policies and fishery statistics. In every province, county and city there are fishery bureaus that represent the local office of the Department of Fisheries and manage fishery affairs.

The data collected for inland capture fisheries includes total national production, production in different provinces or cities, production from different water bodies, production of dominant

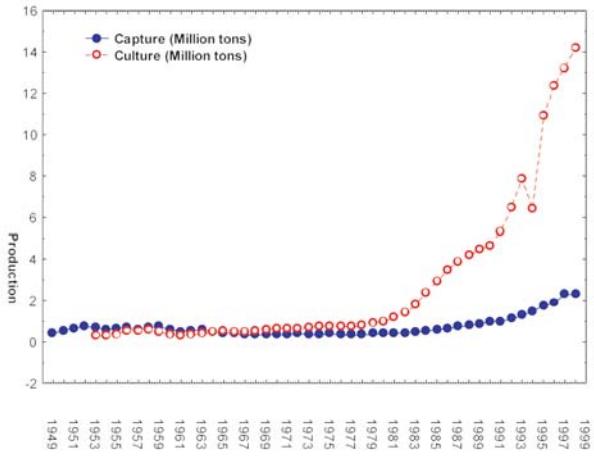


Fig. 1 Annual inland fishery capture production in China

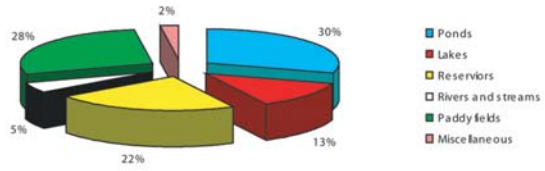


Fig. 2 Proportion of different fishery areas in inland fisheries in China

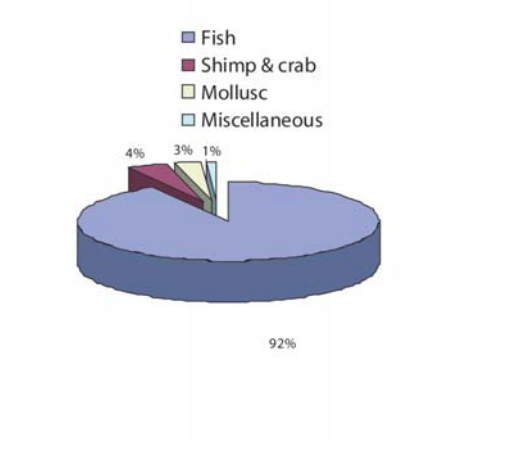


Fig. 3 Proportion of different fishery production from inland waterbodies

species in different regions, areas of fishery water bodies in different regions and for different species, output value of different typologies, fishery effects (including boats used, labour used, people working in fisheries, etc.). Statistics are compiled at district level with information collected by staff at sub-district level. District officers report the information to county officers and then to provincial officers, who compile it and forward it to officers in the Department of Fisheries. Data are normally collected from fish farmers by local officers. For some areas where the data is difficult to collect, the local officials will estimate the production. Some scientists collect data by sampling, market investigations, licenses to fish farmers and fish catch in each boat. Scientific data are normally used for research work and not used for statistics. Due to the development of aquaculture in lakes and rivers, some data are compounded by inland capture fisheries and freshwater aquaculture. This type of report is normally given at the end of the year and the statistical data is only collected annually. There is sometimes a lack of data in different seasons or months.

Marine capture fishery and aquaculture statistics are collected through the same infrastructure. In contrast to inland capture fishery statistics, marine fisheries and aquaculture data are based on an estimation of the capture per boat times the total number of boats and on market surveys. For marine fisheries, information is also collected on numbers of fishers based on licensed gear or a count of fishers working onboard licensed vessels.

Aquaculture information includes areas of culture systems, species and marketing data. Generally, the statistical data for inland aquaculture is more accurate than the inland capture fishery data. Compared with inland fisheries, the statistics for marine capture is less accurate due to the difficulties in data collection.

The information produced

The statistical data provides detailed information on fisheries in China. Figure 6 shows the inland fishery capture production in a number of

provinces and cities. The highest capture fishery is in Hubei Province followed by Jiangsu. Hubei is a province of "Thousands of Lakes" and stocking in these lakes has been very well developed. No data are available for the total capture in China at different seasons but Figure 7 shows the aquaculture areas in different regions. Most of the data include both capture and aquaculture fisheries because stocking fish in lakes is also called aquaculture in China. To the total aquaculture production, fish contributes about 70% (Fig. 8). The productivity of aquaculture in China is shown in Figure 9. Ponds have the highest productivity. Fishing effort is also reported in the types of vessels used (Fig. 10) and the number of people working for fishery management including administration, ship verification, research, hatchery etc. (Fig. 11). Women play different roles in different areas but the highest proportion of involvement is in hatchery farms and colleges.

Labour in the capture fishery is shown in Figure 12, but this is the total data including marine capture fisheries. Several 'high-capture labour provinces' are seaside provinces (Jiangsu, Zhejiang, Fujian, Shandong and Guandong). Data from different provinces and cities are also published every year and similar information could be collected and the analysis for different regions could be based on these data.

It is likely that the inland capture figures are affected by under-reporting but the extent is difficult to assess. For example, fish farmers normally report their production minus their own consumption. Some family fish farmers are just fishing for their own consumption. The production from other family fish farmers cannot be collected. Another problem in fisheries statistics concerns small fishes captured from natural water bodies. Due to the development of piscivorus culture, a large volume of small fishes is used as food to feed the piscivours fishes such as Chinese mandarin fish (*Siniperca chuatsi*). Some waste (or trash) fishes are also used as fish feed for carnivorous fish culture.

It is more difficult to capture fishery statistics in rivers. Normally, local officers report estimates. In each province, data on production of some

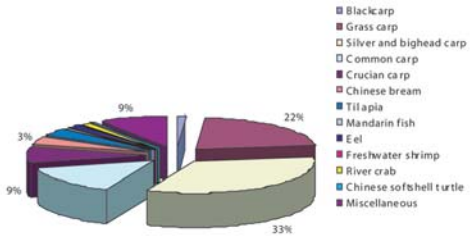


Fig. 4 Proportion of different fishery species in inland fisheries in China

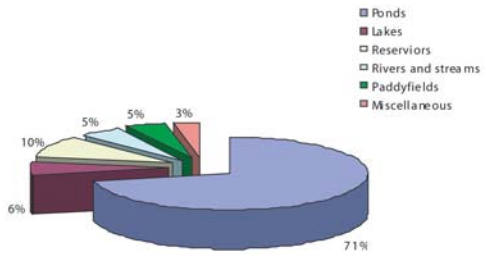


Fig. 5 Proportion of inland fishery production from different waterbodies in China

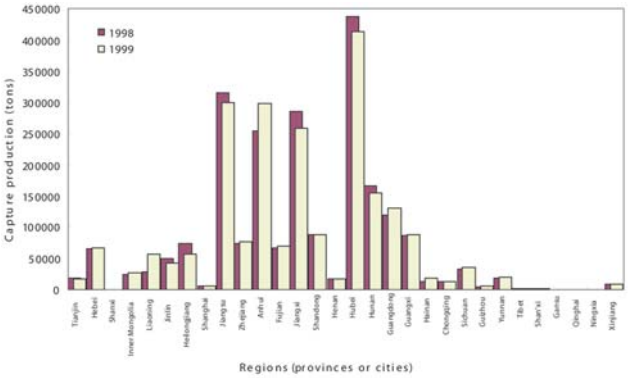


Fig. 6 Inland capture fishery production in selected provinces and cities, 1998 and 1999

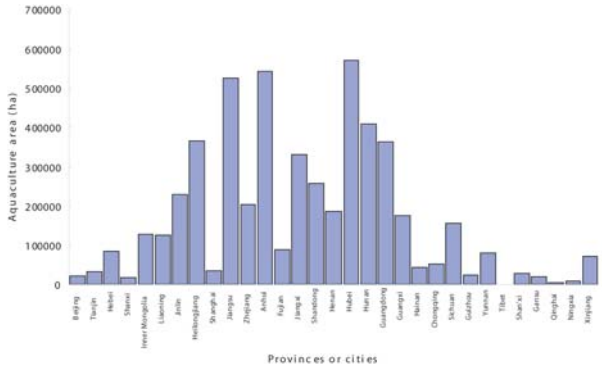


Fig. 7 Aquaculture areas

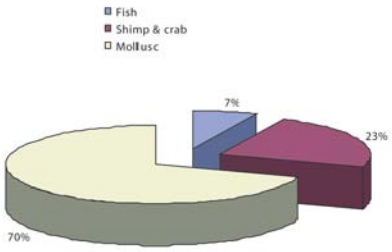


Fig. 8 Proportion of aquaculture areas for different species of inland fisheries in China

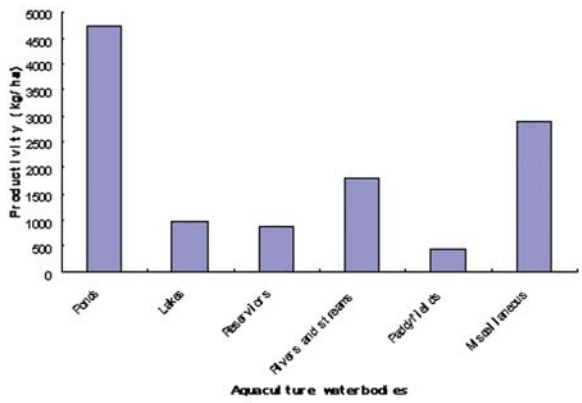


Fig. 9 General productivity of aquaculture water bodies

important species are also collected, for example in Hubei province (Table 1). It can help the government and fish farmers to adjust the fishery structure, especially for aquaculture.

Table 1 Fishery production, Hubei Province, 2000

		Production (tons)	Proportion (%)
Total production		2342350	
Silver carp and bighead carp	*Hypophthalmichthys molitrix* *Aristichthys nobilis*	878128	37
Grass carp	*Ctenopharyngodon idella*	496772	21
Common carp	*Cyprinus carpio*	163235	7
Black carp	*Mylopharyngodon piceus*	30976	1
Chinese bream	*Megalobrama amblycephala*	90242	4
Tilapia	*Oreochromis sp.*	5518	0.2
Chinese mandarin fish	*Siniperca chuatsi*	5153	0.2
Mitten crab	*Eriocheir sinensis*	10327	0.4
Ricefield eel	*Monopterus albus* (Zuiew)	2456	0.1
Chinese longsnout catfish	*Leiocassis longirostris* Günther	50	0.002
Yellow catfish	*Pseudobagrus niyidus* Sauvage et Dabry	500	0.02
Chinese softshell turtle	*Trionyx sinensis*	12889	0.6
Freshwater shrimp		64739	2.8
Miscellaneous		599642	25.6

Perceptions of inland fisheries and objectives of the statistics

Inland fisheries play an important role in providing food and jobs. It is estimated that about 20 million people rely on fisheries in China. Due to new environmental legislation, capture fisheries have been limited and more capture fishery farmers have changed to aquaculture. A stocking fishery in lakes has also been developed in the past 20 years but is limited to definite species and densities to protect the aquatic ecosystem. As seen in Figure 1, the capture fishery is still increasing.

The data on the capture fishery and aquaculture production are used for two main purposes: to manage the fisheries in different areas to meet the market requirements and maximize the benefits for fish farmers; and to monitor the fishery resources in natural water bodies including rivers and lakes to protect the biodiversity and maintain a sustainable fishery.

Fish farmers are not always clear about the purpose of the data collection. Some farmers can get useful information from this data and plan

their fishery production for the next year. They can see which species the market is lacking and how much production is required. They can even find out where they should sell their fish. For those who are managing lake fisheries, they can also find out how much fish they have captured from the lake and based on the data from the past years, they can determine the status of the natural fishery resources and change their fishing practices accordingly.

For example, in some lake fisheries, the Chinese mandarin fish is considered the main stocking species due to high production of food fish in lakes, high market value and almost no impact to the lake ecosystem at a suitable stocking density. However, high market demand has stimulated higher stocking density of mandarin fish. Using the statistical data on the fishery, they found that the production of small food fish decreased and the weight of mandarin fish at same age was lower than those in the past years. They then decided to cut down the stocking density to allow recovery of the small food fish to maintain a sustainable fishery. As a result of over-exploitation in some lakes, there are reported shortages of small fish (Song, *et al*., 1999). Therefore, fish farmers and the government are paying more attention to the fisheries data from the lakes so that they can make better plans for next year's capture.

The statistical data collected by the government is different from the data collected by scientists. For example, research investigations in some lakes showed that the capture fishery production was between 50-198 kg/ha in 1999 (Zhang and Li, 2002). This data is lower than that reported by the government in 1999 (around 300 kg/ha), however, the government data may have included the production of aquaculture in the lake.

Conclusions and recommendations

Generally, the statistics on inland fisheries in China is relatively complete and has been collected for many years. All this data can be used for fishery anaylsis and provides important information for the government to make plans for inland water fishery management. In recent

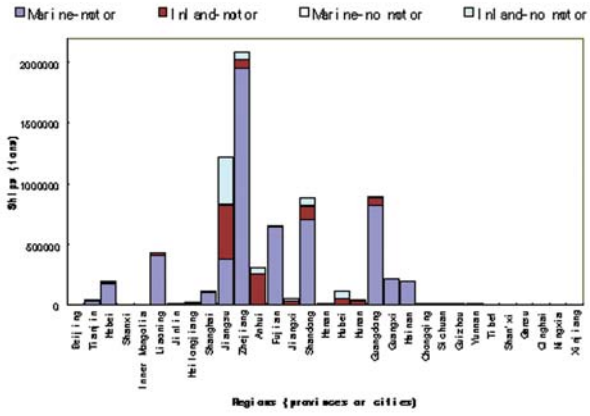


Fig. 10 Fishery ships in provinces and cities

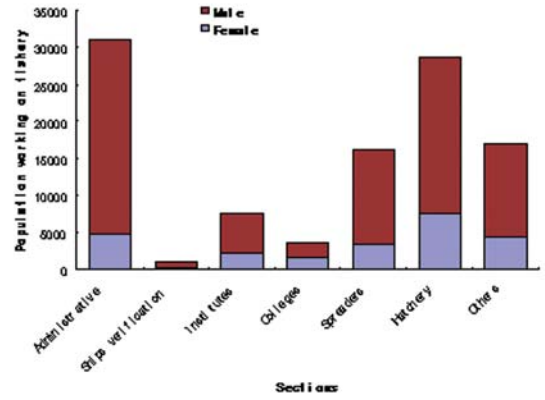


Fig. 11 Number of people working for fisheries in different offices of fishery management

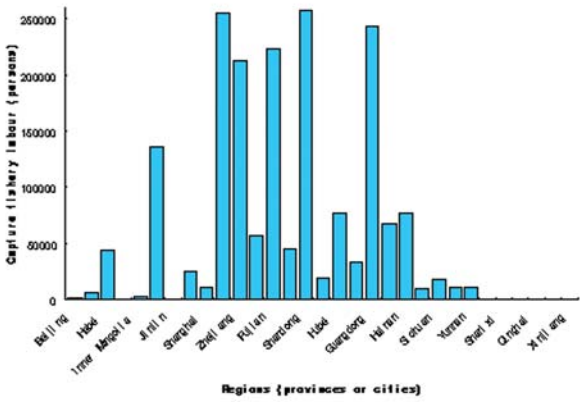


Fig. 12 Capture fishery labourers in different regions (provinces or cities) in China

years there has been a growing awareness and more attention to the aquatic environment and protection of water bodies and wetlands. Fish production by weight would be limited and considered not so important. Scientists have also suggested cutting down the stocking of herbivores and filtering fishes. Herbivores stocked in China normally can reproduce in nature and improper stocking would result in disappearance of large numbers of macrophytes which would lead in turn to a change from a macrophte-type lake to phytoplankton-type lake and eutrophication. Fertilising or introducing sewage to lakes for fish stocking is now not recommended and prohibited in some regions (Zhang *et al.*, 1997). Scientists have further suggested stocking high priced species including freshwater crabs and some piscivores such as Chinese mandarin fish and snakehead to protect the ecosystem and maintain the present level of benefits for fish farmers. Net cage culture in lakes is also recommended but the proportion of cage areas or production of cage culture is limited by the government. Therefore, in the future, the inland capture fishery production will grow at a relatively constant level and may even decrease while aquaculture production will continue to increase.

Possible improvements to the present data collection system

Sampling should be done at different places for different fishery styles and also continuous sampling at definite sites. Most of the data collected at present is from the reports of different administrative levels and the reliability depends on the officials and fish farmers collecting the data. Most statistical data are collected only once a year. With the development of the fishery and the requirements of markets, the fish are sold at different seasons and the fish farmers cannot record the entire amount they sell. This will introduce high levels of error to the data. Due to the economic reforms taking place in China, more family farmers are running fish farms which also adds to the difficulties of data collection.

Statistical data should be coordinated with other data such as market data, tax data, scientific reports and banking data. On some large fish farms, data can be calibrated to the data collected from the tax office. This can reduce the tendency of some fish farmers to exaggerate data to show their 'good" achievement. Due to certain inefficiencies in the tax system, some fish farmers may report lower production figures to tax officers to reduce their taxes.

Sampling should be carried out in several places and used to calibrate the reports from the fisheries offices. The most important thing is to fund fishery scientists to undertake sampling to give more actual data at some selected places and allow calibration of the statistical data to make it more reliable.

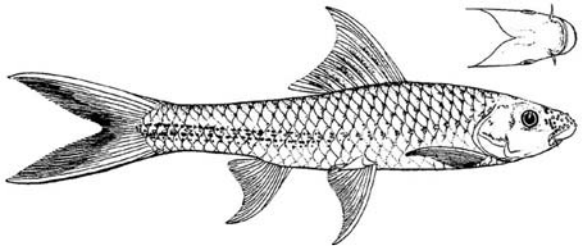
The government should shift its emphasis from high production to more generalized economic benefits, sustainable fisheries management and environmental protection. The present emphasis on high production leads to a number of problems.

Fish farmers ignore environment protection and try to increase their fishing effort by using small eye-nets (sometimes called 'no next generation nets') and capture almost all fishes of different ages and sizes. This practice is prohibited by the government in some places. Some fish farmers fertilize or introduce sewage to increase production of some carps. This accelerates the eutrophiciation of lakes and ultimately results in many other problems including lower biodiversity and poor water quality. The high production of low-value species does not increase the overall economic benefit. The government should use economic data and environmental evaluations in place of production-only. This would help fish farmers improve lake fisheries and keep them sustainable.

Data collection should include subsistence and recreational fisheries. With improvements in the standard of living, more inland water bodies are being used as recreational fisheries. Normally these data are not included in the statistics.

In conclusion, production from the inland capture fishery in China has dropped considerably in

recent years and should fall even lower due to introduced measures for the protection of inland water bodies. More fishery production will come from aquaculture. The inland capture fishery will be conjoint with stocking some high value species and more attention will be paid to aquatic environment protection. At present, more family fish farmers are forming fishery companies and most lakes and other water bodies are being operated by fishery companies. It wil be easier to collect this data and data will be more reliable and useful.



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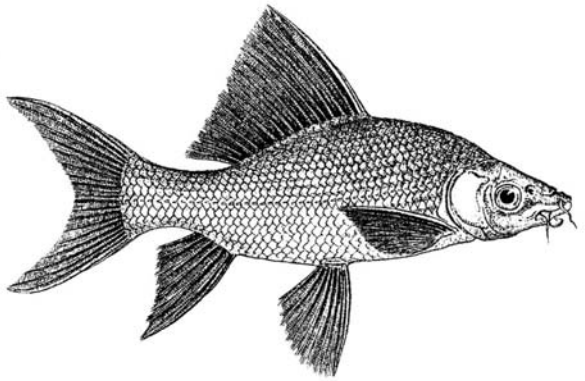
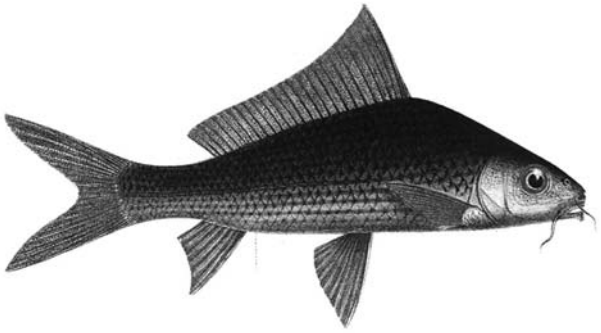


Footnotes

[1] Data used in this paper are from the Annual Report of Fisheries in China, 1999. Department of Fisheries, Ministry of Agriculture, China. Agriculture Press, April, 2000. pp.317.



"Fisheries statistics are a key component of a fisheries information system required for policy, planning, monitoring and management of fisheries."

Status of Inland Fisheries Statistics in Lao PDR

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The main objective of the Lao Government in the agriculture sector is to improve and increase the productivity of all types of agricultural commodities to achieve national food security. In Lao PDR, inland capture and culture fisheries involve a wide range of participants in the rural areas. The catch from these fisheries plays an important role in food security as it is mostly consumed by local communities and is an important source of animal protein in peoples' diets. Apart from this, inland fisheries also provide employment and livelihood opportunities. Fisheries are believed to account for about 8% of National GDP.

Lao PDR covers about 202 000 km^2 of the total Mekong catchment, which accounts for about 97 % of the total area of the country. It contributes some 35% of the average annual flow of the Mekong. However, the data on living aquatic animals are limited. Generally speaking, statistical data and information on the economic significance of the fisheries sector is difficult to obtain because of the limitation of financial support, limitation of human resources and knowledge of fishery scientists in statistics. A lack of information and statistical data on inland fisheries has undermined their importance and the subsequent management of the resources. With a growing population, it is important to maintain the contributions of inland fisheries to food security and to increase production. Concerted action is required in this regard. There is a need to improve the collection of statistical data that can be interpreted in economic, scientific and ecological terms for use in planning and development. However, most fishing in Lao PDR is subsistence fishing, although there is significant commercial fishing in the Nam Ngum Reservoir.

Status of inland fisheries

Government agencies involved

In Lao PDR, the fishery statistics system is a subsystem of the agricultural system, which in turn is a part of the different statistical agencies whose primary functions are the generation, processing, analysis and dissemination of official

statistics. The government agencies directly involved in the generation of fishery statistics are:

- National Statistical Center under the Committee for Planning and Cooperation
- Division of Statistics of the Planning Department, Ministry of Agriculture and Forestry (MAF)
- Department of Livestock and Fisheries (MAF)
- Living Aquatic Resource Research Center of National Agriculture and Forestry Institute (MAF)
- Provincial Livestock and Fishery Sections
- District Livestock and Fishery Units

In the past, there were several types of information available that were relevant to the fishery at the National Statistic Center and the Ministry of Agriculture and Forestry such as:

- Lao Expenditure and Consumption Survey 1992-1993 (LECS I)
- Collection of CPUE in Khong Island in 1993
- Lao Expenditure and Consumption Survey 1997-1998 (LECS II)
- The Agriculture Survey Census 1998-1999.
- Meat and Fish Consumption in Xiengkhouang Province 1998
- Foreign Trade Statistics
- Consumer Price of Fish Index
- Compilation of GDP
- Baseline study in five provinces on aquaculture development projects supported by FAO (1998)
- Fisheries Surveys in Luang Prabang Province 1999

Main species produced and methods used for catching

Table 1 shows the different water resource areas and their productivity in the year 2000. Previous studies of capture fisheries in southern Lao PDR were conducted in Kong falls area where there is a traditional fishery targeting migratory species. These studies produced useful data on catch effort for some fish species and can be used for managing the resource.

Table 1: Topology of national inland fisheries in 2000

Type of fisheries	Water resources	Total area (ha)	Productivity (kg/ha/year)	Estimate total production (tons/year)	% of total catch
Capture Fisheries	Mekong river and 14 tributaries	254,150	70	17,790	25
	Reservoirs	57,025	60	3,421	4
	Sallow irrigation and small reservoirs	34,460	150	5,169	7.40
	Swamps and wetlands	95,686	30	2,870	4
Aquaculture	Fish ponds	10,300	1,000	10,300	15
	Rice-Fish	3,050	150	475	0.60
	Rain-fed rice and irrigated rice field	477,176	50	23,850	34
	Small natural pools, oxbows and irrigation weirs	12,934	573	7,441	10
TOTAL		944,781		71,316	100

The actual record does not determine the species, but it weighed separately scale-less and scale, small and large fish for selling purposes. The main species caught are listed in Appendix 1 at the end of this paper. According to 1999 studies by the Mekong River Commission's Assessment of Mekong Fisheries Component, fishers used more than 20 different types of fishing gear and methods. The most frequently used methods were stationary, drifting gill net, long-line, cast-net, traps, hook with line, small scoop net and other traps.

Current situation of inland fisheries statistics

The production figures of capture fisheries are based on the sampling data of the yields per unit area for several types of topology. However, the information on aquaculture was obtained from data collection. Data on capture fisheries were mainly taken from fish landing sites such as Nam Ngum Reservoir and Nakasang Village on Khong Island.

Catch price at first sale varied according to the species and size of the fish and it was not recorded regularly. The average price across the country is estimated to range from 7 000 to 20 000 Kip/kg[1].

The Department of Planning (DOP) under the Ministry of Agriculture and Forestry (MAF) is responsible for disseminating basic statistical

information on agriculture including crop production, crop area, crop yield, livestock population, animal production and fisheries. This information is prepared by technical departments and institutions such as the Department of Livestock and Fisheries (DLF), Department of Agriculture, Department of Forestry, Department of Irrigation and Living Aquatic Resource Research Center (LARReC). Technical fishery management information such as fishery production, topology of fisheries, number of fishing units, fishing gear, fish price, number of hatcheries, rate of fish consumption, rate of fry survival, fish feed production and type of fish farming is collected and compiled by the Department of Livestock and Fisheries in collaboration with LARReC, Provincial and District Livestock and Fisheries Units. This includes specific information (standard of fish stocking in pond, rate of raising in rice field, etc.), and aquatic animal health information. The trade data on fish and fish products are collated and reported by the National Statistical Center. Their data clients are decision-makers, scientists, planners and vendors.

Quality, coverage, methodological reporting

Statistical data are not readily available or, if available, are scanty and not always accurate. There are only estimated data on inland fisheries such as estimates of fish production by sampling the yield per unit of a particular type of water body then multiplying by the water area. The main reasons for the poor knowledge of these fisheries are the large number, dispersion, variety and dynamic nature of inland water bodies and the diversity of their aquatic fauna. These account for the complex and numerous fisheries giving rise to a variety of distribution and marketing systems. This makes the collection of data costly, but when weighed against the contributions of the sector in the larger socio-economic context, it may be well worth undertaking.

A household expenditure and consumption survey was taken from March 1992 to the end of February 1993 by the National Statistic Center (NST). The sample was made up of 2 940 households from 147 villages. All household expenditure and income were recorded in a diary over a one month period. At that time the amount of expenditure on fish by household was similar to the estimated official fish production figures.

The second household expenditure and consumption survey was taken from March 1997 to the end of February 1998 by NST. This time the survey included household data on fish production in terms of value, rate of consumption from their own production and fish expenditure (Table 2).

Table 2: Consumption of fish

Items	Consumption value, in million kip	
	1997-1998	1992-1993
Fresh fish	30 750	11 040
Canned fish	1 237	1 021
Frozen fish	1 351	500
Dried fish	2 183	1 208
Prawns, crabs, ect.	1 853	162
Fermented fish	2 934	1 519
Preserved fish	755	
Others	4 995	3 626
Own produced fish	93 410	26 540

Source: LECS I and LECS II by NSC (1993, 1998)

In 1997, a field study on meat and fish consumption was conducted by Chanphengxay in Xiengkouang Province. The sample sites were taken in two districts (Pek and Phoukout) in one month of the dry season. One was representative of urban areas while the second was representative of rural areas. The figures show that the rate of fish and aquatic animals consumed was around 4.7 kg/head/year and 4.4 kg/head/year respectively. In rural areas it was 2.5 kg/head/year for fish and 2.8 kg/head/year.

The first Lao Agricultural Census was conducted from 1998 to 1999 by NSC in cooperation with the Ministry of Agriculture and Forestry. It covered all 141 districts in the country. The census was undertaken in two parts: a complete enumeration of all 798 000 households to collect basic data about agriculture, and a sample survey of the households to collect more detailed information mainly on crop production and livestock, including some data on the number of families involved in fishing and aquaculture and the area of fish ponds.

Improvement of data

Because the resources required for the collection of these data have decreased, the quality, availability,

reliability, accuracy and timeliness of data compiled at the national level is not satisfactory. The strengthening of the national fishery statistical systems as an integral part of a planning and decision-making process should be a major national fisheries objective in the drive towards sustainable fisheries and food security. The need to improve and strengthen data collection systems should not be limited to an individual country alone. The prospect of developing a harmonized fisheries statistics system among the countries in the region should be encouraged so that the region can share and use the data more readily to facilitate the management of their fisheries, especially in the case of shared stocks.

Since the collection and analysis of fisheries data is costly and time consuming, the needs and objectives for the statistical system must be clear and a thorough review of national statistical frameworks must be undertaken, including their linkage with priorities and objectives and the needs of respective data users. As management of the fisheries should be based on the best scientific information available, these data are critical to the sustainable management of fisheries resources.

Main issues and constraints to improving fishery information:

- Lack of feedback from users
- Lack of objectives and incentives for enumerators and other staff to produce quality data
- Lack of awareness, especially by policy-makers, of the importance of the sector in planning and development
- The collected data is not always used which further contributes to the lack of motivation among enumerators
- Low levels of capacity among personnel, especially at the local level, who are mandated to collect the raw data

Fisheries statistics are not used effectively in the determination of national fisheries policy, the formulation of national management frameworks and actions or even as a basis for understanding the status and condition of fisheries resources. Since the production of effective and timely fishery statistics is a costly exercise, improvement in the use of statistics at the national level should be accorded high priority.

In the case of inland fisheries operating within an international river basin such as the Mekong Basin, these methodologies need to be harmonized with adjacent countries, and the catchment approach promoted in this regard. Once the minimum requirement for a national fishery statistical system is achieved, a gradual strengthening process can be conducted, taking into consideration the national capacity and priorities.

Conclusions and recommendations

Fisheries statistics are a key component of a fisheries information system required for policy, planning, monitoring and management of fisheries. Improvements to national and regional fisheries statistical systems including data collection, analysis and reporting are required to maximize the utility, timeliness, accuracy and reliability of fisheries statistics.

A review and reassessment of current statistics for the capture fishery is needed to obtain accurate and reliable information. The compilation and exchange of fishery statistics for the region is required to provide a wider view of the importance and status of fisheries in the economies of basin countries. Clearly, the collection and analysis of data should be standardized to facilitate this exchange. Comparable information technology and databases will assist in this regard.

Recommendations

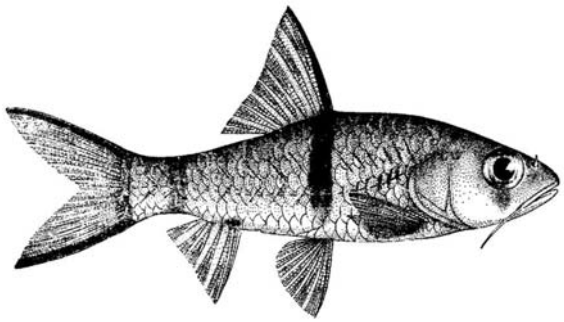
National Level

Strengthen national fisheries statistics systems as part of a national decision framework for policy-making, planning and monitoring to achieve sustainable fisheries by:

Determining the objectives and minimum requirements of fishery statistics data and

information with particular reference to national and local requirements;

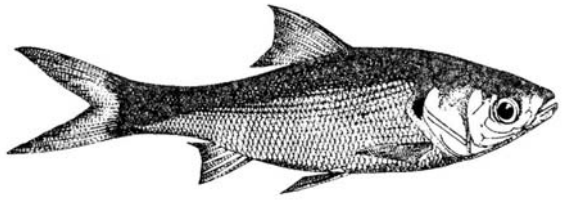
Coordinating collection and use of fisheries statistics data between the national fisheries authorities and other authorities including those responsible for trade, vessel registration, freshwater aquaculture and rural development;



Building capacity at both national and local levels to collect, compile, analyze and disseminate quality statistical data and information in a timely manner as an empirical basis for formulating policies and decisions for fisheries management;

Prioritizing statistical data and information needs with particular reference to practical indicators for fishery management and the specific requirements of the region's fisheries;

Applying internationally or regionally standardized methodologies for statistical data to facilitate regional compilation and data exchange where appropriate; and

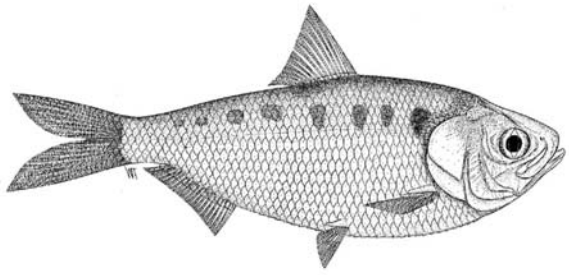


Reviewing the national fishery statistics systems to identify areas needing improvement.

Regional Level

Supporting, upgrading and expanding regional fisheries statistical systems by developing regionally compatible methodologies for national statistical data to facilitate regional fisheries assessment and data exchange; and

Promoting technical cooperation between national agencies responsible for fisheries statistics to improve national systems, including development of guidelines and handbooks.



Footnotes

[1] 1 US$ = approximately 15,000 Kip (September 2002)

Appendix 1: Connonly caught species in the Mekong mainstream and main tributaries

Scientific Name	Family	Lao Name	Water Resources					
			MK	TR	RL	WSPO	RFPF	IW
Akysis variegatus	Akysidae	Pa khao	x	x	x	x	x	x
Amblyrhynchiehthys truncatus	Cyprinidae	Pa khao tapo	x	x	x	x	x	x
A. bantamensis	Babinae	Pa khao	x	x	x	x	x	x
Acantopsis choirorhynchos	Cobitinae	Pa it	x	x	x	-	-	-
Anabas testudineus	Anabantidae	Pa kheng	x	x	x	x	x	x
Amphotistius laosensis	Dasyatidae	Pa phahang	x	x	-	-	-	-
Amyda spp	Soft-shelled turtle	Pa phaong	x	x	x	-	-	-
Aaptosyax grypus	Cyprinidae	Pa sanak (adult)	x	x	x	-	-	-
Acantopsis sp	Cobitinae	Pa harkkoy	x	x	x	-	-	-
Arius stomi	Artidae	Pa khat ock soplem	x	x	x	x	x	x
Achiroides sp	Soleidae	Pa pane	x	x	x	-	-	-
Annamia normani	Homalopteridae	Pa thihin	x	x	x	x	-	-
Barbichthys laevis	Barbinae	Pa cheork	x	x	x	x	-	-
Bagrarius bagrarius	Sisoridae	Pa ke	x	x	x	x	-	-
Botia hymenophysa	Cobitinae	Pa khieokai	x	x	x	x	-	-
Bagroide macropterus	Bagridae	Pa kihia	x	x	x	x	-	-
Bangana behri	Cyprinidae	Pa vananor	x	x	x	x	-	-
Barbichthys nitidus	Cyprinidae	Pa vahangdam	x	x	x	x	-	-
Chitala blanci	Notopteridae	Pa tonkay	x	x	x	x	-	-
C. ornata	Notopteridae	Pa tongkouay	x	x	x	x	-	-
Catlocarpio siamensis	Cyprinidae	Pa kaho	x	x	x	x	-	-
C. enoplos	Cyprinidae	Pa khao	x	x	x	x	-	-
Cirrhinus jullieni	Cyprinidae	Pa dork ngyo	x	x	x	x	x	x
C. molitorella	Cyprinidae	Pa keng	x	x	x	x	-	-
C. microlepis	Cyprinidae	Pa phone	x	-	-	-	-	-
Cirrhinus lineatus	Barbinae	Pa soi	x	x	x	x	x	x
Clarias batrachus	Clariidae	Pa douk na	x	x	x	x	x	x
C. macrocephalus	Clariidae	Pa douk ouy	x	x	x	x	x	x
Channa marulius	Channidae	Pa kho na	x	x	x	x	x	x
C. micropettes	Channidae	Pa kado	x	x	x	x	-	-
C. orientalis	Channidae	Pa kouan	x	x	x	x	-	-
C. striata	Channidae	Pa ko	x	x	x	x	x	x
Discherodontus ashmendi	Cyprinidae	Pa seou	x	x	x	x	x	x
Dngila spilopleura	Cyprinidae	Pa khao	x	x	x	x	x	x
Euryglossa panoides	Soleidae	Pa pane	x	x	x	x	-	-
Hypsibarbus lagleri	Cyprinidae	Pa paktongpae	x	x	x	x	x	x
H. mekongensis	Siludae	Pa nang hang dam	x	x	x	-	-	-
Heterobagrus bocourti	Bagridae	Pa kagneng	x	x	x	x	-	-
K. apogon	Siluridae	Pa nangnoy	x	x	x	x	-	-
K. schilbeides	Siluridae	Pa nangleuang	x	x	x	x	-	-
K. cheveyi	Siluridae	Pa nanghangdeng	x	x	x	x	-	-
Labeo erythrurus	Barbinae	Pa va	x	x	x	-	-	-
L. dyocheilus	Barbinae	Pa vanoy	x	x	x	-	-	-
Mekongina erythrospila	Cyprinidae	Pa sa ih	x	x	x	-	-	-
Morulius chrysophekadion	Cyprinidae	Pa phia	x	x	x	-	-	-
M. nemurus	Bagrinae	Pa kot leuang	x	x	x	x	-	-

MK **Mekong River**
TR **Tributaries**
RL **Reservoirs and Lakes**

RFPF Rain fed paddy field
IW Irrigation weirs
X Available
- Not available

Data source: DLF, 2001

COUNTRY REVIEW

"Better resource management is urgently needed to sustain inland fisheries resources."

Inland Fisheries Information in Thailand

Oopatham PAWAPUTANON
Department of Fisheries, Thailand

Inland fisheries is significant for Thailand in terms of providing food security and employment to a large number of fishers and rural dwellers. Inland fisheries contributes approximately 200 000 metric tonnes per year, which is less than 6% (in 1999) of the total production of fish (Table 1). Although the share from inland fisheries is not high, inland fisheries are considered the most accessible and inexpensive source of protein for most Thais, it is thus important to the socio-economic and rural development of Thailand.

Table 1: Total inland capture fisheries (1 000 ton) 1978 to 1999

Year	Capture Fisheries production			Total Area
	Total	Marine	Freshwater	rai
1978			102.1	NA
1979			103.1	NA
1980			110.4	NA
1981	1989.0	1756.9	116.5	NA
1982	2120.1	1949.7	87.7	NA
1983	2255.4	2055.2	108.4	386,610
1984	2134.8	1911.5	114.4	538,421
1985	2225.2	1997.2	92.2	544,025
1986	2536.3	2309.5	98.4	546,176
1987	2779.1	2540.0	87.4	554,440
1988	2629.7	2337.2	81.5	561,669
1989	2740.0	2370.5	109.1	573,355
1990	2786.4	2362.2	127.2	2,640,326.52
1991	2967.7	2478.6	136.0	2,661,785.72
1992	3239.8	2736.4	132.0	2,731,966.78
1993	3385.1	2752.5	175.4	2,898,831.33
1994	3523.2	2804.4	202.6	2,729,470.26
1995	3572.6	2827.4	191.7	2,801,188.33
1996	3549.2	2786.1	208.4	2,696,171.56
1997	3384.4	2679.5	205.0	2,696,171.56
1998	3505.9	2709.0	202.3	NA
1999	3625.9	3166.4	206.9	NA

The development of inland fisheries in Thailand can be traced back hundreds of years, but became more systematic since the foundation of the Thailand Department of Fisheries in 1926. The Department at that time was mandated almost solely to survey and manage inland fisheries resources. Today, this task remains as one of many other missions of the Department. However, its development is hindered by many constraints. Degradation of inland habitats and the lack of up-to-date statistics are problems that need urgent attention.

State of inland fisheries in Thailand

Inland fishing in Thailand is carried out in natural and human-made freshwater bodies of various

types from rivers and their tributaries to reservoirs and fishponds. The total area of inland habitats is 4.5 million hectares. This is divided into 4.1 million hectares of rivers and wetlands and another 400 000 hectares of large reservoirs. There are 47 rivers and 21 large reservoirs that contribute to the production of freshwater fish. These impoundments are situated in various parts of Thailand and play a key role in the subsistence of communities involved (Table 2). In the past, floodplains were also important inland fisheries habitats but these have almost disappeared due to the construction of dams and other infrastructure developments.

Table 2: Reservoirs and large wetland water bodies in Thailand (000 of tonnes)

Year	Capture Fisheries production			Total Area
	Total	Marine	Freshwater	rai
1978			102.1	NA
1979			103.1	NA
1980			110.4	NA
1981	1989.0	1756.9	116.5	NA
1982	2120.1	1949.7	87.7	NA
1983	2255.4	2055.2	108.4	386,610
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1998	3505.9	2709.0	202.3	NA
1999	3625.9	3166.4	206.9	NA

Fish caught from inland habitats are multi-species and vary in abundance depending on the productive status of water bodies. In general, tilapias, Thai carp, snakehead, common carp, walking catfish, climbing perch, pangasius and macrobrachium are the dominant species (Table 3). These species make up more than 90% of the total capture freshwater fish catch of approximately 200 000 tonnes.

Fishing gear used in inland fisheries is traditionally developed for small-scale fishing activities. The most widely used gear includes stationary lift net, gill net, pole and line, scoop net and cast net. These gear are quite selective and simple to use. However, the use of fishing gears in public waters has to be permitted by authorities according to the Fisheries Act 2525 (B.E.).

Practically, inland fishers can fish all year round but the amount caught may vary from season to season. Freshwater fish is abundant during the rainy season from June to September. During this period rivers, wetlands and floodplains are very productive as new water activates spawning. Yearling fish will grow to full size during this season and are the target of fishing effort. Following the rainy season (October to December) water levels in most inland habitats start leveling off. This enables fishers to easily access grown fish from the rainy season using various fishing gear. Fishing can be done all year round in reservoirs but fish are caught more readily from July to September when the water level is low.

Inland fisheries management

Better resource management is urgently needed to sustain inland fisheries resources. However, without good information and statistics for policy guidance and action planning, this cannot be achieved. Some of the tasks necessary for inland fisheries management include:

- Conservation of inland fisheries resources
- Rehabilitation of fisheries habitats
- Upgrade the livelihoods of small-scale fishers
- Strengthen fisheries control measures
- Identify maximum sustainable yields of inland waters
- Promote maximum use of catches to reduce waste
- Assessment of inland fisheries

Thailand has continually assessed the abundance, diversity, population structure and distribution of inland fish. The methodology most used is based on Spatial and Temporal Random Design, where various replicates of sampling sites and sampling times are applied to scientifically represent habitats and seasons of interest. Practically, the assessments are carried out on at least five study sites and four sampling months

(January, April, July and October). Data collected is processed according to indicators such as weight and length relationship, population dynamics, biomass and diversity for further statistical analysis using Cluster Analysis and Multidimensional Scaling.

Table 3: Fish capture in inland habitat by species 1991-1999 (Unit: 1 000 tons)

Species	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total	136.0	132.0	175.4	202.6	191.7	208.4	205.0	202.3	206.9
Snake head	14.4	14.0	18.6	21.4	21.8	25.5	24.1	16.7	18.0
Walking catfish	7.0	6.7	8.1	7.1	8.1	5.8	3.4	10.9	12.1
Climbing perch	6.0	5.8	8.1	6.0	6.7	3.7	3.6	4.5	6.3
Thai carp	23.1	22.4	23.1	22.5	22.5	25.7	25.3	44.4	45.5
Tilapia	42.2	40.9	53.9	63.4	55.7	29.2	28.7	40.2	49.8
Common carp	6.8	6.7	8.7	8.2	10.1	7.4	7.4	11.5	13.7
Sepat siam	0.5	0.5	0.8	0.2	0.2	0.4	0.3	1.5	0.5
Pangasius	0.8	0.8	1.1	6.3	5.7	0.5	0.5	0.9	1.1
Swamp eel	0.0	0.0	0.4	4.4	5.5	0.4	0.4	0.0	0.0
Other food fish	35.1	34.1	52.4	60.0	51.2	106.7	108.4	70.2	59.4
Macrobracium	0.0	0.0	0.0	0.4	0.3	0.6	1.5	0.0	0.1
Shrimp	0.1	0.1	0.1	2.4	3.1	1.5	0.4	1.4	0.3
Others	0.0	0.0	0.1	0.3	0.8	1.0	0.1	0.1	0.1

Besides the sampling methods described above, there are other means of obtaining inland fisheries information. Some of these are port and market samplings to obtain landing volume, species, size and catch composition. Although this sampling method is readily used, care should be taken regarding the accuracy of data and sample size. Interviews and questionnaires are also often used for collecting data on inland fisheries. These methods are good for gathering overall views and information from various stakeholders. However, the findings may not be accurate unless the responders agree to share true data.

Constraints on inland fisheries information collection

Inland fisheries cannot be successfully managed unless information on key aspects is known. The key element that needs more investigation in Thai inland fisheries is the population structure of freshwater fish in major habitats. Such a study would reveal species composition, species distribution, maximum sustainable yield, fish production, catch and effort data and the socio-economics of communities involved. However, studies to obtain these parameters are difficult due to the following constraints:

Lack of basic up-to-date data: Information needed for inland fisheries research planning is scarce. Studies usually begin with very simple designs and are site specific and may not reflect the structure of fish communities in those particular areas.

Accuracy of data collection: The difficulty in inland fisheries data collection is due to the dispersion of data sources. If data collecting is done through interviews and port or market sampling, collectors may not get enough accurate data because data sources are numerous and disperse.

Knowledge of scientific data collection: Data collection is considered a science and gathering data has to follow scientific procedures. The lack of basic knowledge and standardization of data collecting protocols causes difficulties for inland fisheries statistics in Thailand.

Scattered information: Inland fisheries is carried out throughout the countries by mostly small-scale fishers. The information is piece-meal and scattered, making it difficult to process into an inland fisheries profile of the country as a whole.

Size of the habitat: Scientific surveys of fish populations in large ecosystems are a problem in Thailand because of the limited budgets, equipment and qualified people. These constraints need to be resolved through internal arrangements.

Solutions for inland fisheries information collection

Information is a powerful tool for planning and management of inland fisheries resources. Thai Department of Fisheries realizes the need to strengthen its framework to overcome difficulties. Some changes are currently taking place. DoF has reorganized its structure by integrating tasks that involve information into a single unit and is applying information technology to process data. DoF is also strengthening human resources to improve knowledge of scientific data collection by cooperation with intergovernmental organizations like FAO, NACA and MRC. DoF has revised the Fisheries Act to cover fisheries activities that obligate people to report data to the government.

COUNTRY REVIEW

"In the eyes of managers and policy makers, inland fisheries have never been seen as an economic activity."

Inland Fisheries Statistics in Viet Nam

THAI Thanh Duong
Fisheries Information Centre (FICen)
Viet Nam

As a country possessing large natural water surface areas, the fisheries in Viet Nam appeared very early. According to legend, the fishery was one of the first means of subsistence of the people. The modern fishery includes three operations: marine fisheries, inland fisheries and aquaculture.

In recent years, Viet Nam's fisheries have experienced rapid development, becoming one of the major economic sectors and a key export sector making up about 7% of country's GDP. However, while the fisheries sector has developed rapidly, in particular marine fisheries and aquaculture, inland fisheries have not been given due attention even though it plays a significant role in peoples' lives.

Inland fisheries in Viet Nam include fishing for food and other purposes such as making ornamental objects, medicines and capture of seeds for aquaculture. Recently, leisure fishing has become popular around urban and tourist areas. At present, inland fisheries are declining rapidly. The capture of fish seed for aquaculture has lost its role as the only source for seed supply for aquaculture. Nevertheless, the catch from inland fisheries still plays an important role in the regular supply of animal protein for rural residents who face difficult economic conditions and have to rely on food sources they can seek themselves. In farmer households, one can find at any time certain kinds of fishing gear such as rods, crab baskets, fish traps or cages. Species usually caught include fish (carp, snakehead, catfish, eel), crustaceans (shrimp and prawns, fresh water and brackish water crabs) and mollusks (snails, clams, oysters).

However, in the eyes of managers and policy makers, inland fisheries have never been seen as an economic activity. Previously, fishers in inland waters were considered to be the poorest people with low education and no position in society. Actually, the number of inland fishers is very low and this practice is only one activity to provide food for their meals or for selling to other local people. This has some consequences. First, a source of employment to create additional income and provide food for the population has

not been managed and brought into play, especially in terms of poverty alleviation. Second, non-managed fishing activities such as the use of toxic chemicals and electric shock to catch fish have resulted in the destruction and extermination of fisheries resources. Finally, without an appreciation of the role of the inland fisheries, there is little or no concern about the influence of other economic sectors on fisheries resources.

Due to the lack of concern for inland fisheries, the record of statistical data is weak. In reality, no agency is responsible for doing the statistical work. Any statistics on inland fisheries are only estimates.

Fisheries management systems

The organization chart of fisheries management in Viet Nam is rather complicated (Fig. 1). The Ministry of Fisheries (MOFI) is a government agency responsible for implementing state administration of the fisheries sector. The MOFI system includes the ministerial agency and some professional units of which three have branches in different localities, namely the Department for Fisheries Resources Conservation, the National Fisheries Inspection and Quality Assurance Agency (NAFIQACEN) and the National Fisheries Extension Centre.

The Department for Fisheries Resources Conservation has branches located in the coastal provinces and some inland provinces with large fisheries (mainly in the Mekong River Delta). NAFIQACEN has six branches set up at fisheries centres. The National Fisheries Extension Centre has a network of fisheries and agriculture extension centres in all provinces across the country.

In coastal provinces, the agency implementing the state management of fisheries is the Department of Fisheries (DOFI) which is under the management of the Provincial People's Committee. It is also subject to the professional management of MOFI (actually, there are 25 Departments of Fisheries and one Department of Fisheries-Agriculture-Forestry). Two coastal provinces have no Department of Fisheries. In other provinces, the mission of managing fisheries is carried out by the Department of Agriculture and Rural Development.

At district level, an Economics Bureau or an Agriculture-Forestry-Fisheries Bureau implements fisheries management. At commune level there is an Agriculture Board or an Agriculture-Fisheries Board.

Fisheries statistics systems

The fisheries statistics system in Viet Nam is complicated, not mentioning short-term investigations implemented by programmes and projects. At present, regular statistical data on fisheries are being collected in parallel by two systems, namely the statistical system of the Ministry of Fisheries and that of the General Statistics Office. Nevertheless, neither system has been designed to include all information fields necessary for the management of fisheries. This situation is due, on the one hand, to the complexity of the state administration apparatus as described above and on the other hand to the process of shifting the national economy from a centrally planned mechanism to a market one. These two mechanisms have different methods and requirements for economic information and statistics and have different ways of organizing the system. The qualifications and working style of officials is also different. At present, efforts are being made to strengthen the capacity of the fisheries statistics system to keep pace with countries in the region and in the world.

The main agency responsible for collecting fisheries statistics in coastal provinces is the Department of Fisheries (supervised by an Economics Bureau or an Economics & Planning Bureau). In the remaining provinces this work is done by the Department of Agriculture and Rural Development. Collection of fisheries statistics by the Department of Fisheries is done according to the following methods:

- Registration book and license
- Reports made by district officials

- Reports based on the original data of the Sub-Department for Fisheries Resources Conservation, the Centre for Fisheries Extension and the Market Management Board
- Interviews and survey forms
- Estimates of monthly, six-months and annual fisheries statistics, which the Department of Fisheries uses to make a report for MOFI's agency in charge of fisheries statistics

Before 2000, MOFI's agency responsible for statistics was the Planning & Investment Department, staffed with two or three specialized officials. Since late 2000, this role has been transferred to the Fisheries Information Centre (FICen). Besides, the Provincial Departments of Fisheries, the Departments of Agriculture & Rural Development in the provinces also submit statistical data to MOFI prepared on a quarterly, six-month and one-year basis or at the request of FICen (mainly data on aquaculture production). FICen also receives reports from the General Customs Department on production and the business of corporations and statistical data on fishery products exported through border gates.

FICen is responsible for processing and analyzing reports to make a monthly, quarterly, six-month and annual report serving management and policy-making bodies of MOFI and local authorities. Every quarter FICen (on behalf of MOFI) meets with the General Statistics Office to make comparisons and analyze data. Thus, statistics published by MOFI include outputs of the marine catch, aquaculture and from inland fisheries in coastal provinces (Fig. 2).

In addition to the statistical system of MOFI, the General Statistics Office has a network of Departments of Statistics in provinces and Bureaus of Statistics in districts and officials in charge of the statistics work in communes. They gather statistics at the national level, including fisheries data (Fig. 3). In provinces where there is a Department of Fisheries, every month an official in charge of statistics holds a meeting with the Department of Statistics to make comparisons and analyze data, then prepares a report to submit to the provincial People's Committee, the General Statistics Office and MOFI.

In provinces where there is no Department of Fisheries, the monthly statistics are usually not introduced into the collection content but only quarterly or six-month statistical data. Statistics on inland fisheries include mainly aquaculture output and the catch from inland waters.

Data on inland fisheries are collected in one of two ways: first, output is estimated through registered and supervised fishing gear (set net, bag net) or through on the spot markets. Generally, data on inland fisheries output are not adequately reflected.

Second, fisheries data supplied by the General Statistics Office are the State's official data, including: output and value of marine catch and output and value of aquaculture output. In general, there is a difference between statistics put forth by the General Statistics Office and MOFI. This difference is partly due to the output of inland capture in non-coastal provinces.

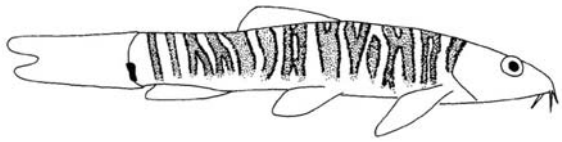
Orientations

The lack of Viet Nam fisheries statistics both on marine catch, aquaculture and inland fisheries has been recognized by management agencies which are actively seeking ways to improve the situation.

Under the direction of the Government and with support from FAO in October 2001, the General Statistics Office co-coordinated with the Ministries of Agriculture and Rural Development and Fisheries to conduct the second census on agriculture and rural areas and the first census on fisheries. Collected data are being processed and the results will be announced by the end of 2002. Though this investigation does not focus on fisheries, it is hoped that the result will indicate a general picture of the role of fisheries in rural livelihoods in Viet Nam.

MOFI has assigned FICen to implement a theme to raise the statistical capacity of the fisheries

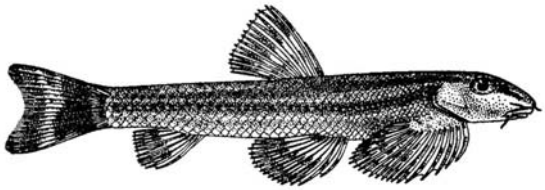
sector and make preparations for conducting some investigations focusing on socio-economic matters of the sector.



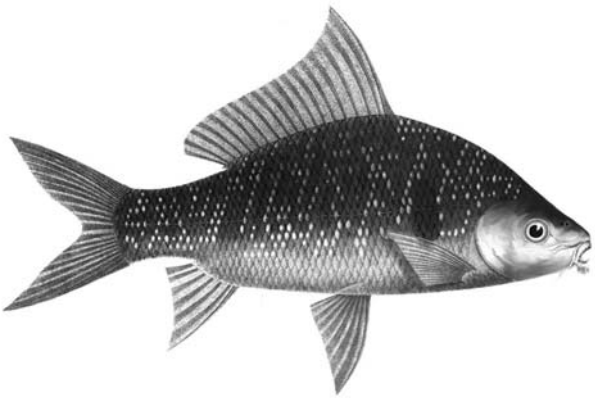
However, in the process of raising its capacity, MOFI is faced with the following difficulties:

- Lack of trained human resources
- Lack of funds to conduct investigations
- The system of statistical criteria is not adequate
- Reported fisheries data still mainly rely on administrative reports

Officials in charge of fisheries statistics are required to be trained professionally and possess knowledge of the fisheries. This demand is not easy to meet. Due to the lack of a unified statistical system and a limited state budget, actual statistics activities of the fisheries sector face many difficulties.



Viet Nam will require assistance and collaboration from international organizations and other countries, especially countries in the Mekong River Basin, to build and put into operation a fisheries statistics system meeting the requirements of management, policy- making and data exchange.



THEMATIC REPORT

"All countries regard the main value of their inland capture fisheries as sustaining the livelihoods of poor rural communities and contributing to food security."

An Overview of Inland Capture Fishery Statistics of Southeast Asia

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Inland capture fisheries are characterized by diversity in the range of gear used, types of environments in which they are used and the socially and culturally complex societies within which they operate[1]. Inland fisheries have many of the features of marine fisheries and many others that the latter does not possess. The greater complexity of inland fisheries has a major influence upon the type and quality of statistics it is possible to collect and the problems with obtaining them. Collection of fishery statistics generally favours the marine sector, both in ease of collecting information and motivations for doing so (taxation, export revenue generation etc.). Aquaculture information is generally easier to collect than inland capture fishery information due to better defined areas and ownership. Although statistical information for marine fisheries and aquaculture are not perfect, it is certainly more representative than that available for inland capture fisheries.

According to recognised definitions, it can be generalized that most published figures for inland capture fisheries in Southeast Asia do not actually qualify as 'statistics' because they are not based upon data. Even for the exceptions, qualification as true statistics is debatable, since none of the information is based upon measurement or observation. This is not necessarily a problem, however there is the serious issue that this information is reported as real data and subsequently accorded an importance and veracity that is undeserved.

Statistics collection

A wide variety of methods are used by the countries covered in this report to estimate inland capture fisheries production. These range from estimates made in offices without any information collection (verging on guesses), through basic or elaborate sampling based surveys, to attempts to obtain full cover of the entire fishery based upon the compulsory licensing of all gear. There are also widespread suspected, unofficially recognized or officially confirmed differences between the official systems in place and actual practice. In only two countries, out of the eight covered in this report,

is there any degree of confidence in the level of knowledge of the system that is actually used in practice. In one case, the official system is that no information is actually collected and the other where it has been subject to extensive independent research over the past six years.

None of the countries reviewed derive their statistics based upon direct observations, report verification, sampling of catch or landings, or any other form of independent monitoring. This includes Cambodia, where the statistics have recently been substantially revised (*i.e.* corrected). This revision was made based upon new information produced by research, not through the introduction of an improved statistics collection system. Estimations are inherent in all of these country's systems and range from responsible attempts to estimate actual catches through to arbitrary supposition. Many are genuine attempts by over-worked and under-resourced staff. But underlying some of the field level estimates is a general disinterest in accuracy and occasionally mis-reporting.

Trends in the reported statistics

Based upon the statistics currently available, there is no apparent trend of declining production for any country (except possibly for the Philippines, less so for Viet Nam). This is somewhat at odds with the frequently expressed view that inland capture fisheries are in terminal decline, and illustrates that the perceptions of these fisheries are not influenced by the available statistical information which questions the purpose and value of inland fishery statistics.

Two countries have reported significant increases in actual production in recent years. Thailand's increase is attributed to the impacts of stocking in reservoirs. Myanmar, however, reports a 65 percent increase in production from already substantial river and floodplain fisheries over the past 4 to 5 years, achieved through improved aquatic resources management (environmental restoration and rehabilitation, restocking floodplains and improved governance) which has not required any substantial physical resource inputs. This example eclipses any known production increase that has been achieved through aquaculture development that started from a similar point and strongly challenges the widely held view that river fisheries cannot be improved.

Inland capture fisheries are clearly seriously under-reported in all of the countries reviewed. The discrepancy between officially reported catches (where available) and estimates based upon independent scientifically based surveys (*i.e.* collection of actual data) varies by a factor of between 4.2 and 21.4. Overall, for all the countries combined, the total reported production from inland waters appears to be under-estimated by a factor of between at least 2.5 and 3.6

Participation in inland capture fisheries is very high, but adequate information on this is rarely collected. Most fishers are not licensed and operate on a part-time or seasonal basis. Large numbers of people are also involved in processing, marketing, transportation and other service sectors. Where information exists, it suggests that participation in inland fisheries might equal that in marine fisheries and possibly exceeds that in aquaculture by a factor of at least three times. The figure published by FAO for the number of inland capture fishers worldwide (4.5 million, including all levels of fishing) is easily exceeded by those fishing in inland waters in the eight countries covered by this report alone! The role and importance of inland capture fisheries to the livelihoods of participating fishers should be defined by the stakeholders themselves, not externally. This importance is not necessarily related to the gross production figures. Equally, the significance of inland fisheries to a national economy should also not be assessed using narrow or inappropriate economic criteria.

The total reported freshwater aquaculture production for 1999 in the eight countries covered in this study was 1 268 968 tonnes. This figure is slightly exceeded by the reported freshwater capture fisheries production (1 303 247 tonnes). Reported figures for inland capture fisheries are almost certainly under-estimated and in this report, it is argued that the

actual production from inland capture fisheries is likely to be at least three times that reported for freshwater aquaculture. This raises questions as to the relative attention and investment made in the two sub-sectors.

Sources of error in statistics

Major sources of error in officially reported statistics include: errors in catch reporting; under-estimates of the importance of small-scale fishing activities (a serious problem in inland fisheries because most of the catch arises from this sub-sector); mis-reporting by government officials; and estimates made without data collection. Other constraints include inadequacies in recording the level of participation in capture fisheries, lack of description of the species composition of catches, inability to monitor fishing effort, lack of attention to bio-diversity considerations, ornamental fish and recreational fisheries, and livelihoods aspects. Compounded to this is the considerable problem of the almost universal uncritical acceptance of the information being produced.

Countries cannot be ranked in order of those having the 'best' statistics. The current statistics must be considered not only in terms of potential accuracy, but also in terms of the effort expended (cost) in obtaining them. Interestingly, there does not appear to be a direct relationship between effort (costs) expended on information collection and the accuracy or relevance of the information produced. This has very significant implications for those thinking of investing heavily in improved inland fishery statistics based upon existing models.

Purpose of the statistical collection

One of the most interesting and relevant areas that was covered by this report, was that of the objectives of compiling inland capture fishery statistics and the use to which the information is put. In many countries, 'statistics' are compiled because they are requested or demanded by central government, however the actual use to which these statistics are put is often uncertain. National fishery statistics are sometimes compiled primarily, as a perceived obligation to FAO, therefore the information that FAO requests has a major influence on what is collected or compiled. Countries are reluctant to admit to FAO, and even within or between their own agencies, the true nature of the information reported. Consequently, the "statistics" reported are often taken as factual. Most countries report that the statistics are used for "fisheries management purposes" but few countries are actually managing their inland capture fisheries. Even if they were, the information produced through their statistics is not adequate for most management purposes. In the few cases where fisheries management occurs, the national statistics are of limited use in assessing the impacts of management, or meaningful statistics are only gathered in controllable situations (*e.g.* for reservoirs).

All countries regard the main value of their inland capture fisheries as sustaining the livelihoods of poor rural communities and contributing to food security (not withstanding that many countries still have significant commercial/industrial inland fisheries). By contrast, in general, marine fisheries are regarded as being important for revenue generation, export earnings and formal economic benefits. In most cases so is aquaculture. All countries agree that the current information collected, even if it were accurate, does not provide adequate information for addressing, monitoring or managing issues that relate to rural livelihoods. There is a clear realisation of the need to obtain such information but considerable uncertainty regarding how it can be done and who should do it. All countries reviewed also agree that the main threats to inland fisheries, particularly for rivers and associated wetlands (less so for reservoirs), is habitat loss and environmental degradation.

The information currently collected does not assist in monitoring such trends, nor does it contribute to moderating the degradation itself. All countries recognise the importance of issues relating to sustaining bio-diversity in inland waters, but the current statistics are widely regarded (correctly) as irrelevant to this subject also.

Statistics collection: from extraction to feedback

The history of fishery research and management has had a significant impact upon statistics collection systems and levels of attention to the various sub-sectors. The complex multi-gear, multi-species, inland capture fisheries have been a casualty of this process. The research and management needs for inland capture fisheries have generally been addressed by trying to translate approaches and methods originally developed for marine fisheries. These have not generally worked and tend to ignore the differing characteristics of this sub-sector.

More recently there have been significant shifts in policy emphasis towards: (i) poverty issues and 'livelihoods centred approaches', (ii) the environment (and bio-diversity), and (iii) the promotion of co-management systems for fisheries. All three of these are beginning to emphasize the importance of inland fisheries. However existing statistical systems are incapable of addressing information needs for the first two policy areas and are not particularly compatible with the third, being primarily based on extractive assessment methods.

A significant challenge for the future is to respond rapidly to these shifts in policy and emphasis by adjusting information generation and dissemination activities to cater to these new needs. There are constraints in doing this, because many member countries themselves will have difficulties in shifting emphasis towards more pro-poor, livelihoods oriented forms of information generation. There is an excellent opportunity for FAO to be pro-active and to start to request such information, and to assist members in deciding how best it can be generated. The initial step in this process is to raise the awareness of member countries to this need and is probably more important than obtaining the information itself.

The move towards co-management approaches for fisheries offers significant opportunities to improve information generation. Effective co-management should improve confidence and trust between fishers and government staff together with the willingness to divulge more accurate information, and more cheaply. It is largely because most of the current information systems are extractive by nature that they are inherently unreliable.

The overall impression that comes out of this report is that most of the countries in Southeast Asia struggle with limited resources to compile information that, in many cases, they do not themselves trust, need or use. At the same time, most of these countries are aware of what information it would be more logical to collect, but lack the methods and support to obtain it.

Recommendations

There are a number of recommendations that might be adopted by individual countries to improve their information on inland capture fisheries. These strategies will largely depend upon the extent of their current inland fishery statistical systems and the degree to which they have specific requirements. An overriding consideration will almost certainly be the extent to which further investment in improvement is needed or appropriate.

Countries should review their existing statistics based upon impartial desk-top appraisals using existing information. This type of review would include:

1) The estimated production of inland fisheries, the degree of participation the extent of dependency upon inland capture fisheries.
2) An explanation of where there are inadequacies in the current statistics
3) Where possible, the opportunity to incorporate inland capture fishery information requirements into surveys done by other agencies.

It should be widely and openly acknowledged that most existing statistics are not useful for monitoring trends in inland fisheries because of their poor quality. There is a need to explore options for obtaining better information enabling trends to be tracked, using low-cost and

sustainable methods. They should not assume that tracking trends in fish stocks is the priority. Some of the supporting information relevant to fisheries but not production is:

1) Existing statistical systems should be revised to make it easier to incorporate ancillary information (*i.e.* that generated outside of fishery statistics collection systems) into estimations and subsequent reports.
2) The monitoring trends in the environment relevant to inland capture fisheries.
3) The monitoring trends in biodiversity.
4) The inclusion of livelihoods related information into statistics and information generation activities.

This type of supporting information gives meaning to the quantitative data generated.

Those countries with existing extensive inland capture fishery statistical systems should consider how best to improve them, without necessarily incurring significant additional costs. Those countries that currently have more limited statistics collection activities should be careful about investing in improved systems, if they are based upon the models currently in place in other countries.

1) Institutional recognition that, as policies and priorities change, information requirements change along with them. This represents an opportunity for countries to re-vitalise their statistical systems in response to these changing requirements.
2) Statistics and information systems should be reviewed, revised or developed with the full involvement of appropriate stakeholders at governmental level (*i.e.* appropriate statistical agencies, collection agencies).
3) Countries should integrate co-management approaches and the generation of fishery information.
4) Countries in Southeast Asia should share their information on inland capture fisheries and statistical/information systems. They have much to learn from each other.

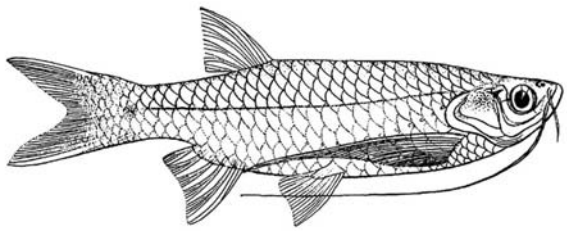
The publication of global statistics is one of the roles of FAO which is a stakeholder in this information process. It is recommended that the inland capture fisheries statistics produced by FAO should include better indications as to their basis and meaning. Such as the inclusion of qualifying notes, indicating the reliability of the information in its yearbooks of inland capture fishery statistics. As part of this process, FAO should provide improved advice to member nations on what kind of livelihoods relevant information should be collected and how it can be obtained cost-effectively

Reference

Coates, D., 2002. *Inland capture fishery statistics of Southeast Asia: Current status and information needs*. Asia-Pacific Fishery Commission, Bangkok, Thailand. RAP Publication No. 2002/11, 114 p.

Footnotes

[1] The findings of this paper are drawn from a report commissioned by the FAO Regional Office for Asia and the Pacific titled: "Inland capture fishery statistics of Southeast Asia: Current status and information needs" (Coates, 2002). This report assesses the quality and relevance of existing statistics on inland capture fisheries and the extent to which the statistics meet management objectives. The report suggests ways in which the existing statistics might be improved through cost-effective means and explores the information needs for inland capture fisheries. The scope of the report covers five countries visited during the information collection process (Indonesia, Malaysia, Myanmar, Philippines and Thailand) and three other countries that are based upon prior experience (Cambodia, Lao PDR and Viet Nam).



THEMATIC REPORT

"Casual observation indicates that women play an integral role in inland fisheries."

Women as a Source of Information on Inland Fisheries

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Theo VISSER
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This paper explores the constraints on the involvement of women as information providers despite the fact that women are very much involved in all aspects of inland fisheries. They have as much experience and local knowledge as the men although this experience is different as women are involved in slightly different activities and under different circumstances. This means that the information women provide often complements that provided by men. In some sectors, especially subsistence/family fishing, marketing/processing and nutrition/consumption, women often have more knowledge and information than men.

A complete picture of the fisheries sector must involve women in data collection to ensure that their experiences and viewpoints are taken into consideration. The task lies squarely with the planners and field staff who design and conduct surveys. Special attention for women is warranted as they are largely ignored in official statistics.

Introduction

Fish is recognised as the major animal protein source for the majority of people in the Lower Mekong Basin (LMB). Rural people living in the LMB depend on rice as their staple food and fish and other aquatic resources as a sizable portion of their protein intake (Ahmed, *et al*., 1998). The high proportion of fish consumed has a historical base in the long development of agricultural-fishing societies in which rice and fish are the major foods. Fishing and farming are difficult to separate as rural people do not consider themselves to be 'fishermen' (or fisherwomen) yet depend heavily on fishing for their livelihoods.

Fishing related activities can be roughly divided into catch, culture and processing/selling. Catch activities are often assumed to be carried out mainly by men. In the case of marine capture fisheries, men form the majority of the labour force because marine fishing is heavily industrialized, is considered dangerous work and includes long periods where the fishers cannot return home to their families. In inland capture

fisheries it is common to see women fishing or supporting their husbands' fishing activities. This includes actively helping to catch, process and market the fish caught. This is especially true for subsistence fisheries.

Role of inland fisheries

Inland fisheries habitats are characterized by an annual cyclic flood pulse that causes the river to flood low lying lands next to the river and after a number of months to retreat back into the main river channel. The fisheries have a distinct seasonality whereby a distinct river and floodplain component can be observed, depending upon the hydrological conditions. Environments vary from freshwater to full seawater according to flood and tidal conditions (Coates, 2002). The bulk of fishery activities in the LMB is at the subsistence/family level with the exception of certain fisheries in the Tonle Sap Lake, the Mekong Delta and some localized areas of the Mekong and its tributaries where large commercial fisheries can be found.

Women's involvement in fisheries

According to official statistics women's participation is low. However, little information about women is collected. And yet, the most casual observation indicates that women play an integral role in inland fisheries. Women are involved in different activities in different ways. Many women join their husbands in fishing or fish alone. Women are often in charge of children and the supply of food and all their tasks are geared to maintaining household members' quality of life. This means women are responsible for:

Finding food for the family. This is a common responsibility for women in rural areas. Women are usually in charge of maintaining the family protein food supply. Many studies on inland capture fisheries have shown that catch in the LMB is seasonal. Professional and part-time fishing activities have a peak in the flood season when the fishers target the migrating fish stocks. At the same time, studies have shown that women need to fish and collect other aquatic organisms all year round to provide family food on a daily basis. During the dry season when men go to work as hired labour, women stay behind to take care of the house and find food for the family. On a daily basis, women continue to gather snails, frogs and aquatic plants and fish in nearby habitats in the dry season when most commercial fishing operations are at a low level of activity.

Processing fish in times of abundant supply for family or sale is also a common activity for women. Men are rarely involved.

Selling products is one of the many activities that women perform well. Women have good experience in marketing and women traders often outnumber male vendors.

The knowledge available from men and women about the same habitat is often complementary.

Supporting a husband in fishing and mending, making or repairing fishing gear is a normal practice. Women face physical constraints when the men are using large sized gear or fishing far from home. Still, this does not keep women from supporting husbands or working as crew on a fishing boat. In rural areas, it is quite usual to see women and men side-by-side fishing or mending gear.

Inland fisheries information

Inland fisheries information is needed for assessment, planning and management purposes and many approaches have been developed to collect data and assess fisheries production. There are two main sources for fisheries information:

1) Biological surveys to provide information in relation to biology and ecology of fish species, environment, etc. and

2) Socio-economic surveys that provide the bulk of statistics and information from very general descriptions to complex data on the relationships of communities, their activity patterns, livelihood

strategies and their resource use in relation to the fisheries environment.

These two types of survey are translated into common approaches used for gathering fisheries related data and information. The biological survey is required to understand the ecosystem. These surveys are usually conducted in localized areas on species occurrence, trophic relationships and growth and interactions with surrounding habitats. A complementary approach would be to supplement these surveys with Local Ecological Knowledge provided by resource users. The biological information needs to be supplemented with information on the people component: fishing operations, processing/marketing, involvement, food security issues and alternative livelihood strategies.

The study on the Status and Perspective of Fisheries in the Lower Mekong Basin by the Mekong River Commission (Sverdrup-Jensen, 2002) recognizes that the techniques used for the surveys does not provide accurate information on the actual situation. The methodologies used leave much to be desired. The main problem is exclusion of the single most important group in inland fisheries - those involved in subsistence/ family fishing. Moreover, the surveys normally do not consider gender aspects. This results in missing essential data on the state of the fisheries and resource use.

What fisheries information can women provide?

In a traditional rural lifestyle, men and women work together in the fields but perhaps in different areas performing different tasks. Women often support activities that are considered 'male' activities and even may be the leader for some work. Men generally engage only in income generating activities while women will do both income and non-income generating activities. Women can have as much, or more, local knowledge on certain aspects of fisheries, fishing habitats and related information than men. They may fish in the same habitats but they may select different places or periods and use different gear. These differences stem from a number of factors.

Differences in the physical abilities of men and women lead to differential fishing times and habitats. Night fishing and fishing in places with strong currents is normally done by men.

Responsibility for housework, childcare and reproductive activities limit women to go fishing in certain places but allows them to go fishing near the house. Men are less restricted in the distance they can travel to a fishing ground and the length of time they can stay away from home.

Access to training in new technology restricts women to low-tech or 'no-tech' fishing techniques (Kusakabe and Kelkar, 2001).

Table 1 shows womens' participation in surveys and their value as information providers or logbook recorders during a 1996-2000 study. There were two different survey types; socio-economic aspects of fisheries (baseline surveys) and biological surveys supplemented with Local Ecological Knowledge (LEK). Data gathered during biological/LEK surveys on fish migration in the Songkhram tributaries found that women provided good quality information about fish behaviour and fishing. For the socio-economic baseline surveys, no data on the quality of the interviews was gathered but the general impression by the enumerators was that women could provide excellent information, especially on women's roles and knowledge in fishing, consumption, food processing and marketing.

Table 1: Percentage of women providing fisheries information in different surveys and study areas in the LMB during 1996-2000

Survey Area	Interviews	Men	% total	Women	% total	Quality	Remarks
Migration Mainstream	450	449	99.8	1	0.2	unspecified gave no species details	Most data collectors were men
Migration Tributaries	256	250	97.7	6	2.3	average to good	An effort was made by Thailand to identify expert women fishers
Logbook Migration Monitoring	44	44	100.0	0	0.0		Only men selected

Table 2 illustrates that experience in fishing for men and women is not much different. How women convey their experiences is different from men and this should be kept in mind when collecting information. Data collectors must be sensitive to local traditional and customs.

Table 2: Comparison of experience in fishing between men and women (years)

Group of fisher	Average age	Average experiences
Female	42.5	23.5
Male	44.8	26.1

Source: Database of Fish Migration and Spawning in the Songkhram Tributary, NE Thailand

Data collectors should make a special effort to select women to provide information on fishing activities. The low number of women providing information on fisheries does not mean that women are not involved or have no skill and knowledge but that data collectors should be better trained to include women.

Gender: The key to more complete fisheries information

Riddle (2000) indicates that there are at least four main types of gender differences in acquiring local knowledge or traditional ecological knowledge:

- Knowledge in different aspects
- Knowledge about similar aspects
- Different ways to organize or perform tasks
- Different ways to preserve and transmit the knowledge acquired

In addition to gender, age is also important. Both old and young can have a good understanding of their environment and of different fishing activities. In surveys, an attempt should be made to include women and children because children can have an excellent knowledge of the immediate environment. The habitats where children go and the animals and plants they collect may be quite different from adults of either gender. The information may not be of interest to 'real' fishers, but it makes an important contribution to the food a household consumes. For example, there are many kinds of small fishing gear used by women and children such as hand-gathering, scoop nets and scoop baskets (Gordon, *et al.* 1997).

Taking gender into consideration provides better fisheries information for the whole year. For inland capture fisheries, many men fish only as a part-time or seasonal occupation. The data gathered from many studies in different areas in the LMB show a peak catch period that occurs in the rainy or flood season. Women often catch and collect fish and aquatic animals all year round due to their responsibilities for the food security of the family. Because women have a more 'continuous' experience, their information is essential for building a more complete and accurate picture of the inland fisheries.

Knowledge available from men and women about the same habitat is often complementary. Women often seem to have better knowledge about the smaller non-commercial species and about juveniles as these may be a valuable food supply. This is often ignored by male fishers who target larger species and adult fish. Since use of different gear affects the species caught, catch data from both women and men can complement each other since women use different fishing gear and fishing methods.

Gaining access to women's knowledge

Interviewers and survey staff need an understanding of gender as one of many requirements for obtaining local knowledge.

Techniques used to involve women need to be fine-tuned to allow women to encourage women to participate. The role of women is still considered to be merely supportive to the activities of the men. This misconception limits women's participation.

Timing is essential. Women have many burdens and ‘a woman’s work is never done’.

Suitable times and places must be selected to allow for maximum involvement. It is important that both male and female staff are employed to conduct surveys. Female respondents often feel more comfortable talking to women interviewers.

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"There is a growing recognition that women are active not only in post-harvest activities but also in harvesting fish."

Gender Issues in Small Scale Inland Fisheries in Asia: Women as an important source of information

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The international community is paying more and more attention to women and their role in maintaining the health of the world's fisheries. But our knowledge is sketchy, and our ability to reach out is limited. Until quite recently, the macho image of the fisherman colored much of our thinking, but that image is changing fast. *Meryl Williams, Director of the World Fish Center, Future Harvest website*

Introduction

Meryl Williams of the World Fish Center estimates that at least 50 million developing country women are employed in the fishing industry (Future Harvest website). Small-scale inland fisheries play a significant role in the country's development by providing inexpensive protein to the poor and generating employment in the rural areas (CIRDAP, 1989). In some countries in Southeast Asia, inland capture fisheries provide an important export item. The largest export item in the border market in Poipet, Cambodia is fresh fish (Sok Sothirak, 2002). In many other places, inland fishes are consumed either at home or in the domestic market.

Fishing has long been considered a male occupation and women were thought to be involved only in post-harvest activities. However, there is a growing recognition of women's contribution in capture fisheries in all activity spheres. In China, rural labour force statistics for 1991 showed that women accounted for 26.3% of the rural labour force in fisheries (UNDP/FAO, n.d. quoted in FAO/SD website 1). In Asia, women are active in both artisanal and commercial fisheries. In parts of India, women net prawns from backwaters; in Lao PDR they fish in canals; in the Philippines, they fish from canoes in coastal lagoons (FAO/Gender in Fisheries website 2). In areas where male migration is prevalent, women are bearing heavier responsibility in fisheries (Suwanrangsi, n.d.) and with the feminization of fisheries, women's roles in fisheries and aquaculture are becoming increasingly important.

Studies on women in fisheries so far have been more or less concentrated on fish processing and

preservation techniques and activities, extension, and socio-economic status of women (Vega, 1989) and on women's participation in fisheries or in aquaculture (Harrison, 2000). There has been less focus on looking into gender relations or examining how gender relations in the household and community affect fisheries related activities. That is, women's activities have been treated as separate activities and the complimentary and conflicting roles and relations between women and men have been given little attention (Harrison, 2000).

This paper provides an overview of current studies that focus on women in fisheries and discusses the challenges we face in bringing gender perspectives into fisheries. To successfully address gender issues, information and statistics have to be collected accordingly. The final section of this paper offers recommendations on statistics gathering to better understand gender relations and the mechanisms of womens' subordination.

What do women do in inland fisheries?

There are different levels of involvement in inland fisheries. Some fishers, especially around large lakes and reservoirs, are engaged in capture fisheries as a primary source of income. In many areas, inland capture fisheries are a secondary income source or a supplementary source of protein for home consumption. Ahmed *et al*. (1998) in their survey in Cambodia found three equally important reasons for choosing fishing as a preferred activity: fishing is the only alternative available for food and income; fishing is part of traditional food collection for family food supply; and it is cheaper to catch fish than to buy it from the market. Engagement of women and their contributions would be different for different levels of fisheries activities.

In developing countries fish handling, sorting, preservation and processing have been carried out by women. In Southeast Asia, marketing of fish has also been dominated by women. Ahmed, Rahman and Chowdhury (1999) noted that in Bangladesh, tribal women around the Kapati reservoir were involved in fish harvesting, marketing, drying and post-harvest activities such as carrying fish from the pontoon to land, sorting, icing, packing and loading the transport vehicle. Twenty-two percent of their women respondents were involved in retail marketing. Women were responsible for small fish trading while men were responsible for trading large fishes. Unlike in Southeast Asia where net mending is done more by men, in Bangladesh it is women's work.

In China, rural labour force statistics for 1991 showed that women accounted for 26.3% of the rural labour force in fisheries.

There is a growing recognition that women are active not only in post-harvest activities but also in harvesting fish. Women are seen to use smaller equipment to fish (FAO/Gender and Fisheries website 2). Women fish individually or assist men in fishing. In Yunnan, China, the Trans-Watershed Water Supply Project has flooded the Lashi watershed. As a result, neither women nor men could carry out their farming activities and became increasingly dependent on fishing (Yu Xiaogang, 2001).

With fishing now the major income source of the household, women are now going out with men in small boats to fish. Some women go alone. Although there is still a strong perception that women are not suited for fishing and cannot fish individually, the following quote of a respondent in Yu Xiaogang's research shows that women are independent fishers, even though their fishing methods and techniques might be different from that of men.

"The dugout canoe is more suitable for men as it is fast but unstable. The fishing nets are also unsuitable for us as they are 1.6 meters high. We prefer smaller fishing nets. Some methods that men use are also not appropriate for women. For example, men often rock boats to drive the fish towards the nets. We cannot do this. However, women practice hard and learn many skills through experience. We feel empowered. In the last decade we have faced so many challenges and uncertainties (Yu Xiaogang, 2001:30)."

In the Nam Ngum Reservoir in Lao PDR both women and men go fishing in motorized boats and use gill nets. Women control the boats, pull nets and take fish from the net while the men dive. If there is no woman to control boat and pull the net, men will hire someone to do the job (Viravongsa, 2000).

Ahmed *et al*. (1998) found in their survey in Cambodia that out of the 162 female- household heads interviewed in Siem Reap province, 21 percent were engaged in fishing. It was found that in communes with limited access to agricultural land, such as communes located within inundated forests, female members from nearly 30 percent of the households actively participate in fishing (Ahmed *et al*. 1998:35). The category of fishing in the Ahmed *et al*. (1998) survey does not include fish selling and fish processing, an area where women are generally more active. The percentage is only for harvesting and the study shows that women's participation is quite high.

Women's involvement in fisheries can change over time. In Yunnan, Yu Xiaogang has found that because of the inundation caused by a water project, women are increasingly turning to capture fisheries, which was before done almost exclusively by men. Yu Xiaogang has quoted one of his respondents saying:

"*Before the dam was built, we had land and women practiced agriculture. Women's income was better and more stable than men's income. My family lost more than 10 mu of land (because of flooding by the Trans-Watershed Water Supply Project) and we have only about 7 mu. This year, the rest of my land and home garden have also flooded and we lost almost all our crops. Though our culture does not allow women to go fishing, about 50 per cent of the wives now go fishing with their husbands. Women work to support the family. Staying home will lead to a decline in their position*" (Yu Xiaogang, 2001:30).

Because women and men do different tasks, they have different knowledge from their experience.Yu Xiaogang (2001) has attempted to juxtapose the different knowledge of women and men and come up with sustainable fisheries management of the reservoir. Discussion with the men's group revealed that the highest fish yield is from March to June and the lowest from October to February. Discussions with women's groups revealed that fish prices are lowest from March to September and highest from December to February. Farm work, which is done mainly by women, is heaviest in April to June. This leads to an understanding that the newly introduced fishing ban from April to June can be beneficial if men can help women in agricultural activities during this time. This will protect the fish during the spawning season, and thus higher yields can be expected during winter. Women's knowledge shows that the fish price is highest in winter. Thus, high yields in winter will benefit the fishers. Women have more time to participate in fishing in winter, thus would be able to work together with the men. Men's engagement in agriculture during April to June will decrease women's workload in agriculture. By combining both women's and men's knowledge and by adjusting their activities, this case showed that higher benefit and more sustainable use of natural resources can be realized.

Box 1: Misunderstanding gender relations in a fish-smoking project

In Guinea West Africa, women play an important role in the processing and marketing fish, which are generally caught by men. An arrangement known as 'kostamente' between both husbands and wives and women and unrelated men ensures commitment to supply and purchase fish. In this arrangement women either pay fishermen directly for their catch or take it and repay a share of the profits after processing. They may supply fuel, effectively paying for the fishing trip.

Source: Goetz, A.M. Fishy Business: Misunderstanding gender and social relations in a fish-smoking project in Guinea, unpublished manuscript, quoted in Harrison, 2000:11.

Women and men's roles are complementary as much as conflicting (Harrison, 2000). It is important to understand the relationships between women and men in carrying out fisheries related activities. As can be seen in Box 1, focusing support only on women's activities can lead to failure to achieve project objectives if the omplimentary or conflicting roles and relations between women and men are not considered.

A project initiated by a UN agency aimed to increase the productivity, income and working conditions of these women. To do this, women were organized into groups and trained in improved techniques for treatment and storage. The project also aimed to be empowering through promoting solidarity among women. The project failed to meet its objectives. The supply of fish broke down for some women and many of the groups failed to function. At the root of the problem were a number of inappropriate assumptions.

First, the project assumed a sharply dualistic division of labor. Because women undertake all fish smoking, it was assumed that men have nothing to do with it. In fact, all production involves interdependent activities between men and women. However, in targeting women alone the project threatened this interdependence. Some men raised their prices because they perceived the women as part of an externally funded project. Many women were more concerned to protect their *kostamente* (traditional) arrangements than to be involved in the project.

The project also assumed that all women have the same interests. Diversity in age, conjugal rank, class and religion influenced the ability of the women to work together. The idea of female solidarity did not prove sufficiently strong to hold the groups together. A further assumption, that women's time is elastic, also proved to be wrong. The project imposed regular hours for attendance and work that conflicted with the many other claims on women's time.

Marketing fish

In most countries in the Mekong Basin both women and men are involved in marketing captured fish. There are two segregated markets and market routes. The formal markets are dominated by men and deal with large fishes from reservoirs and lakes and are often transported to the capital and exported. Women dominate the informal markets that sell small fishes and serve local demand. Most of this fish is either consumed at home or bartered. These transactions seldom enter the cash economy accounts.

Around the Kapati reservoir in Bangladesh, rural women account for 49 percent of the small retailers. One of the reasons why women trade only clupeids and small prawn is because the investment requirement is low (Ahmed, Rahman and Chowdhury, 1999).

In Cambodia, fishes from Tonle Sap Lake serve the domestic markets and are exported to Thailand and Viet Nam. Large fishes from the Tonle Sap are bought by licensed fish traders under the supervision of a formerly state-owned fish export company (Seyha *et al*., 2001; Sothirak, 2002). This market route is dominated by men and most of the fish is exported to Thailand. Women dominate the retail trade of small fishes from the Tonle Sap Lake and from rice fields. These are sold in domestic markets or smuggled into Thailand on a small scale and sold to smaller middlemen on the Thai side (Sothirak, 2002). The women's market route is more significant than the formal trading route in terms of providing the poor with protein. It also employs many independent traders and creates employment for low-income women.

In the Nam Ngum Reservoir in Lao PDR, fish marketing is controlled by a fish dealer company and small fishers are not able to sell directly in the market (Viravongsa, 2000). Women are also not able to sell the processed fish products. Fish processing is one of the most lucrative activities in the area. The community received external support in credit and equipment to improve their fish processing activities. However, since women did not have any access to the market, they are

not able to get as much benefit as they should. Women in this area, like other women in Southeast Asia, are responsible for household financial management. Since they are not able to get income from the fish processing activities, they have to seek cash income from other activities such as banana planting, home gardens and raising livestock (Duangchith, 2000). This has increased women's workloads. Since their husbands concentrate on fishing, agriculture is women's sole responsibility, and women are engaged both in fishing and agriculture. Duangchith (2000) found that women in fishing groups work on average 12 hours for productive work, of which 7 hours is for fishing. Men spend an average of 6 hours concentrated time fishing. Her case study has highlighted that difficulty in access to markets has affected both women and men but has affected women more because they had to make up for the lost opportunity.

Access to technology and resources

Most women involved in fishing lack access to tools and credit, a voice in decision-making and opportunities to receive training (Future Harvest, website 3). Women also have less time available to adjust to take advantage of the growing opportunities. Women's time is less flexible because of their reproductive responsibilities (Elson, 1992). Compared to the activities that women do in fishing, studies on women's access to resources and decision-making is less. It is a well-established fact that women are not represented in community fishing management committees. Based on the wealth of research on women's participation in agriculture, it is anticipated that a similar situation regarding women's access to training, credit, and other production resources exists in women's participation in fisheries.

Women's time constraints and their decision-making power in the household indicates that a household is not a single unit where all the members share the same needs and benefit equally. For example, improved technology can increase the catch and benefit the household income. However, whether the increased catch would result only in increasing the workload of women or would increase women's independent income and decision-making power in the household needs to be examined.

Newly introduced technology can affect the present activities of women. For example, technologically advanced fish processing with ice plants and transportation systems can eliminate small-scale fish processing and trading that are now being carried out by women (Harrison, 2000; Suwanrangsi, n.d.).

Most women involved in fishing lack access to tools and credit, a voice in decision-making and opportunities to receive training.

Since extension officers have assumed that fishing is men's work, extension work has not particularly targeted women. When technologies for women are conceptualized, they tend to focus on small-scale, simple technologies that will bring little improvement in yields compared to more advanced technologies. For example aquaculture technology for women concentrate on home-management and backyard-garden techniques (FAO, 1995). Women's aquacultural activities are considered an extension of household activities and technology promoted for women is 'simple'. As Dehadrai (1992:371) noted, "Rice-fish technology is not sophisticated and could easily be adopted by women". Such pre-conceptions of suitable technology for women will limit the possibilities of women's access to better technologies. Rather than pre-determining and defining suitable technology for women, it is important that the extension system takes an approach that can allow women wider choices and also to adjust the technology based on their experience and knowledge.

The understanding that women are resource-less leads to the popular strategy of forming women's groups (Harrison, 2000). The assumption is that through these groups, women will be able to help each other, pool their scare resources and increase their bargaining power by acting collectively. However, whether or not groups function as expected depends on how the groups were

formed and whether or not women see it as relevant and necessary.

At the same time, it has been pointed out that women do not have an organizational basis (CIRDAP 1989) for their problems and issues to be heard and influence decision-making. Women's groups often do not provide women with an adequate organizational basis since they tend to be separate from the mainstream decision-making body and tend to be too small to exert enough pressure to influence decision-making. Women's groups do not always have a perspective in improving women's positions or in challenging existing decision-making bodies, but rather follow and justify the decisions of the mainstream thus further strengthening the present power structure (Goetz, 1997). It is thus important that women's participation in existing decision-making bodies such as cooperatives and community committees are realized.

Conclusion and recommendations

Based on the above review of the literature, four main points can be highlighted. First, women are involved not only in post-harvest activities but are also active in harvesting fish. Women are active in small-scale processing and marketing that caters to poor people's diets, while large-scale traders aim for export where profit margins are higher. It is important that women's activities are fully supported so they will be able to continue to contribute in providing inexpensive but high quality protein to the country's poor.

Second, women's roles in fisheries are changing. As in the case from China, women's involvement in fishing changes with environmental and economic changes. People's perceptions are slower to change than what women and men are actually doing. Both women and men consider fishing as men's work but women are almost equally involved in fishing activities. Gender division of labor cannot be assumed to be static.

Third, because of gender division of labor in fisheries and in other activities, women have different experiences than men. Because of these different experiences, women have different knowledge about markets, tools and techniques of catching fish. It should also be noted that women are not a homogeneous category. Since women of different age, ethnicity, and class are engaged in different activities, their experience and knowledge will also be different. Fourth, a household is not a monolith and there are both complimentary roles and conflicts of interest and needs between different members in the household.

Recommendations improving statistics on inland capture fisheries

1) Collect information on gender division of labor in the household

A household is not a single unit. Information gathering should not take the household as a unit but be aware of the different activities that each member does and the different needs each member has. It is important to gather information on gender division of labor in the household. To understand women's and men's workloads, information should be gathered not only on gender division of labor for fisheries related activities but for all the activities including household and community work. It should also be noted that gender division of labor is not static and can change with environmental, economic and demographic changes. Thus, it is necessary to update the information on gender division of labor periodically and not to assume that the same division of labor will continue forever.

Coates (2002) noted that official statistics on the activities carried out in inland capture fisheries are not able to cover the wide range of activities that are actually carried out. Data on women's involvement is all the more scarce and the only information available is in scattered case studies. Although these case studies provide insights to the possible range of contributions that women are making to inland fisheries, it does not seem to be enough to eliminate the popular misconception that fishing is a 'man's occupation' and not suited for women.

2) Ask women for information

Since women and men do different things, women have different information from men.

Thus, it is important to ask women directly for information especially for activities that they are doing by themselves. Perceived needs in fisheries will also be different between women and men because they are engaged in different activities. For example, women are probably a better information source on food preferences and nutritional needs in the households.

Women are generally not experienced in answering questions from outside interviewers or participating in group discussions, especially when men are around. Women perceive that (or act as if) men can answer better so they leave the men to reply to the interviewer's questions.

To directly access information and knowledge that women have, it is important to interview women one-on-one or to organize a women-only group discussion separate from a men-only group discussion or a mixed-group discussion. For women to better communicate it is effective to have women interviewers or women extension officers do the interviews.

Women-only group discussions should also be treated with care. It should not be assumed that every woman would be able to express her opinion freely in a women-only environment. Even among women there are power relationships and some women would find it difficult to express their opinions in a group.

These 'silent women' tend to be the most marginalized. Individual interviews with these women should always be combined with a group discussion.

3) Women are not a homogeneous category

In collecting information, differences among women according to their age, ethnicity, marital status, conjugal position, class and position in the fish market chain should be noted. Different women have different roles, activities, knowledge and information and also have different access to and control over resources. There are conflicting and complimentary relationship among and between groups of women and men.

4) Analyze resource requirements for each activity

When examining the gender division of labor in fisheries related activities it is also important to collect information on the necessary resources to carry out these activities. Do women and men have access to and control over these resources?

Resources will include credit, labour, markets, supply of raw material, tools and equipment, knowledge and information, extension services and time. Special attention is needed for the dependent relationships between actors. Do women need men's approval or help to carry out their fishing or processing activities?

It is also necessary to know the relationships between different institutions. What are the relationships between extension service institutions and credit service institutions? Do they have any linkage? Are they targeting or providing access to the same people?

5) Increase women's participation in decision-making in the community and other organizations

Women are currently under-represented in public decision-making bodies. This is all the more so in fishing-related organizations because of the perception that fishing is a man's occupation.

By improving women's participation in decision-making bodies (either for statistics gathering or policy-making) women's contribution to fisheries activities, the specific problems they face and their needs would be better highlighted.

6) In-depth case studies for non-reported activities

As Coates (2002) observed, many inland capture fisheries activities are not noted because it is informal and small-scale and people do not see it as an important activity. This is even more so for women's involvement in fishing. It is small-scale, and mostly for home consumption. Women themselves often do not consider it important and thus fail to report their activities. Therefore, it is

important to conduct in-depth case studies to note and observe the non-reported fishing activities of women and their importance to household nutrition. By using the knowledge from case studies, it is possible to come up with questionnaires with better coverage on activities and benefits of small-scale capture fisheries.

7) Monitor the changes in women's control over resources and their position in the household

Improvement or deterioration in fishing activities can affect women's empowerment. It is important to monitor the impact that fishing activities are having on women's control over resources and women's position in the household.

Are women gaining access to and control over resources more than before? For example, are women gaining on aspects such as access to fishing areas and control over decision-making in the use and management of the fishing area, access to and control over fishing gear, access to and control over technology and extension services, access to and control over household income from fishing and decision-making over household expenditure? Has gender division of labour changed so that work burdens are shared equally between women and men?

The recognition of women's labour and knowledge should also be monitored. How much of women's work is reported by men? Are women's contribution to the fisheries seen as important by other members of the family? How much do men think women know about fisheries?

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THEMATIC REPORT

"Fisheries management has moved away for an early preoccupation with the fish to a greater concern about the livelihoods of the fishers and their families."

Data Requirements for Inland Fisheries Management

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Any resource can only be managed if sufficient good data and information are available. Unfortunately this principle has been generally overlooked in the case of inland fisheries where data are essentially weak and generally insufficient for taking the kinds of decisions that are needed. This lack has contributed to the generally poor state of inland fisheries resources around the world.

There is, therefore, a general need to collect more and better data and information on the inland water environment, the fish and the fishers that form the essential components of a fishery. Collection of data and information is expensive in that it requires people, transport and communication systems to be effective. Furthermore it requires trained people that may not always be available. Because of the cost and the demands on often scarce trained personnel it is important that any programme for the collection of fishery information be efficient. It is also important not to collect more data than is needed for the management of the fishery. Especially in financially constrained circumstances the data and information collected should be tailored to the job on hand. This requires a clear definition of the objectives of management and knowledge of the functions and limitations of the different types of information. This paper identifies some of the types of information and data required for management at different levels of complexity and for different purposes.

Purposes of data and information collection

Information and data about a fishery are collected to support the objectives and programmes of whoever is managing the fishery. There are a number of objectives for management, which are not always shared by all stakeholders in the fishery, whose priorities may often differ according to their interest. Objectives of inland fishery management include:

Extractive objectives, such as fish protein supply or recreational opportunities;

Social objectives, such as income, equity of distribution of benefits, reduction of social conflict;

Fiscal objectives, such as revenue and foreign earnings; and

Conservation objectives, such as sustainability or biodiversity conservation.

Most fisheries are managed for a mix of these objectives. It is, therefore, important to agree on a common approach to the fishery so that data collection systems serve the greatest number of interested parties.

Types of data and information

A distinction is made in this paper between data and information. Data are raw numerical values (statistics) that must be analysed to become information. Information may also be non-numerical and deal with such questions as whether it is the men or women who fish or whether a particular species migrates. In both cases the interpretation process is as important as the collection process. Data and information for various sources must be put together to form the basis for management.

Data can be:

1) Absolute, which attempts to assign values to such variables as catch that are as close to reality as possible. Absolute values are generally a snapshot of the situation at a point in time.

2) Relative, which attempt to trace the movement of values over time from a baseline. The baseline itself may be an absolute value or one that is selected arbitrarily in the time series.

Subjects of information

Information can be obtained about:

The fish, including data and information on feeding, breeding, growth and mortality as well as any migrations and other aspects of biology;
The fishery, including statistics on landings and effort, information on gear and its performance, information on behaviour and income of the fishers and their families;
The environment, including information on water quality and quantity and the degree of modification of aquatic habitats and ecosystems.

Timing and location of data collection

Information and data can be obtained from:

1) One-off studies and surveys that are expensive and detailed operations usually designed to establish absolute magnitude of a resource for valuation of a fishery, to obtain essential livelihoods information on the social and economic situation of fishers, to establish baseline information and to set up a sampling frame. A frame survey divides a river or lake into various strata or zones according to ecological, fishery or social characteristics, identifies sampling locations that are typical of the various strata, and lays down a schedule for the timing of sampling. Division of the area into strata makes it easier to group sampling sites and interpret the data collected from them.

2) Regular surveys are carried out at regular intervals to monitor changes following major studies. A sampling frame may be used to select the number and location of the sampling sites.

Daily/weekly collection of data is used to establish local trends at individual markets and landings. A sampling frame may be used to specify landings and markets that are main data collection points.

Research programmes that address particular issues or aspects of the fishery and its environment. Research is needed, for example, to define details of the biology and ecology of the living organisms involved in the fishery, the social and economic circumstances of the fishers and their families, market patterns and conservation needs.

3) Existing data and information should never be overlooked. With the exception of the very largest lakes and rivers, inland fisheries are replicated systems based on many similar small lakes, streams and reservoirs. As a result, there is an accumulation of data and information internationally that has been codified in series of textbooks, guidelines and indexes that can be transferred to a national fishery

with relatively little effort. Within a country there is also much information on aspects of the fisheries in a particular basin that can contribute to establishing a historical baseline and measure of change.

Data can be collected from:

1) Markets, which are the great concentration point of the fish sold and passing through the commercial network. They are particularly useful in diffuse fisheries where there are no defined landings. Because of the volume of fish passing through, and the fact that the product has often been treated by smoking, salting or drying, they can be relied upon only for coarse statistics on weight of the fish and maybe main species types. Market surveys carry the danger of double counting, as the same fish may appear more than once in the same market or in successive markets in the chain.

2) Landings, which are the primary collection point of fish landed. These are particularly valuable in lakes or large rivers where definite points have developed for landing and sale of fish. They collect data primarily on quantity of fish landed by the fishery and can also be used to gather data on species, weight, length and sexual condition. They are also good for the collection of data on the types of gear in use. Landing statistics are less applicable in some river fisheries where landing and sale are diffuse and the majority of the fish caught is not channelled directly to discrete localities. Landing data are also incomplete in that it misses the often considerable amount of fish consumed by the fishers, their families and associated communities (autoconsumption).

3) Fishing villages, through family and household surveys, which can detect sources of fish that are not dependent on landings and boats but which are collected from small water bodies by women and children. Such surveys are also useful for understanding how the fishery works. They can supply data on gear use patterns and on the social and economic organization of the fishers. Individual fishers, who are difficult to sample on a regular basis in most fisheries. They are however the best source of data on the performance of individual gear use and on the types and sizes of the fish caught. They can also be helpful in providing information about autoconsumption patterns and the allocation of work among participants in the fishery.

Complexity of Information:

Data can be divided into:

1) Indicators, which are criteria, species or processes that are identified as representing changes to the fishery. These can be values, changes in quality or quality, trends in relative values or a simple presence or absence of a condition or species. Indicators are usually related to reference points or values that signal critical changes in the fishery. Indicators should be chosen so they are relatively easy to sample and calculate from routinely collected data. Reference points are more difficult as they depend on the management model to be adopted or the policy regarding the fishery as a whole.

2) Variables, which are the components of indicators and are the actual material collected. Which variables are collected are determined by the particular management model used and by logistical considerations such as ease and cost of collection and the availability of trained people.

3) Indexes, which are combinations of variables into simple models that are based on information collected over a period of time and a wide geographic area. They serve primarily as a basis for comparison of the situation in a particular fishery with a wider standard. For example indexes such as the morpho-edaphic index or the river catch index can be used to determine approximate values of the catch to be expected from lakes and rivers and integrated biotic indexes (IBI) can be used to monitor the health of the fish stock.

Detail and exactness of data

Accurate data is that which closely corresponds with the true situation of the fishery. However, data can be collected at differing levels of detail. For example catches can be calculated precisely to the second or third decimal point but such a degree of precision means very little because the fishery is constantly changing and such a level of detail has little influence on the decisions to be made. It is generally more important to be

accurate and arrive at a more general figure of catch that actually influences policy.

The type, amount and degree of detail of the data collected depends on the type of model used for management of the fishery and governmental policy on the degree of intervention in the management of the fishery. In resource poor situations it is better to adopt simpler models that require less data. It is better to collect less data that is accurate than to expend effort collecting large amounts of poor quality information in the hope that the extra detail adds more information. In general, however, the more complex the decision to be made the more information

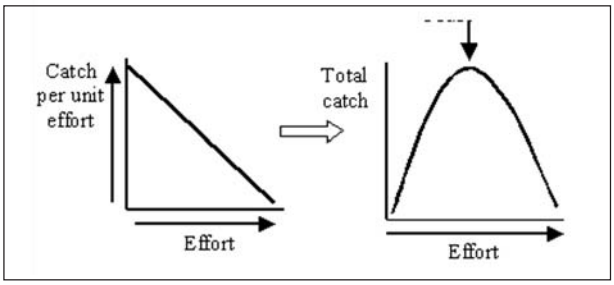

Figure 1 Diagram of MSY model

required to make the decision in an informed manner. For example, a decision regarding whether or not to establish a sampling site at a particular landing can be made simply on the basis of a general knowledge of catch in the area that can even be obtained from a simple index. Decisions regarding the number of individual catch quotas and licenses at the same landing could require detailed knowledge of the performance of the fishery and the social and economic circumstances of the fishers. Whatever the circumstance there should be a long-term commitment to collect at least the most basic catch statistics at representative landings.

Maximum sustainable yield (MSY)

The maximum sustainable yield concept provides a reference point that predicts the level of effort at which the maximum amount of fish can be sustainably captured from a stock (Fig. 1). MSY tends to be an absolute value. There are two approaches to this model. The first is a simple approach based on an analysis of catch against effort and requires data on both these variables. This is, therefore, a relatively easy model to use and requires very little data. However, it can only be done on a single species basis and so the same two variables have to be collected for all species in the fishery. This means that it is a useful model for lakes where few species make up the majority of the catch. It is equally useful in river fisheries that concentrate on a few large species. It is less useful in true multi-species fisheries. The second method provides better estimates of MSY but can only be obtained through more complicated stock assessment procedures that require complete data on mortality, recruitment and growth for each species.

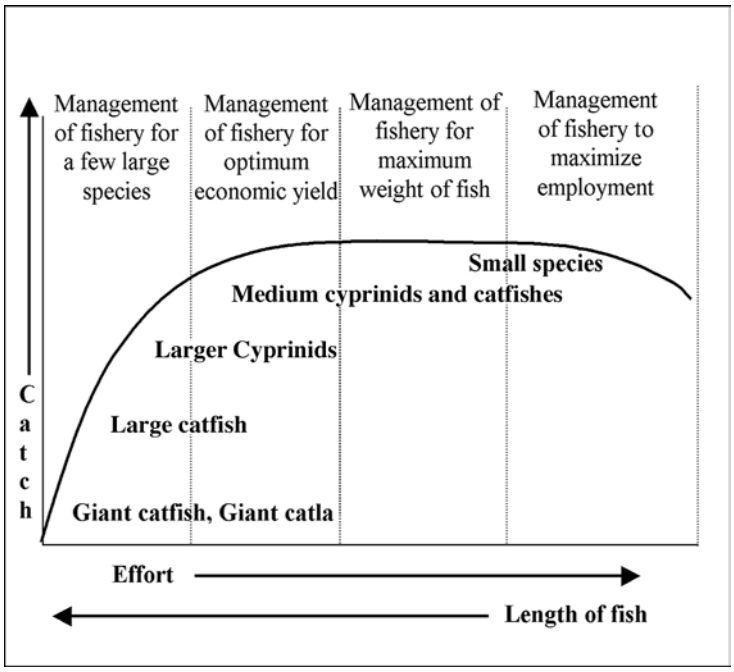

Figure 2 Diagram of multi-species model

Models of the fishery

The following two models of fishery management illustrate the differences in data needed by different models.

Such complicated models allow for more detailed evaluation of management regimes,

such as those based on size limits, but do not necessarily provide better estimates of MSY.

These types of models are also known as surplus production models (SMP) and are only of use when there is plenty of contrast in the data. This means that the fishery is often overexploited by the time the trends to maximum sustainable yield become clear.

Information and data about a fishery are collected to support the objectives and programmes of whoever is managing the fishery.

Multi-species fisheries

The multi-species (Fig. 2) model predicts the behaviour of complex assemblies of fish when subject to fishing and environmental pressure.

It shows a total yield that is sustained for a considerable range of effort giving a flat or plateau type yield curve. This sustained yield hides a series of changes to the fish community whereby successively smaller species replace the larger species.

The model tends to be relative as it does not predict the level of sustained yield but does trace the health of the fish assembly as a series of measures (Table 1).

Many of these measures are relatively simple and easy to obtain such as the mean length of the fish. Assessment of the state of complex fish stocks can probably be done on the basis of mean length alone. Other measures are more difficult to obtain such as the Production/biomass ratio (P/B) that measures the total biomass present and the rate of production by the fish community or species.

One problem with this model is that both fishing and environmental factors influence the fishery in a similar manner. It is, therefore, important to be able to disentangle the relative contribution of the fishery and the environment. This generally requires better knowledge of environmental states than is often available.

Information for Specific Purposes

The following section examines examples of the decisions that have to be made regarding the fishery and the type of data required.

National decision-making

National decision making on the fishery usually concerns an assessment of the value of the sector to the national economy, the allocation of funds to the sector or the amount of funds that can be obtained from it in the form of taxes and license fees. Table 2 indicates the type of information that is needed to answer the sorts of questions that are likely to be asked for economic planning of the inland fisheries sector.

Management of fish stocks

The classical approach to management of fish stocks is by centralized control of the fishery through mesh size restrictions, prohibitions on gear, closed seasons, harvest reserves and restrictions of access through licenses or catch quotas. Classical fisheries management requires very complete data on the fish, the effort and the selectivity and performance of the fishing gear used. Completeness of data of this order is needed for all major species in the fishery. All too often the data needed for such decisions was lacking and the national authorities in charge of the fishery assigned arbitrary values to such factors as mesh size. This led to a general disregard for regulations on the part of fishers and is a contributing factor to the poor state of inland fisheries today. More recent approaches tend to concentrate mainly on restriction of effort and co-management involving the participation of other stakeholders in the fishery in decision-making and management. The information needed for this approach is far simpler and qualitative, length-based data often suffice. Furthermore the audience for the information is different. In centrally controlled systems only the government planning authorities need the information. In more recent systems the

information also needs to reach the stakeholders to assist them in local decision-making.

In addition to the output and input controls traditionally applied to the fishery, fish stocks are increasingly manipulated by such processes as stocking or introduction of new species. Table 3 indicates the type of information that is needed to manage fish stocks.

Fishers and their communities

Fisheries management has moved away from an early preoccupation with the fish to a greater concern about the livelihoods of the fishers and their families. This increased social and economic dimension has given rise to the need for other categories of information than the simple fisheries statistics that formed the traditional basis for management.

There is increasing concern with such issues as equitable distribution of the benefits from the fishery, reduction of conflict both within fishing communities and between the communities and other users and gender participation in the fishery. Table 4 illustrates some of the issues and the types of data needed for their resolution.

Conservation and rehabilitation

There is increasing concern about the conservation of inland fish resources. In part, this is a response to the contractual obligations of the individual countries to the Convention on Biological Diversity, and any other conventions such as Ramsar to which they might be signatory. It is also a response to the perception that fish stocks are in decline everywhere and large species particularly are disappearing and may well become extinct. Conservation has built up a supplementary need for information, examples of which are given in Table 5.

Conclusion

This paper suggests some principles for planning, collecting and interpreting data and information.

First, data collection should only be pursued with a clear view as to what the data is to be used for. Fishery management policies and objectives should be defined and the models for management chosen. Reference points and variables need to be chosen to guide the policies and support the models. The data and information needed for the variables can then be selected.

Second, in resource poor societies the data collected should be limited to that which can be collected with the resources available while conserving the quality of the data. Accuracy of data should be favoured over precision. Policies and models should not be overly complex and should be consistent with the data gathering capacity of the society.

Third, data on their own are of little use and must be analysed to become information. The process of analysis is as important as that of data collection.

Fourth, whatever the circumstance there should be a long-term commitment to collect at least the most basic catch statistics at representative landings.

Many institutions in a modern state generate fisheries related information. Central or regional government agencies are usually charged with the collection and interpretation of basic fisheries data. Research on particular topics is usually the function of specialized research institutes and programmes in government or in universities. Externally funded projects may carry out particularly intensive one-off studies such as frame surveys. To this can be added the wealth of traditional knowledge held by the fishers and other stakeholders in the fishery. There is also usually a considerable amount of information already available in the world's libraries that can contribute to our knowledge. The problem you are facing is probably not new and has already been studied by others, so the answer may lie somewhere in the literature.

Information is only of value when it is used. The information from all sources has to be interpreted and fed into the management plan. One problem that the fisheries sector has faced is the poor quality of its data as compared to other users of

aquatic resources. A further problem lies in the exclusion of certain types of information gathering mechanisms from the management process such as universities or traditional knowledge of fishers. This means not only that fisheries management has been generally defective, but also that the sector has not been able to secure an adequate share of the water on which it depends. This situation needs to be rectified by the improved development of sampling and other information gathering activities as well as the development of mechanisms that bring together the information from the various national and international sectors.

Table 1 Criteria used in assessing the state of health of multi-species fisheries. Trends indicate a fall in the general health of the fish assemblage.

Indicator	Trend
Level of catch	• Falling levels of total catch levels in single species fisheries, • Catch levels can be maintained over a wide range of effort
Mean length	• Disappearance of larger fish and falling mean size within species • Disappearance of larger species and falling mean size of catch as a whole
Number of species	• Initially rise in number of species in catch from a few large to many small ones • Later falling numbers until the fishery is confined to few very small species
Type of species	• Decline and disappearance of anadromous and long distance riverine migrants • Decline and disappearance of native species • Rise in numbers of exotics where introductions have occurred • Decline and disappearance of higher trophic levels (predators) • Decline and disappearance of species with high oxygen requirements [eutrophication]
Response time	• Shortened time between flood events and response by population
Other indicators:	• P/B ratios rise • Mortality rates(Z and *f*) increase • Higher incidence of diseased and deformed individuals [extreme eutrophication and pollution]

Table 2 Examples of informaiton needs for national decision-making

Management action	Information required	Source of information
Evaluation of gross contribution of fisheries to the economy	• Gross national catch (absolute)	• Market based review
Valuation of individual fisheries	• Gross catch by water body • Price structure of fish market • Costing other social and ecological services carried out by the fishery	• Frame surveys • Cost benefit analyses
How much funding to devote to the sector	• Gross national catch • Number of fishermen (absolute)	• Market based review • Frame survey
Whether to establish a sampling site/research facility	• Morphology (mean depth) • Water chemistry (conductivity) • Detailed gross catch by water body/landing (absolute)	• Use of indexes • Landing survey
Amount that can be equitably extracted as tax/license fee	• Gross catch • Price structure • Marketing chain • Number of fishermen • Gross income • Social structure	• Landing survey • Market survey • Survey of family incomes survey • National income surveys
Allocation of water between different users of the resource	• Value of fishery under different hydrological regimes • Value of other sectors using water • Value of ecological services provide by intact river	• Frame surveys of the fishery • Price structure of the fishery • Stakeholder survey • Scenario based models of response of fishery to external impacts • Valuation of other users of water • Identification and valuation of ecological services

Table 3 Examples of information needed for management of fish stocks

Management action	Information required	Source of information
Assessment of the general health of the fishery through trends in catch – weight and composition	• Weight of catch (relative) • Species composition of catch (relative) • Effort (relative)	• Landing data
Management of the whole community – length based management Issuance of licences and fixing of catch quotas	• Gross catch (absolute) • Number of fishermen (absolute and relative) • Length of fish (relative)	• Long time series • Landing data
Management of individual species - management by MSY for species. (Mesh size, closed season, minimum size) Issuance of licences and fixing of catch quotas for individual species	• Assessment of stock size • Detailed catch by species • Detailed length/weight information by species • Nature and functioning of gear • Effort	• Frame survey • Landing data • Survey • Research
Stocking	• Data on number and size of fish stocked • Catch and cost data • Information on impact on other stocks	• Assessment of target stock • Monitoring of stocking programmes • Experiments • Mark-recapture data
Introductions	• Information on history of the species when stocked elsewhere • Information on the biology of the species in its native waters • Information on success or failure of introduction	• Detailed literature surveys • Impact assessment research • Monitoring trial introductions

Table 4 Issues and needs for the incorporation of social and economic issues into fishery management

Management action	Information required	Source of information
Equitable distribution of access and benefits	• Income distribution • Costing of fishing • Numbers of fishermen • Family structure and function	• Social and economic Survey • Landing data • Research
Ensuring social justice for women and children	• Women's and children's involvement in the fishery	• Social and economic Survey
Avoidance of conflict	• Stakeholder involvement • Tradition access rights • Nature and functioning of gear	• Landing data • Stakeholder analysis • Research

Table 5 Examples of issues and information needs for conservation of

Management action	Information required	Source of information
Assessment and monitoring of state of the environment	• Water quality • Environmental integrity	• Water quality surveys • Studies on the integrity and diversity of the main river channel • GIS
Improvement of water quality	• Location of point source discharges • Extent of diffuse pollution sources	• Water quality survey • Testing fish for heavy metal or pesticide residues
Assessment of impacts of engineering works	• Identification of impacts • Identification of methods for mitigation of impacts	• Impact assessment surveys • Post works impact monitoring
Removal of bottlenecks in environment	• Nature and location of bottlenecks • Biology of individual species	• Habitat survey • Research • Fish behaviour studies
Establishing environmental flow scenarios	• Ecology of the system • Hydrology • Impacts of different flow regimes	• Habitat survey • Research • Fish behaviour studies • Hydrological studies
Need for and setting up of reserves and protected areas	• Biology of individual species • Ecology of the various ecosystems	• Habitat survey • Research • Fish behaviour studies

THEMATIC REPORT

"No data is better than misleading data."

Data Requirements for Fisheries Management in the Tonle Sap

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MRC Fisheries Program
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Cambodia has very few income generating possibilities beyond its natural resources and is economically almost fully dependent on agriculture, forestry and fisheries. The country's inland fisheries support a thriving industry of great economic and social importance and have a potentially bright future.

Cambodia's freshwater capture fisheries production of over 400 000 tonnes per year is large, even by world standards. It may be among the world's ten largest producers.

The most recent estimates of the National Institute of Statistics in Cambodia indicate fisheries contribute 16 percent to the national GDP.

The Tonle Sap contributes over half of the fish produced in the country. More than 1.2 million people in the Tonle Sap area alone depend on fishing for their livelihoods.

An MRC/DoF socio-economic survey of 4.2 million people living in central Cambodia estimated that average fish consumption was 67 kg/person per year (in fresh weight equivalents, 1995/96 data (Ahmed *et al*. 1998).

There is no other food supply as readily available or as inexpensive that can replace fish in the diet of the Cambodian people.

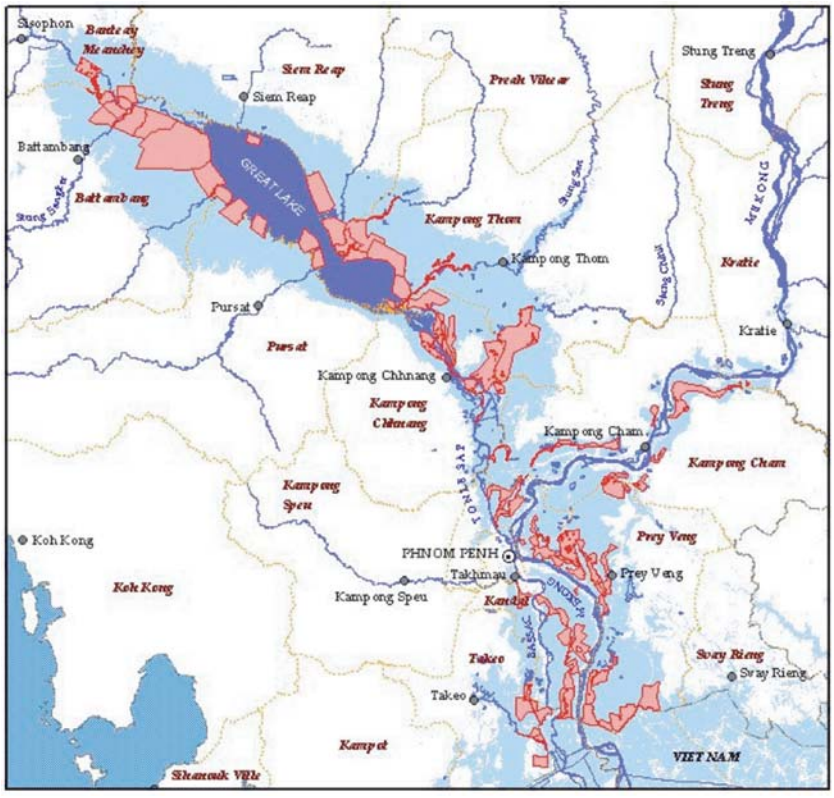
Management of these important resources is a crucial matter. It requires an understanding of the issues at stake and reasonably accurate statistics are critical to a proper perspective. The work done by MRC/DoF in the Tonle Sap area since 1994 provides a basis to discuss what we can hope fisheries management could realistically achieve and how the needed information could be collected.

The Tonle Sap fishery

Since the Great Lake in Cambodia was formed some 5 000 to 6 000 years ago (Carbonnel 1963 in Rainboth 1996) it must have abounded with fish. The rise of the Khmer Angkor Empire may, to a large extent, have been possible due to the availability of a rich fishery resource and well-developed rice irrigation schemes. The abundance of fish pictured on the reliefs of the Bayon and Angkor Wat temples and the proximity of the temple complex to the Great Lake in Siem Reap province are testimony to this.

The combination of rice and fish is still the staple food for the great majority of Cambodians. Recognizing the value of the fisheries, the French colonizers modeled their taxation system on the traditional royal fund-raising practice of issuing leases for fishing lots, introducing the first fishery laws of the country (Petillot, 1911 in Van Zalinge *et al*. 2000).

Petillot also reported that in 1910 about 50 000 tonnes were exported in the form of dried, salted and live fish, as well as fish oil and paste. In the 1920s and 1930s exporting dried fish to Java was a big business. Chevey and Le Poulain (1940) reported that an average of 25 000 tons was shipped annually from Cambodia mainly via Singapore by Chinese traders. Given a fresh-to-dried fish ratio of 3 to 1 (Chhouk, 1996 in Van Zalinge *et al*. 2000) this corresponds to 75 000 tonnes of fresh fish. Chevey and Le Poulain (1940) estimated the total fish yield of the Tonle Sap at 125 000 tonnes per year. At present, this trade no longer exists, although similar quantities are being exported to Thailand and Viet Nam, mostly as fresh, dried and smoked fish or as paste and sauce.



Fishing Lots in 2001 (Lot areas*red*; Flood plains: *light blue*)

The main reason for the enormous wealth of fish in Cambodia is the monsoon, which each year swells the rivers and creates a flood of water that inundates the highly productive floodplains. The temporary access to enormous quantities of food from a wide range of natural habitats drives the huge production of fish. White fish have evolved to synchronize their time of spawning with the onset of the monsoon so that fry and juveniles are ready to enter the plains as they flood. Black fish spawn and feed in the inundated floodplains. Without the floods and the floodplains, the fish catch would be only a small fraction of what it is now.

The Tonle Sap floodplain at maximum inundation varies considerably in size from year-to-year (roughly between 10 000-15 000 km^2). Thus, in a dry year (*e.g.* 1998-1999) fish production is much less than in a wet year (*e.g.* 2000-2001). This is illustrated for the dai fishery in Figure 1 below. The relationship between the maximum flood level of the season and the fish catch shows that a permanent lowering of the average peak flood levels (*e.g.* due to flood

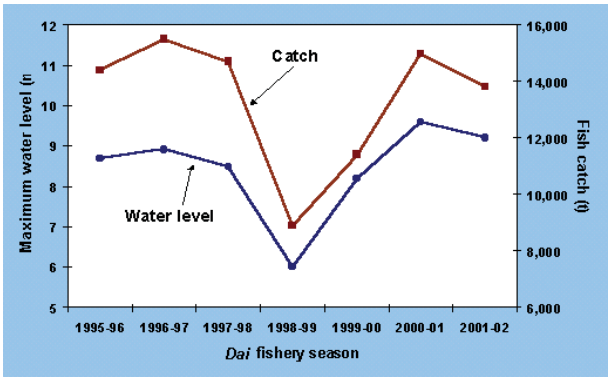


Figure 1: Productivity and Water Level

controls) would result in a more than proportionally lower fish catch. Among other variables, fish productivity is related to the extent of floodplain inundation. Thus, flood controls like dams, irrigation canals, river canalization and diversions have a negative effect as they lower peak flood levels.

Natural floodplain habitats like the flooded forests have the highest productivity and species diversity. Hence, flooded forest destruction or conversion to rice fields also has a negative effect.

Species composition of the catch

Long-distance migratory species or 'white' fish (about 60% of total catch)

Migrations take place annually between the spawning areas in southern Lao PDR and northeastern Cambodia and the floodplains around the Tonle Sap, south of Phnom Penh and the Vietnamese portion of the Mekong Delta and back. Larger species tend to spawn later in life. Many large species have dramatically declined in number, some nearly to extinction, such as the famous Mekong Giant Catfish *Pangasianodon gigas* and the Giant Barb *Catlocarpio siamensis*. The Catfish is reported to spawn for the first time at a weight of 150-250 kg by which time it may be six or more years old (Pholprasith and Tavarutmaneegul, 1997). Very few individuals survive the heavy fishing pressure long enough to reach sexual maturity. In the year 2000, eleven Giant Catfish were caught in the dai fishery and only seven in 2001. Thus, the later a species matures the more vulnerable it is to overfishing.

In the dry season, illegal fishing with explosives takes place in the deep pools and channels of the Mekong River in the northeast of Cambodia. This further reduces the spawning populations of some of the bigger species. Smaller species are usually early spawners. Most have not declined and dominate present catches. A good example is the Cyprinid, Trey Riel, *Henicorhynchus siamensis*. It spawns for the first time when about one year old. As most of the larger species are predators, a decrease in their number leads to an increased survival rate of their smaller prey. Smaller species are not overfished and could even be fished with greater intensity.

Short-distance migratory species or black fish (nearly 40 per cent of total catch)

Movements are much more limited, usually from flooded forests to lakes and rivers and back. Stocks have probably not declined as these fish do not run the same gauntlet of fishing gear as the long-distance migratory species. Snakeheads (*Channa* spp.) are the most important species group. They spawn in the flooded forests and are the most valuable species in the catch of the Great Lake fishing lots.

Fishery management system

Fishery Laws: The 1987 Fiat Law is still in force. Many of the regulations are largely based on colonial legislation. The fisheries of Cambodia can be divided in two broad categories: limited and open-access fisheries.

Limited access fisheries: the fishing lot system

The most productive part of the Cambodian fisheries has been privatized for more than a century through a system of government leases on fishing lots. The rest is open-access.

Resource rent: In the recent past, the lot system provided over US$ 2 million annually in tax revenues and more in an informal way. The open-access fisheries, however, do not contribute to public taxes.

Fishing lots vary from a simple anchoring position (dai) in the Tonle Sap to a large area of floodplain. The value of the lot depends on the expected fish production. Many lots occupy relatively large areas of floodplain (the largest Great Lake lot is 500 km^2). The Tonle Sap Great Lake lots contain mostly natural habitats, but there are also rice fields and sometimes villages within their boundaries. The natural habitats comprise flooded forests, shrub forest and grasslands, which are essential for the feeding and breeding of many fish species. In the past, there were close to 300 lots but now there are 164 covering approximately 30% of the floodplain area that was occupied in 1919.

In the recent past the open-access areas witnessed a rapid expansion of fishing effort in waters outside the lots. Catch rates were falling and this has caused an increase in conflicts over access to the fish resources. Many conflicts between lot operators and local villagers ensued (Degen and Loeung, 2000). The government intervened on behalf of the family fishers and further reduced the size of the lots. Community fisheries management is encouraged in the freed-up areas. It is still too early to judge what impact community management might have.

Open-access fisheries

Open-access fisheries have expanded dramatically in the past two decades and have contributed to the recent increase in fishing pressure. Close to 200 different types of fishing gear and methods are used in these fisheries (Degen *et al.* 2002). The majority of the fishers in the Tonle Sap Great Lake area (the 1995- 1996 estimate was 1.2 million) are engaged in these open-access fisheries. Most fishers are living at the edges of the floodplain, but quite a number have adjusted their lifestyle to 'living with the floods' by creating floating villages or houses on tall stilts.

Middle-scale fisheries: A number of gear types specified by the fishery law require a license, such as gillnets, seines and arrow-shaped traps.

Family or small-scale fisheries: The remaining gear types are free for anybody to use, although not everywhere or at any time. These gear types include small castnets, small dipnets, small gillnets and certain types of traps. Rice field fisheries fall into this category.

Illegal fisheries: A number of types of gear and methods have been declared illegal, such as brush parks, explosives, poison and electrified gear.

Over-exploitation

The high intensity of fishing operations in the Tonle Sap area supports a general impression that the system is overfished. This impression is strengthened by anecdotal evidence from many fishers who claim that their catches have been decreasing over time. However, overall catches are probably higher now than in the past, although individual catch rates have declined because the increase in population and number of fishers outstripped the increase in catch (Table 1). At species level the situation is more complicated.

Table 1 Tonle Sap Great Lake Region

Period	Cambodian population	Fishing commune inhabitants (11.2 % of total pop.)	Great Lake fish production (tons)	Increase in fish catch	Fish catch / fishing commune inhabitant / year	Decline in catch per fisher
1940's	3 200 000	0.36 million	125 000 t		347 kg	
1995-96	10 700 000	1.20 million	235 000 t	1.9 x	196 kg	44 %

Due to the reduction of larger fish species in the catch and the shift to smaller sizes, the average

value per kilogram has decreased. Thus, not only has the catch rate per fisher dropped, the value of his catch has decreased as well. Nevertheless, the overall tonnage of fish caught is still increasing. A number of larger species are overfished, but smaller species are not overfished at all. Multi-species river systems cannot be intensively exploited without loss of the larger species in the fish population, which are less abundant and reproduce more slowly (Welcomme, 2001).

During the fishing-down process, fishing effort on the large and medium-sized fish species increases to levels above what allows for the

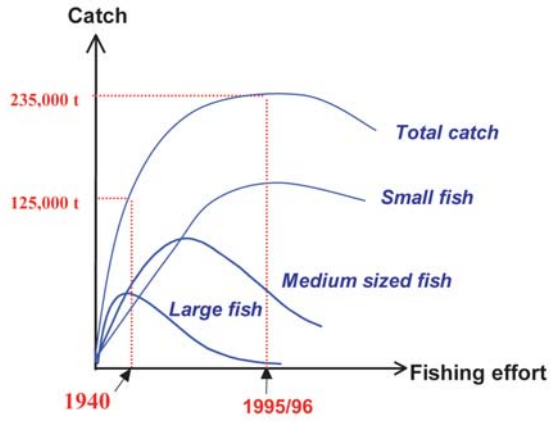


Figure 2: Catch versus fishing effort

maximum sustainable yield of these species. Meanwhile, the yields of smaller species may be still growing and thereby increase total fisheries output. Species usually do not become extinct and the potential for fish productivity does not diminish as long as the natural habitats remain intact and the average level of flooding remains stable. The fishing-down process is illustrated in Figure 2. In 1940, the Tonle Sap Great Lake region catch of 125 000 tonnes consisted mainly of large and medium-sized fish, while the 1995-1996 catch of 235 000 tonnes contained hardly any large fish and was dominated by small fish.

Fisheries management problems in the Tonle Sap stem from lack of governance and public sector reform, which hinges on two main issues: 1) the legal framework is still inadequate, especially with regard to land tenure and community fisheries legislation is not yet in force and 2) government staff (DoF, military, police, commune heads) are not being paid adequate wages, hence they have to use the power of their authority to make ends meet.

History of recent data collection in the Tonle Sap

From 1980 to 1998, government-produced statistics were generated for internal reporting on progress and for planning. They did not accurately reflect catch levels and could not be used for fisheries management purposes. Between 1995 and 1997, more accurate estimates of catch levels (280 000 to 445 000 tonnes) were produced by the MRC/DoF/DANIDA Project for Management of the Freshwater Capture Fisheries of Cambodia and these figures were subsequently used by the government. At present, only the dai fishery in the Tonle Sap River is annually monitored. There is a great need for cost effective and comprehensive data collection on catches and exports.

Need for accurate fishery information

Accurate information and statistics is necessary for balanced government planning and decision making in national or regional water resources management because:

1) Fishery resources are vulnerable to upstream river interventions
2) The fishery is vitally important for food security and livelihoods of the rural poor
3) Governments need to know the true contribution of fisheries to the national economy (presently estimated at 16% of GDP in Cambodia), to employment creation and to foreign exchange earnings through exports
4) Lack of knowledge of the true value of the wild fisheries could result in permitting or even stimulating agricultural expansion in prime fish producing floodplain habitats to alleviate perceived food shortages

Attempts to improve fisheries data collection systems

Catch assessment system

In the catch assessment system, catches were estimated on the basis of CPUE by gear type and frame survey data. Initially, the large-scale fisheries (fishing lots, barrages and dais) and middle-scale fisheries (licensed mobile gear and traps) were targeted. The plan was to expand data collection to include family fisheries. It was hoped that this would provide the basis for an improved fisheries statistics gathering system in Cambodia. However, this system was not expanded to cover the family fisheries and was actually stopped. Main reasons for this decision were:

Failure to collect accurate data on the lot fisheries. Neither lot operators nor officials were sufficiently prepared to cooperate. The only exception is the collection of data on the dai fishery in the Tonle Sap River.

Collecting more accurate data on the middle-scale and family fisheries with the personnel available proved to be unsuccessful. As the use of most fishing gear is seasonal, regular counts of gear in operation (frame surveys) need to be carried out. The great variety, dispersed nature and often-patchy distribution of the gear make catch assessment a prohibitively cumbersome and expensive exercise.

The cost of running a catch assessment system is currently beyond the means of the DoF.

Only the 'dai' fishery has been successfully monitored since 1995. Regular monitoring has revealed the variability of these stocks in relation to the extent of the annual inundation making it possible to detect long-term trends in migratory fish populations.

Household survey

The household survey was limited in area coverage but successfully estimated fish consumption (67 kg/capita/year), as well as fish catches made by the middle-scale and family fisheries, including gear use and species composition information. In fact, the present estimate of some 300 000-400 000 tonnes produced annually in Cambodia is based on the results of this survey.

Recent small test surveys carried out in a few communes over a period of several months produced average fish consumption rates that were very close to the ones found in the household survey. In the latter survey, randomly chosen households were interviewed only once.

When the survey was set up (1994 -1995), it was limited to districts and communes, which were close to water bodies in only eight of Cambodia's 17 inland water provinces. Fisher communities in the major fishery provinces with a total population of 2.4 million people were directly targeted. Consequently, the data cannot be extrapolated to the rest of the country. During the survey, more than 5 000 interviews were conducted over a relatively short period of time (four months) with teams of four to seven data collectors per province. However, data entry and analysis took a relatively long time.

The fish yield per unit of habitat approach

Another rough way of gauging the overall catch level in the country would be to estimate fish yield per unit of habitat type (flooded forest, secondary flooded forest, grasslands, marshes, rice fields, etc.) and to use land cover information to determine the extent of these habitats. The open nature of the terrain makes the estimates rather imprecise. Using one ha enclosures may give a low estimate of the standing stock in a certain habitat and misses out on the productivity over time. Adding up all fish catches made in the Tonle Sap floodplains, lakes and rivers and dividing this by the surface area gives an overall yield of 139-190 kg/ha (Lieng Sopha and Van Zalinge, 2001). This figure is the average yield of all the habitats found here.

Conclusions and recommendations

Data collection is costly and no data is better than misleading data. The question then arises:

"What could be a realistic focus for fisheries management in Cambodia under the present conditions and what data are the minimum data needed to support this?"

Fisheries management focus

Given the continuing increase in population, it can be expected that fishery resources will experience proportionally increasing pressure. There will be a trend towards greater use of the floodplains for agriculture, as well as an increase in fishing effort as a result of the need for employment. Limiting access to fisheries would be one choice. However, the political reality is that government favours opening up access to the fishing grounds and decreasing the use of fishing lots.

The best option for the protection of the resources and to limit species extinctions is to focus on maintaining the essential floodplain habitats and breeding grounds and their connectivity as best as possible.

First, further degradation of the floodplain habitats and their conversion to agricultural use should be stopped. Upstream breeding grounds (deep channels) should be protected and connectivity should be maintained (no mainstream dams). Secondly, the present flooding regime of the plains needs to be maintained if present fishing levels are to be sustained. Damming may change this.

To achieve this, a twofold government action is required. First, the government should try to engage more of the many NGOs in Cambodia to support a fisheries management approach and work with floodplain and upstream communities. Community involvement in the management of fishery resources is still in its infancy. Even though major efforts to facilitate co-management are still to come, success in protecting fisheries resources is not guaranteed.

Second, the government needs to strongly defend the nation's fish wealth in regional fora dealing with the future use of the Mekong's water resources.

Data requirements and collection methodologies

The following are considered to be the essential items of information needed to support this approach to fisheries management in the Tonle Sap. Appropriate collection methodologies are suggested.

To be collected at regular 5-year intervals:

Economic value of the fisheries resources by fishing method and species.

To determine the economic value of the fisheries resources a different approach needs to be taken to fishing concessions and open-access fisheries. Fishing concessions are notoriously difficult to monitor. Staff should be very carefully selected.

Floodplain lots: Stratification may be possible using habitat distribution in drainage areas. Monitoring during the main fishing period is essential. This period is often limited to about 4 months around the Great Lake (March to June).

Barrage lots: Targeting migratory fish in the early stage of operations (October to March), thereafter sweeping channels (April to June).

Dai lots: A stratified sampling scheme is worked out and operational. Stratification needs updating.

Open-access: In our experience, assessment through a stratified multi-staged random household fish consumption survey will be sufficiently accurate and cost effective. The survey should be carried out once during the best season for fishing (November to February) and again during the low season (May to June).

Among other factors, fish consumption, sources of supply, fishing involvement, gear use and catch composition should be assessed. A manual including a questionnaire is available (Van Acker, 2000).

Fish consumption and livelihoods

Household fish consumption as above and land use surveys, especially in the floodplains. The last Landsat and aerial photography survey dates from 1992 - 1993. An update is under preparation. More work needs to be done on developing yield-per-habitat indicators as a monitoring tool.

To be collected on an annual basis:

Exports and fish prices, preferably through continuous monitoring.

A strategy has yet to be developed.

Indicator fisheries

On migratory fish: The performance of migratory stocks over time can be followed by continuing the annual monitoring of the dai fishery in the Tonle Sap River as these stocks migrate out of the floodplains of the Great Lake to the Mekong to survive the dry season and for breeding.

On non-migratory fish: Snakehead (*Channa* spp.) is the most valuable species and makes up the main catch of the lake lots. The fisheries are presently not being monitored regularly.

Flood levels

Gauges in Kampong Luong and Kampong Chhnang are good indicators of the level of inundation of the floodplains and hence of fish production. Other gauges along the Mekong River, especially in Pakse, are indicators of long-term trends in water discharge during the wet months. The long-term trend over the period 1924-1998 is negative, hence floodplain inundation and fish productivity must have been larger in the past.

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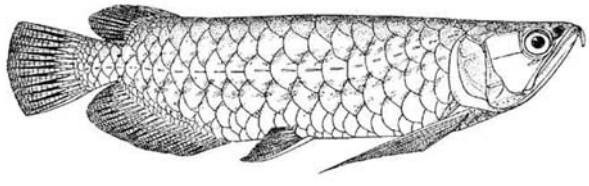

THEMATIC REPORT

"The fishery is undervalued and so cannot fairly compete with other sectors."

Consumption in the Lower Mekong Basin as a Measure of Fish Yield

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Wild capture fisheries in river systems are usually under-recognised and undervalued in official statistics (Coates, 2002). Official estimates of the yield from inland fisheries in developing countries are generally based on larger-scale aquaculture figures and in some cases the catches from commercial fisheries from lakes or very large rivers. Trade figures are also used where available in calculating the food balances produced by the FAO. The small-scale river (including floodplain) fisheries that predominate in the Lower Mekong Basin (LMB) and in many other large river systems are not included in official statistics. The resulting official estimates of yield from the basin are often grossly underestimated.

This lack of recognition of the importance and size of the wild capture fishery has several serious consequences for sustainable development in the Lower Mekong Basin.

The fishery is undervalued and so cannot fairly compete with other sectors (*e.g.* hydroelectricity, irrigation, flood control) which, by changing flow patterns or water quantity or quality, may impact the wild fishery. Decisions on water management planning or projects require assessment of true costs and benefits. For example, gains in GDP through increased rice production or hydroelectricity should be evaluated against losses to the fishery. Similarly, less tangible impacts on livelihoods, nutrition and culture are not fairly accounted when considering development proposals.

Investments in inland fisheries are usually directed to aquaculture or to production of juvenile fish for stocking of dams or reservoirs even though the effectiveness of such strategies is not well known (De Silva, 2001). Investment in the wild fishery, by managing the environment to increase yield, are likely to be highly cost-effective in comparison (Coates, 2002). Similarly, minimal investments to improve the efficiency of processing, storage and transport of wild fish may show greater returns. But wild capture fisheries cannot compete for investment within the fisheries sector if they are invisible in official statistics.

Small-scale fisheries themselves may be impacting the fishery and may be competing with larger-scale river fisheries, which may potentially be licensed and taxed and managed efficiently. Lack of information and the absence of management increase the risk to investors in government-managed fisheries such as fishing lots and so may reduce their value to government. Moreover, governments cannot fulfil their obligations under international treaties if the impact of small-scale fisheries on aquatic biodiversity and endangered species are not known.

Terminology and scope

A river fishery includes the fish, fishers, traders and consumers as well as the environment in which the fish live. In general, the term also includes other aquatic animals (OAAs), both vertebrates (aquatic reptiles, amphibians, water birds and aquatic mammals) and invertebrates (including molluscs, insects and crustaceans).

In biological terms, production refers to the total biomass of fish or OAAs produced (*e.g.* as kg/ha/year). Production includes yield, which is the portion removed by fishers, plus the produced biomass, which is not caught. In national economic statistical tables, e.g. those compiled by the FAO, 'yield' is usually called 'production', a statistic of primary interest in gauging the relative size and value of any food industry.

The yield of a river fishery may be estimated in three main ways:

1) By directly assessing the fishery. For example by counting the number of fishers and multiplying by their individual catches, or by counting gear and multiplying by catch rates per item of gear. In large single-species fisheries (particularly marine) this method may provide accurate estimates. In river fisheries very large errors result from the difficulty of surveying all types of fishers and from the variability in space and time of the fishery.

2) By estimating the total area of habitat and then multiplying by a yield per unit area (if known from detailed study of sub-samples of the habitat). Although flooded area is one useful parameter that generally correlates with yield, it is difficult to precisely define or measure, varies greatly from year-to-year and includes a large range of habitats each with differing productivity. Moreover, yield per habitat also varies depending on the number of fishers and fishing intensity.

Lack of information and the absence of management increase the risk to investors in government-managed fisheries such as fishing lots and so may reduce their value to government.

3) By multiplying the population of consumers by their per capita consumption to provide an estimate of total consumption. From this subtract the volume of imports and add exports, wastage and fish used as feed. The origin of aquaculture-derived fish must also be known, particularly whether such fish represent additional (autotrophic) production, or whether they represent converted wild-caught fish or feed from other sources. The main advantage of using consumption to estimate yield is that population censuses and estimates of individual consumption rates are generally easier to measure or estimate and have lower errors (or absolute ranges) than the measures used to estimate catch or the habitat/yield measures (Bayley and Petrere, 1989). In an environment where all the fish is from wild-capture and all the fish is caught and eaten locally, consumption data provide a very good basis for estimating yield.

This paper briefly describes the method used to derive an estimate of consumption for the entire Mekong Basin, which is the unit of most interest for planning purposes for the MRC. A full description is being prepared for publication by the MRC. We then describe the range of accuracy of this figure and the extent to which it can be used to estimate the yield of the basin. Finally we describe the basic scope of household surveys, which are needed to collect information on consumption and associated fishery statistics and the studies needed to improve the methods used.

Estimating consumption

The first synthesis of LMB consumption was published in Sverdrup-Jensen (2002), together with a map, which shows the basin-wide distribution of consumption. The synthesis was based on multiplying per capita consumption by population for each province. The total estimated consumption (of inland fish and OAAs) for the LMB was 2.033 million tonnes per year by a population of 56.3 million people. This provides a mean per capita estimate of 36 kg/person/year. The range of consumption was quoted at 10-89 kg/person/year.

The synthesis that we are preparing is based on more studies and also corrects a number of minor errors in Sverdrup-Jensen (2002). Some errors were caused by using totals from studies which did not include one or two of the main components of consumption: inland fresh fish, inland processed fish, or OAAs, or by using data which included marine products for the inland fish and OAA total. Further errors arise from not including some provinces, which overlap the LMB catchment boundary, or using population figures from different years. Our final consumption figure is likely to be somewhat higher than that of Sverdrup-Jensen (2002), at about 3 million tonnes per year as whole-animal equivalent weight. For our review, population figures for each LMB province were obtained from national censuses for mid-2000, or in one case from 1998 and adjusted to equivalent mid-2000 figures. Consumption estimates were obtained from 17 studies which had been carried out in the lower Mekong Basin, and which in total covered 32 provinces.

The provincial per capita estimates were then used to estimate consumption in adjacent provinces, judged to be similar geographically and socially. Of the studies reviewed, two were by direct measurement of foods eaten, and two were by logbook, *i.e.* the respondents recorded their own meals. The remaining 13 studies were based on the recall of respondents of foods eaten over a typical year. Consumption was in all cases only one part of the surveys, which usually attempted to describe many aspects of the small-scale fishery and, in some cases, included data on catches and aquaculture.

Quality of the consumption figures

A notable feature of the survey reports that we reviewed was the lack of systematic attention to the quality of the data. It is therefore worth emphasising that environmental surveys should include a Quality Assurance Plan (QAP), the objective of which is to ensure that surveys provide data, which has known quality, consistent with the objectives and budget of the study. A QAP should include five data quality indicators (DQIs): bias, precision, representativeness, completeness and comparability (as defined in Appendix 1, derived from Keith (1988). None of the studies included any explicit information on bias or precision. Most included information on representativeness (*e.g.* the extent to which samples were stratified to represent the target population). Some provided estimates of the variability of statistics, but these are of little value unless it can be assumed that precision is high and bias is low. Therefore, it is not possible to provide any statistical measures of the likely variance of the consumption estimates. Moreover, in many cases the data are not directly comparable, for example OAAs were excluded from some surveys or only partly reported.

Accuracy of the MRC consumption estimates.

Although it is not possible to provide conventional error estimates based on the data for the reasons mentioned above, the range of values possible for LMB consumption can be estimated assuming that errors in the population figures are insignificant compared with errors in the consumption estimates. A reasonable estimate of the possible range in per capita consumption is 30-90 kg/person/year, based on FAO world figures (see Point 3 below). The resulting range, 1.7 to 5.0 million tonnes/yr (30 x 56.3 to 90 x 56.3), provides an indication of the maximum possible range for the final mean estimate of about 3 million tonnes/year.

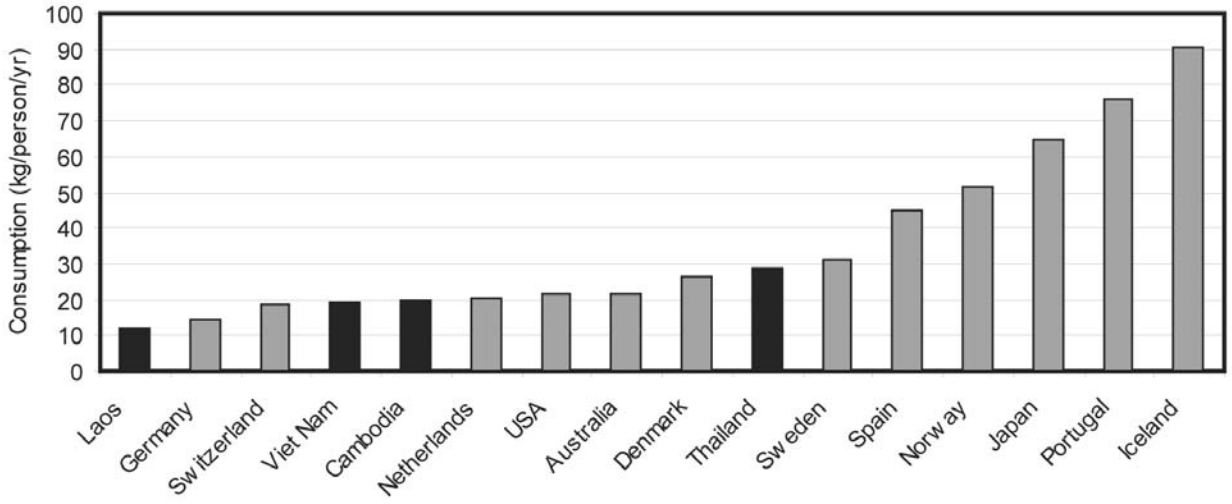

Figure 1 *FAO estimates for consumption of all seafood (fish and aquatic animals) for some developed countries, compared with FAO data for LMB countries (in black).* Based on FAO website data for 2000

Four approaches used to judge the accuracy of final consumption figures:

1) Comparison with fishing activity and catches. The small-scale surveys all showed fishing activity to be important throughout the basin, including highland areas. Most people fish at some time and many people culture fish. There are few people who never eat fish or OAAs (in contrast to some developed countries). In some studies estimates of consumption from reported catches and small-scale aquaculture production were compared with consumption, and showed reasonable agreement.

2) Yield calculations based on floodplain area x production/ha. This comparison is presented in Sverdrup-Jensen (2002) where a yield of 230 kg/ha of floodplain is multiplied by a floodplain area of the LMB of 9.69 Mha of wetlands to derive a yield of 2.23 million tonnes for the LMB. The similarity of this gross estimate to that from the consumption figures is clearly accidental given the errors involved, but does show that the consumption estimate is of the correct scale.

3) World figures for consumption. The FAO provides estimates of per capita consumption of 'seafood', from official national figures on catches, imports and exports, and sales for animal feed, to derive a 'whole animal' figure. Seafood includes all fish and OAAs from all sources. The FAO figures from developed countries may be considered accurate, but are subject to two significant sources of error, which may balance each other to some extent. First, wastage is not subtracted from the whole-animal figures. Second, consumption from recreational fisheries is underestimated or not included. The FAO figures range from 14.5-90.7 kg/capita/year (Figure 1) and among these the official figures for the LMB countries can be seen to be among the *lower* figures. This is in comparison to countries where the general populace does not eat much fish or OAAs compared to people in the LMB. Therefore, the FAO ranking of the four LMB country figures seems far too low.

A comparison may also be made to studies of similar environments. For example Bayley and Petrere (1989) summarised results from consumption studies of inland fish from the Amazon Basin. In lowland areas consumption varied from 27-101 kg/person/year. In highland areas where cheap beef is available the lowest consumption was 4 kg/person/year. Hence the LMB average is also at the lower end of the lowland Amazon range. Assuming some similarity between these two floodplain systems, the LMB figure appears to be conservative.

4) Consumption by expatriate LMB country people. Sechena *et al*. (1999) used quality-assured standardised survey protocols among expatriate Asians in Washington State (USA) and found high annual seafood consumption among people from LMB countries (Table 1).

Seaweed/kelp was subtracted from totals and an average body weight of 60.2 kg (excluding Samoans) was used for converting these figures from g/kg/day.

In terms of whole animal weights, these figures should be approximately doubled. Comparing with the figures in Sverdrup-Jensen (2002, Table 1) for three countries they are between 1.3 and 3.5 times higher than the LMB estimates, suggesting that the LMB figures are conservative. Consumption of course depends upon food availability and income in the new country, but it is also clear that Asians in the USA eat much more seafood than the general population. Moreover, older respondents ate more seafood than younger respondents, perhaps indicating retention of original eating habits. The value of this comparison is that we may have had cause to doubt the LMB figures if the USA figures had been found to be lower than the LMB figures.

Estimated yield from consumption

The total yield from the LMB can be estimated as:

Yield = consumption - imports + exports + animal feeds + waste + fish fed to aquaculture – aquaculture products - marine products
The values for the terms in this equation cannot be entered with certainty but the following points are worth noting:

Table 1 *Consumption among LMB country expatriates in the USA*
From Sechena et al. (2002)

Ethnicity	Consumption (kg/person/yr) as edible portions		
	Total	Shellfish	Fish
Cambodian	**31.2**	20.2	11.0
Lao (lowland)	**42.2**	19.7	22.4
Hmong (highland Lao)	**12.9**	5.5	7.4
Vietnamese	**57.4**	34.7	22.7

Imports of marine products are excluded from the consumption studies. Imports from adjacent basins would be very minor. Therefore, there is no need to subtract imports from the figures.

Exports from the LMB are significant. These include exports of *Pangasius* catfish from the Delta to other parts of Viet Nam and to other countries and fresh and processed fish from the Great Lake in Cambodia to Thailand and other countries. It is likely that exports exceed imports. Animal feed and waste are unknown, but are certainly at least an additional 10% per year.

Fish feed to aquaculture would be mainly for snakehead (*Channa*) and catfish (*Pangasius*) cage culture. For snakehead, the conversion factor of wild fish to aquaculture fish is approximately 4:1 (*i.e.* 4 kg of wild fish produces 1 kg of snakehead). For catfish the conversion factor is approximately 1, because the fish are fed about 50% rice bran, about 25% marine fish and 25% small freshwater fish. Some other fish used in aquaculture (carp and tilapia) provide additional 'new' autotrophic production but these would be minor at present in the LMB.

Overall it would appear from considerations of the other terms in the equation that yield could be much higher than the figure indicated by consumption alone, perhaps by as much as 50%. This would imply a yield higher than 3 million tonnes for the LMB, well within the range of possible values mentioned in Section 4.

Conclusions regarding the methodology for small-scale fishery surveys including consumption

Consumption is of interest basin-wide, as are other indicators of the scale of the fishery, and it is clear even from the rather scattered data which we have reviewed that the fishery is very large and critical for food security, nutrition and livelihoods. Further work to define the scale of the fishery would be of value, but given the threats to the fishery it is more urgent to establish indicators of trends. Monitoring some small-scale fisheries in each country, including their catches and consumption is feasible and would be cost-effective to provide indications of changes. At the same time long-term intensive studies on

relatively few villages would provide the basis for a validation of the large-scale survey methods.

Standardizing methods basin-wide, (and indeed in developing countries generally), would enable valid comparisons of data. In this respect the lessons from studies in the LMB to date are clear, but are perhaps not new. A QAP is essential (Appendix 1), and the following points apply particularly to small-scale fishery surveys.

1) Fewer data of good quality are preferable. Most surveys collected many types of data, many of which were not used, wasting time and resources. For example, catches usually are dominated by five species at any location (50-80% of total weights), so records of their catches and weights suffice. Data on the other species (50+ in some studies) are likely to suffer from poor recall or not be representative.

2) Simple questions, which have categorical answers, are less prone to error than questions that require estimation. It is critical to define participation, either as a catcher/collector, seller or buyer, as an owner of equipment or as a consumer. Such questions can be applied at village, household and individual level. Similarly, frequency data are likely to be more reliable than estimates of quantity.

3) The surveys should be designed with similar formats and questions to allow crosschecking between village, household and individual catches and consumption.

4) The categories of catches or foods should be standardized as far as possible, with particular attention to OAAs for which there is great inconsistency between studies. Many studies did not include some or all OAAs, and in some studies eels were even categorised as non-fish. OAAs can be best categorised taxonomically (separated into vertebrates/invertebrates and then classes) and by habitat: aquatic, amphibious, terrestrial. Similarly, it is important to separate aquaculture from wild fish. Further work is needed to standardise conversion factors used for converting processed fish products to fresh fish equivalent.

5) Visual aids should be used in any interviews. In particular, a comprehensive set of photos is needed for OAAs where there is much confusion over terminology and definition.

6) Quantitative annual data including consumption and catches may be obtained by interviews, but their accuracy has never been validated for the LMB. Intensive studies to compare actual catches and consumption against recall would be invaluable for calibrating results from other broader surveys. If recall is used, accuracy can be improved by using portion size estimation aids (PSEAs), about which there is an extensive literature (*e.g.* Mitchell *et al*. 1996; Sechena *et al*. 1999; Shimizu *et al*. 1999; and Swindale and Ohri-Vachaspati, 1999).

7) Recall (24-hour) is commonly used in developed countries because the target population can be reached by telephone and because field surveyors are expensive. In the LMB, actual measurement of consumption (and catches) supervised by surveyors is more feasible and cost-effective and would produce some reliable figures against which to compare recall.

8) Consumption on certain days may be high for cultural reasons. Consumption may also be clumped seasonally and over short time periods because high fish or OAA catches are obtained under particular environmental conditions (*e.g.* relating to flows or lunar phase). Any longitudinal study of consumption would require minimum time blocks of 2 weeks. Ideally some studies would track families daily for a year so that the results could be used to examine variance and define the optimal sampling frequency and duration.

9) A final point relates to publication. Many of the studies reviewed for this report were difficult to obtain as most are 'grey literature' and some were incomplete drafts. Some other studies in LMB languages could not be found. Others no doubt exist, but are poorly known or not referenced in information systems. To enable a basin-wide perspective and to improve the efficiency of further work, we need to improve peer-review and the publication of documents,

translation into and from the national languages and to consolidate LMB references in a single location with an accessible referencing system.

Conclusion

Consumption of fish and OAAs in the LMB is conservatively estimated at about three million tonnes per year, or 56 kg/person/yr, with a possible range of 1.7 to 5.0 million tonnes/yr as whole-animal equivalents. Various other data suggest that this mean figure is conservative an will be revised upward. Yield from the LMB includes exports, waste and animal feed, and is probably greater than 3 million tonnes/year, a figure that requires refinement based on analysis of existing studies and collection of further data.

Further studies of consumption in each country are of particular value for monitoring trends and should be carried out in a comparable manner using standardised and quality-assured protocols, which still need to be developed and validated.

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Appendix 1

Important elements of a Quality Assurance Plan for environmental data. The plan should define the acceptable values for the five main data quality indicators (DQIs).

Bias = Accuracy: the difference between measured and accepted, reference or true values.

Precision: a measure of variability of measurements of the same property by the same method.

Representativeness: the degree to which data accurately and precisely represent a characteristic of the population.

Completeness: the amount of valid data obtained compared to the amount that was expected under normal conditions.

Comparability: expresses the confidence with which one data set can be compared to another. Covers: sampling networks, analytes and units, methods, QA, accuracy and precision.

THEMATIC REPORT

"The main benefits are not increases in fish catches, but better communication among users and between users and government, sharing of experience and competence, and a greater sense of being heard."

Reservoir Fisheries Information: From Statistics to Management

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This paper summarizes some of the main experiences gained from the Mekong River Commission Fisheries Programme Component: Management of Reservoir Fisheries in the Mekong Basin (MRF) concerning relations between fisheries information and management. The Component initially worked mainly within the central government line agencies but has gradually become more involved at local user level. The first phase of the Component (MRF I) was initiated in 1995. The second phase (MRF II) started in March 2000 and will be completed in early 2004. In this phase, a fourth riparian country (Cambodia) joined the activities of the Component.

During the first phase, the Component focused on strengthening government staff capacity in Lao PDR, Thailand and Viet Nam. Most activities were carried out at relatively large reservoirs in Lao PDR and Thailand or smaller reservoirs in Viet Nam and included training and implementation of catch assessment and socio-economic surveys. These activities included data storage, analysis and reporting. Reservoir fishery management issues were generally addressed indirectly because of the focus on building the capacity of government staff within a few specific areas. The outputs during the first phase generally related more to policy issues and statistics (data collection) than to management, which became the main focus during the second phase of the Component.

Example of an MRF Phase I output: Study on the fishery of Nam Ngum Reservoir

The Nam Ngum is a 477 km^2 hydropower reservoir located 90 km North of Vientiane, the capital of Lao PDR. A study carried out by MRF I in 1998 estimated that the fisheries landings from Nam Ngum had increased by a factor 4 over the 16 years between 1982 and 1998 (Mattson *et al*., 2001). The estimated landings in 1998 were 6,833 tonnes (95% c.i. 4 283 to 9 383), which corresponds to a yield of 143 kg/ha/ year.

The increase in the catch can be explained by the increase in effort, particularly gillnets (Table 1). Figure 1 shows a comparison between

the official statistics on landings at Nam Ngum in 1997 and the estimate of 1998 total landings by MRF I. The official figure was obtained from trade data supplied by the monopolist fish trader (fish exported from the reservoir), and adding an estimate of local fish consumption (Schouten, 1998). The 1998 fisheries total landings were estimated by catch-effort sampling and a fishing effort survey. The amount consumed locally was estimated from a survey carried out among villagers living around the reservoir.

Table 1. Nam Ngum 1982 and 1998

	1982	1998
Population	9 560	16 660
Full-time fishers	1 350	1 500
Total fishers	2 350	3 400
Gillnet effort	940 000	4 300 000
Beatnet effort	None	195 000
Net types	Multi-filament	Mono-filament
Motorized boats	563	1 286

Nam Ngum Reservoir (Metric tonnes)

It may be concluded that calculation of fisheries landings from Nam Ngum using trade data led to an underestimate of the landings. Figures from other inland fisheries in the region show that this magnitude of underestimation is not unique to Lao PDR (Coates, 2002).

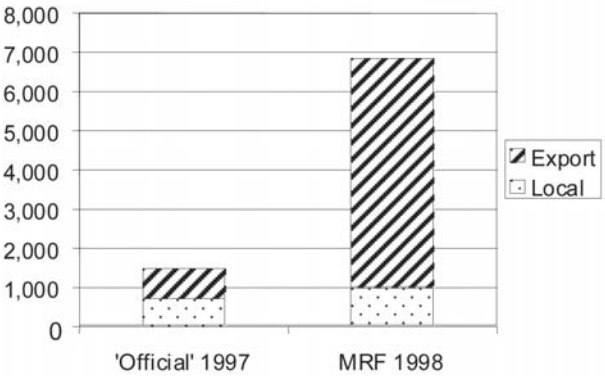


Figure 1: Official versus MRF I estimate of fish production

MRF Phase II

In Phase II, the Component focus was shifted toward participatory resource management. The target group (co-managers) include line agency counterparts, local government staff (e.g. district level) and resource users (fishers). To a large extent, the Component is concerned with facilitating communication between co-managers. A central output is jointly formulated reservoir fisheries management plans. An adaptive planning and implementation process is emphasized with joint monitoring of outcomes.

The Component definition of the term management is quite wide: "Any planned interaction that is needed or aims to maintain the productivity of the resource".[1] Co-management is characterized by the sharing of decision-making in management and includes applied management instruments between government and users. Communication is seen as a cornerstone of the co-management process.

Before managing, indeed before planning for management, it is necessary to decide on the main concerns and objectives. Only then is it possible to choose management measures and interventions and the means to implement them. Once there is agreement on management concerns, objectives and measures to be taken, the question to be answered is: "What shall the institutional and organizational framework for management planning and implementation be?" Table 2 summarises some outcomes of participatory workshops at reservoir level in the four riparian countries.

Based on the initial identification of concerns, objectives and measures, specific management plans for each reservoir were jointly formulated by local government staff and reservoir users.

Table 3 is an example of activities that form part of management plans at four reservoirs in Lao PDR.

Information for co-management

As Component activities moved from the first to the second phase, requirements for fisheries information did not diminish. However, the nature of the information needed and the methods for collecting the information changed dramatically.

Table 2: Management concerns, objectives and measures

Country	Management Concerns	Management Objectives	Actions/Instruments
Cambodia	Effort increase Illegal fishing Habitat destruction Inefficient management	Income diversification Combat illegal fishing Habitat protection Efficient management	Training Organizing management Revise/enforce rules Credit provision
Lao PDR	Low/decreased yields Illegal fishing Habitat destruction Lack of management Fish disease	Income diversification Combat illegal fishing Habitat protection Efficient management	Training Organizing management Revise/enforce rules Improve marketing Fund raising
Thailand	Low/decreased yields Habitat destruction Inefficient management Fish disease	Income diversification Habitat protection Efficient management	Training Organizing management Revise/enforce rules Improve marketing
Viet Nam	Low/decreased yields Inefficient management	Income diversification Efficient management	Training Organizing management Credit provision

Table 3: Reservoir Fisheries Management Plans, Lao PDR

Activities	Reservoirs				Results
	NH	NS	HS	PP	
Organize reservoir fishing committee (RFMC)	S/C	S/C	S/C	S/C	4 RFMC's organized and functioning
Data collection	S/C	S/C	S/C	S/C	Baseline figures collected
Review fishing regulations	S/C	S/C	S/C	S/C	Improved regulations drafted
Conservation zones	S/C	S/C	S/C	S/C	A set of proposals for each reservoir formulated, areas demarcated and regulation enforced
Stocking	P	P	P	P	JUGO Workshop prepared.
Cage-culture	P	-	P	P	JUGO Workshop conducted, cage-culture proposals for each reservoir formulated
Organize fisher groups	S/C	S/C	-	-	Informal groups organized

NH = Nam Houm NS = Nam Song HS = Huay Siet PP = Pak Peung
P= Planned Activity S/C = activity has started or is completed
JUGO = Joint user-local government officer workshop

The information required for supporting co-management systems depend on a number of factors including:

- The nature of the co-management arrangement (who is involved?)
- The objectives of the specific reservoir management activities
- The institutional capacity (what are the decision-making methods, how is data collected and analyzed)
- The co-managers' preferences and (local) conditions under which they operate

Thus the information requirements must be determined by what is needed to address the management objectives. It is crucial to consider the usefulness of the information before it is collected. Managers must feel a sense of ownership about the information and every effort made to ensure that it contributes to a perceived increase in shared knowledge.

Does co-management work?

Results of a first one-year cycle of planning and implementation in Viet Nam and Thailand have shown promising results. Benefits monitoring has been based mainly on a few broadly formulated indicators that are meant to capture the co-manager's own perceptions. While some are more and others are less satisfied with the planning as such, most claim that they have gained some benefits from the joint management system. The main benefits mentioned so far are not increases in fish catches but better communication among users and between users and government, sharing of experience and competence, and a greater sense of being heard. There is also a high level of satisfaction with specific management activities such as the establishment of conservation zones and formulation of fishing regulations.

Problems and constraints

The process of helping people organize and implement co-management is a time consuming task. Numerous meetings and facilitated events are usually required to build up the confidence and capacity of prospective co-managers. Although co-management is often described as a cost-efficient approach to managing resources, the initial stages require significant inputs in terms of funding and time.

Another constraint is the research-oriented nature of fisheries line agency staff. Staff generally have higher education qualifications in the natural sciences. The promotion path in these organisations is often associated with the publishing of scientific research. In most cases, facilitating co-management is not considered valid research. Counterparts may therefore be unwilling to join activities of this nature. The fisheries line agencies themselves usually have natural science based research agendas and such research is often seen as the primary goal.

Earlier activities of MRF (Phase I) may have inadvertently strengthened this scientific orientation by providing training in biological

Table 4: Reservoir managers' satisfaction and perceived benefits

Gender	Satisfaction		Benefit	
	Viet Nam	Thailand	Viet Nam	Thailand
Male	33%	75%	67%	73%
Female	58%	96%	8%	61%
Total	44%	82%	75%	92%

Table 5: Perceived benefits at reservoirs in Thailand

Benefit	Much better	Somewhat better	No difference
Knowledge sharing	59%	16%	25%
Improved communication	32%	48%	20%
Opinions are heard	78%	22%	0%

and socio-economic survey methods. The emphasis on scientific approaches has, to some extent, been in conflict with the participatory management objectives of the second Component phase.

For users and government officers to take part and feel ownership in the co-management process, there is a need to reach some common ground in terms of the information needed for fisheries management. The process and the tools applied for collecting fisheries information must be consistent with the capacities of all co-managers.

Scaling co-management

In large river basins like the Mekong, local management objectives may have large-scale implications. Similarly, large-scale management at distant locations may affect local resources and their management. Typical examples include management of migratory stocks. Local fisheries management may nurture part of the life cycle of a number of species in one location but water development projects such as hydropower dams block migration routes and negatively affect local fisheries in another location.

This adds a dimension to co-management: the need for vertical information flow and communication. Local co-management can play an important role in generating information that can be aggregated with information from other co-management activities in the basin as a basis for the formulation of regional management plans. This aggregated information should be communicated to the co-managers and used to increase knowledge and improve management at the local scale.

Capacity building

In Phase II, MRF developed several approaches to capacity building. One such approach is a regional training course in co-management (RTC) for central government counterparts and staff. This programme is conducted annually and emphasises participation, diversity, facilitation and adaptive management. Each regional course includes a follow-up workshop at national level where the participants from the RTC are invited to discuss their experiences with co-management and express their needs with regard to capacity building.

Another approach is to organize Joint User Government Officer Workshops or JUGOs. Each workshop focuses on a particular theme that has been identified by the co-managers as relevant to the management tasks ahead and emphasizes joint learning and creation of new knowledge through a learning-by-doing process. Part of the workshop consists of field visits to sites with successful examples of management that relate to the theme of the workshop. These workshops usually feature a facilitator as well as subject matter specialists from the central line agency.

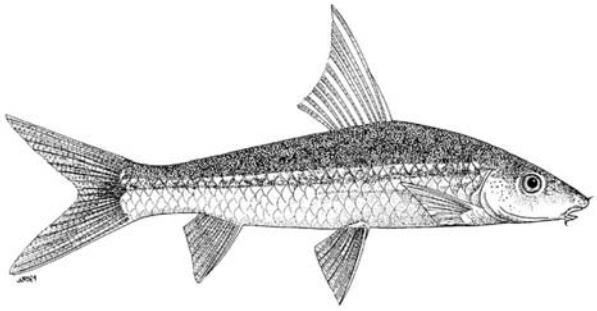
Co-management is characterized by the sharing of decision-making in management and includes applied management instruments between government and users. Communication is seen as a cornerstone of the co-management process.

Some conclusions

MRF's experiences with the implementation of co-management and fisheries information creation can be summarized as follows:

- Information generation is a management function (sometimes called 'management research')
- Information generation must have a clearly stated purpose and be consistent with the management objective
- 'Data-less' (not knowledge-less) management is a real alternative
- To be effective, users should be involved in all stages of research and management options emerging from such research should be negotiated among those concerned
- It is essential to select the information requirements according to the needs of the co-managers

- There is a real danger that management information systems dictate who is included as co-managers
- Fisheries management is managing people and their knowledge of resources



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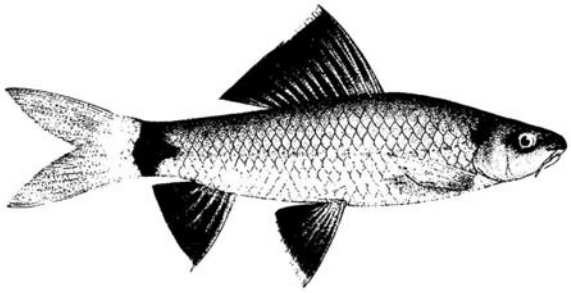
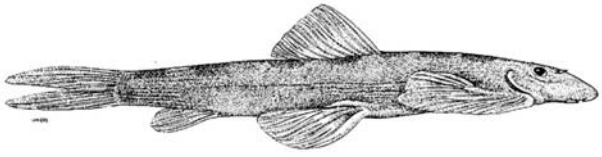


Footnotes

[1] Formulated by Jørgen G. Jensen, former Programme Manager of MRC Fisheries Programme.



THEMATIC REPORT

"Many fisheries biologists and policy makers involved in inland fisheries management and statistics are unaware of the technology and its potential for fisheries management."

Geographic Information Systems and Inland Fisheries Management

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Inland capture fisheries provide a valuable contribution to food security for the lower strata of society in many parts of the developing world. However, accurate information on the sector is often difficult to obtain. Yields are traditionally calculated as the product of the Catch Per Unit of Effort and the effort (Y = CPUE * f).

In marine fisheries this is a valid method as both the catch (Y) and effort (f) are relatively easy to establish. Effort, for example, can be defined as tonnage and horsepower. The bulk of marine catches is taken by large commercial vessels, fish are landed on a centralized landing site and most of the produce is exported. All of these factors make it easier to record the catch and effort data involved.

For many inland fisheries this is not the case. The bulk of the catch is taken by dispersed small-scale fishers, the fishing activities are of an informal nature and fishers operate in remote rural areas. Part-time fishing is the norm, especially mixed farming/fishing lifestyles on floodplains. Most inland fisheries produce is consumed domestically and much of it within the communities where the fishing occurs (Coates, 2002).

Taking into account these obstacles in collecting reliable data, one option to consider is the use of Geographical Information Systems (GIS). A GIS is defined as an integrated assembly of computer hardware, software, geographic data and personnel designed to acquire, store, manipulate, analyze, display and report all forms of geographically referenced information. Simply put, a GIS combines layers of information to provide a better understanding of a place (Fig. 1).

An example of GIS use in inland fisheries monitoring is the floodplain fisheries monitoring programme developed in the Compartmentalization Pilot Project in Bangladesh (de Graaf *et al.*, 2001; de Graaf, in press a/b).

Floodplain fisheries monitoring in the Compartmentalization Pilot Project (CPP), Tangail area, Bangladesh.

The CPP was a water management project implementing a controlled flooding concept in the project area. A habitat-stratified floodplain fisheries monitoring programme was developed to assess the impact of the water-management measures on fisheries. This programme was based on traditional catch and effort data recording, collecting these data from standard habitat types, and extrapolating them over the whole project area using hydrological modelling and GIS techniques.

Basin principles of habitat stratified floodplain fisheries monitoring

The principle of the fisheries monitoring programme used by CPP is a habitat stratification of catch and effort monitoring. Stratification means that the monitored area is divided into different habitat types. In each habitat type, a small representative part with a known inundated area is selected.

These standard sites are then monitored closely with a traditional catch-and-effort monitoring programme (determining the CPUE, f, and Yield). In this case, the traditional methods were applicable because of the limited size of the sampling sites. After the Yield per standard site is established, the Catch Per Unit of Area (CPUA) can be calculated by dividing the Yield of the standard site by the inundated Area of the standard site.

Habitat classification

For the floodplain fisheries monitoring programme in the CPP area, the land type classification of the Master Planning Organization (MPO) of Bangladesh was used. This MPO classification is well known by large groups of planners, scientists, departments, and farmers in Bangladesh. After careful consideration it was concluded that this system could be used for the fisheries monitoring programme in the CPP project. The MPO classifies land according to the risk of flooding for three consecutive days with a certain maximum water level. This risk of flooding determines which type of crops can be grown during the monsoon season. The different classes with their criteria are listed in Table 1.

Table 1: Land classification according to the Master Planning Organization

Land classification	Risk of flooding	Maximum flooding depth for three days (cm)	Land use during the monsoon
F_0	Very low risk of flooding	0-30	Sugarcane, vegetables, rice
F_1	Low risk of flooding	30-90	Rice
F_2	High risk of flooding	90-180	Rice, floating rice, fish
F_3	Certainly flooded	> 180	Floating rice, fish

The land types in a certain area only change if the water management in that area is changed. The developers of the stratified floodplain fisheries monitoring programme assumed that catch data obtained from a land type site was representative for the total flooded area of this land type, irrespective of the actual water level measured at that site. For instance, if the catch in 10 ha of flooded F3 land was well monitored during a certain period, it was considered representative for the total area of flooded F3 land during this period. This assumption allowed concentrating on the fixed sites within the project area. As a result, a sound analysis was possible with limited resources. Figure 2 shows the sampling sites of the most important habitats in the CPP area, while Figure 3 shows the different land types in the CPP area.

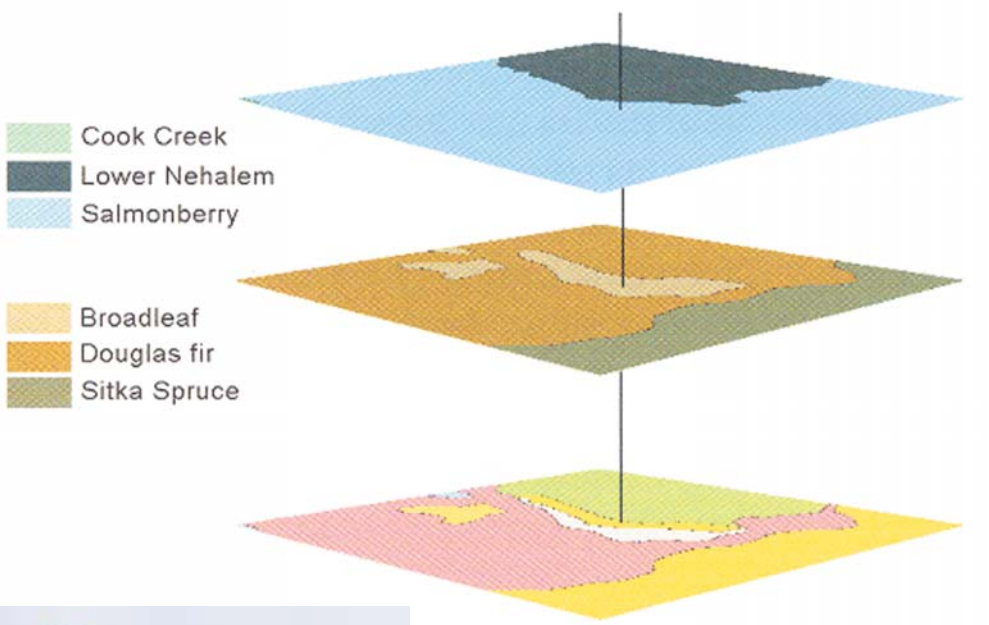


Figure 1: The concept of information layers

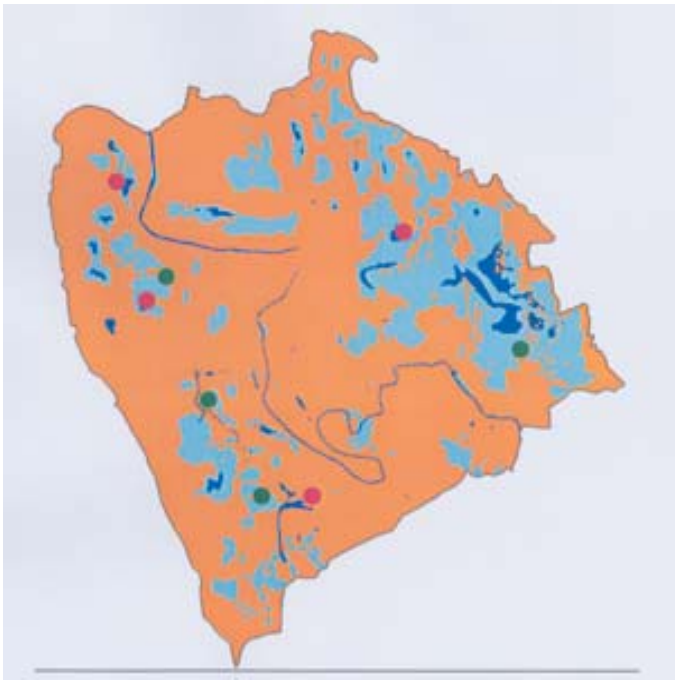


Figure 2: Sampling sites of the fisheries monitoring programme in the CPP project area (red F3 site, green F2 site

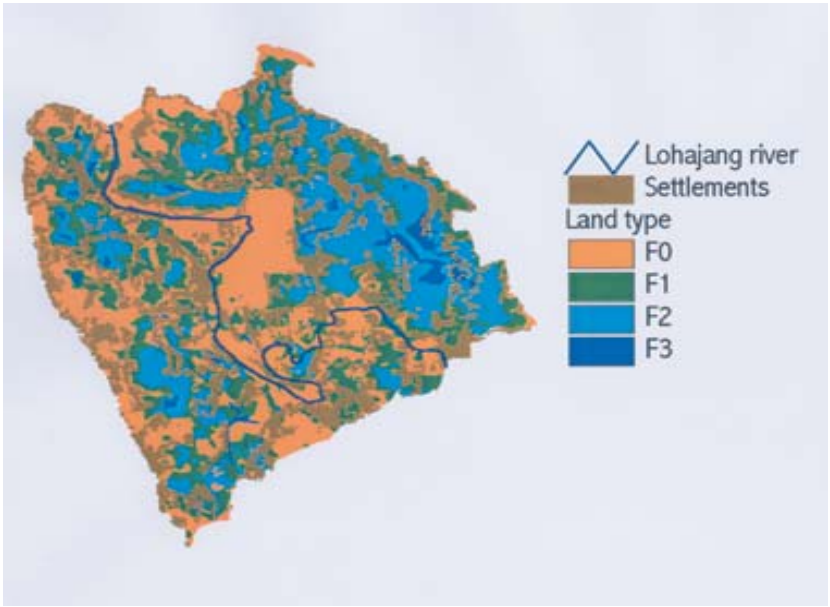


Figure 3: Land types in the CPP area

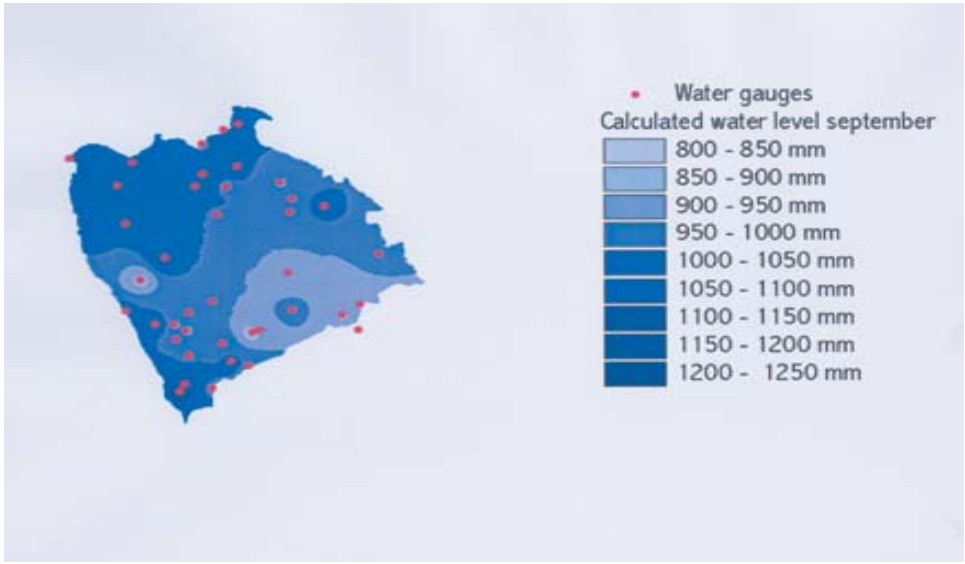


Figure 4: The interpolated water table of CPP

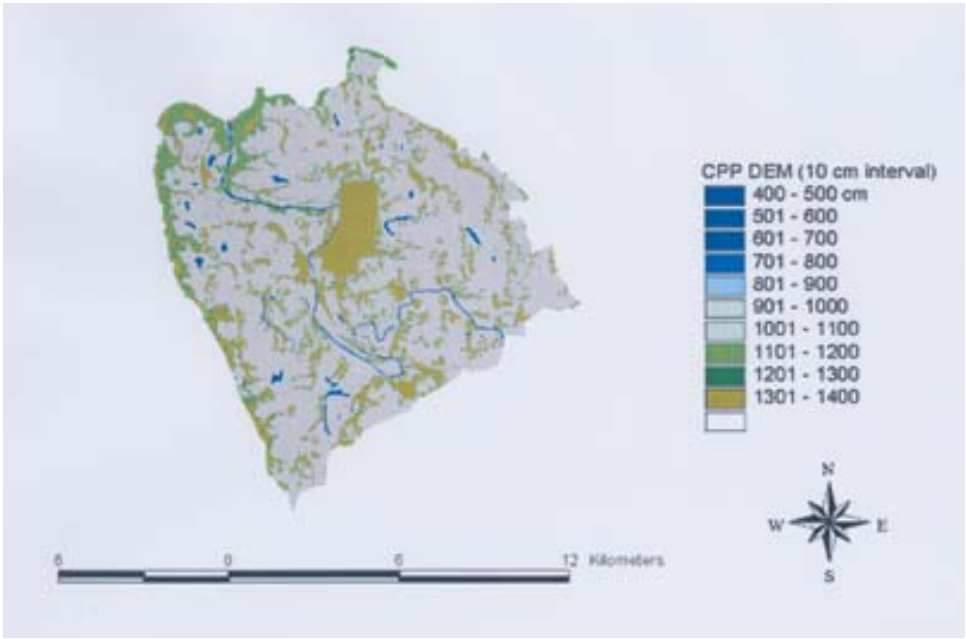


Figure 5: Digital Elevation Model of the CPP area

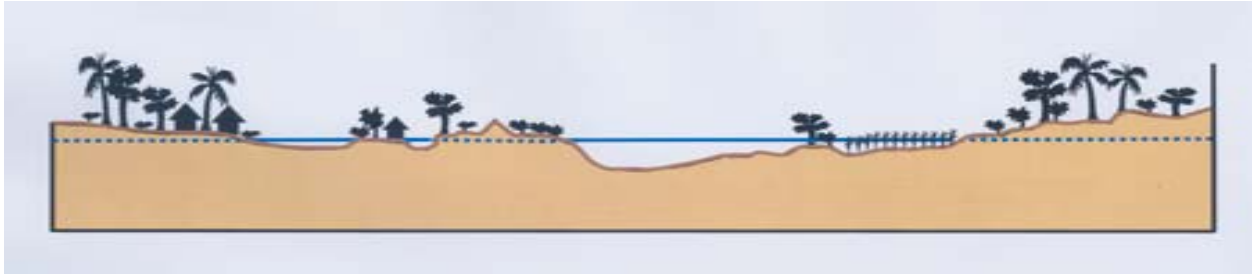


Figure 6: Substraction of water level from land level (DEM)

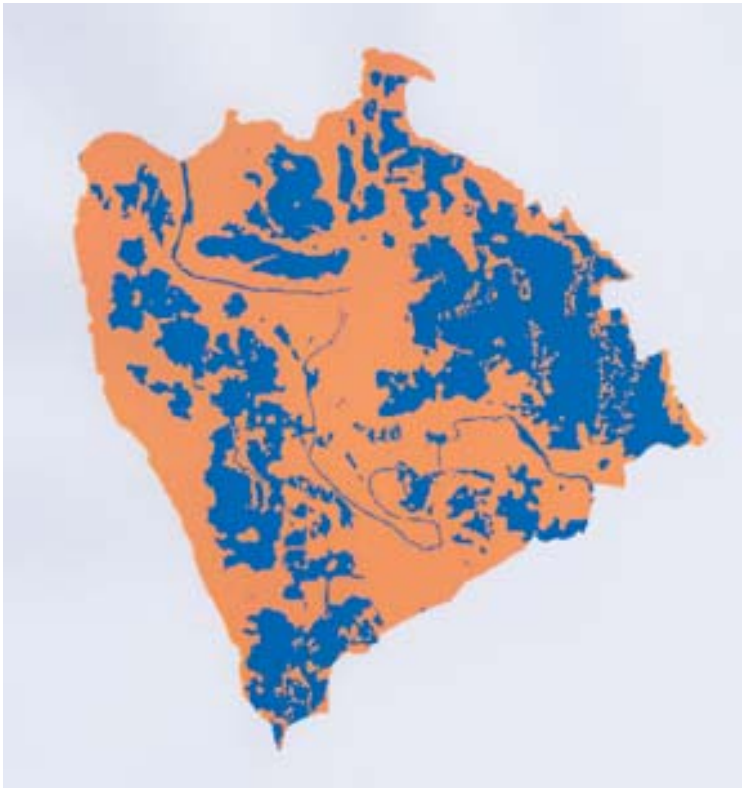


Figure 7: Resulting flood map showing inundated areas in blue

Figure 8: Inundated F3 land (yellow) and F2 land (green)

Determining the monthly Catch Per Unit of Area (CPUA)

Two surveys were done at the selected sites:

Catch assessment survey: providing information on the average monthly catch per fisher (CPUE) at a selected site. The daily catch of every individual fisher at each site was monitored bi-weekly.

Frame survey: providing information on the average number of fishers (f) operating at a selected site. It consisted of regular standardised counting of the number of fishers and types of gear used.

From these two surveys the average monthly catch could be established per site (CPUE * f = Catch), after which the CPUA of the land type the site represented could be established ($[Catch_{Fx}] / [Area_{Fx}] = CPUA_{Fx}$). Table 2 and Table 3 show data collected in 1997 and the resulting calculated CPUA for the considered habitat type (F3 or F2). Table 4 gives the average yearly CPUA per habitat type.

Determination of flooded area of each habitat type

Gauges showing the water level were distributed over the whole CPP area. Water level measurements were recorded daily. The monthly average water level was calculated per gauge, after which the water level (the water table) over the whole project area was interpolated (see Fig. 4).

A Digital Elevation Model of the project (Fig. 5) was available, making it possible to do calculations in a GIS with the land levels (in the DEM) and the interpolated water levels.

This DEM was subtracted from the water levels resulting in a flood map showing inundated areas (Fig. 6, Fig. 7).

This flood map was then used to determine the inundated area per land type, using the land-type map (Fig. 8).

Determination of Yield

After this procedure it was possible to estimate the total catch of that month in the project area ($[CPUA_{F1} * Area_{F1}] + [CPUA_{F2} * Area_{F2}] + [CPUA_{F3} * Area_{F3}]$ + etc = Total Catch). Table 5 shows the production per habitat type over the years that the monitoring programme was in place. These data do not show a significant negative influence of the project on capture fisheries production between the years that the project area was without water management (1992 to 1995) and the years with water management (1995 to 1999), taking into account that the flood season of 1992 was extremely dry and the seasons 1997 and 1998 were very wet (long duration of flood, high flood levels).

Conclusions and recommendations

The example of stratified floodplain fisheries in the CPP area has shown that GIS techniques provide an excellent tool in fisheries monitoring. Without this method it would be extremely difficult to have done this type of analysis. The applicability of the method in other areas depends on the availability of a Digital Elevation Model of the area, sufficient water level measurements (spread over the area, and frequently enough), and of course fisheries catch and effort data.

It is easily understood that the usefulness of GIS is not limited to floodplain monitoring, but extends to improving modelling capabilities, data management, data quality control, and the improvement of communication between scientists, institutions and policy makers. GIS is one tool allowing the integration of fisheries and related data in a user-friendly manner.

However, many fisheries biologists and policy makers involved in inland fisheries management (and statistics) are unaware of the technology and its potential for fisheries management. Therefore, an effort should be made to demonstrate GIS techniques to fishery biologists and policy makers, help them become more proficient in GIS analyses on their own data and help them

Table 2: Fisheries data (1997) from F3 sampling sites

Month	Number fishermen per day **(f)**	Catch per fishermen per day (kg/day) **(CPUE)**	Daily Yield in sampled Area (Kg/day) **(CPUE * f = Catch)**	Monthly yield (kg/month) **(Catch*days)**	**Sampled Area** (Ha)	**CPUA** (Kg/ha/month) **(Catch/Area)**
Jan	3	0.68	2.04	63.24	4.22	**14.99**
Feb	3	1.07	3.21	89.88	3.60	**24.75**
Mar	3	0.87	2.61		3.77	**21.46**
Apr	3	1.06	3.18	80.91	7.19	**13.27**
May	6	1.13	6.78	95.40	8.90	**23.62**
Jun	6	1.41	8.46		10.01	**25.35**
Jul	8	0.63	5.04	210.18	17.10	**9.14**
Aug	5	0.75	3.75	253.80	17.80	**6.53**
Sep	11	1.28	14.08	156.24	17.80	**23.73**
Oct	15	3.06	45.90		12.23	**116.35**
Nov	8	0.96	7.68	116.25	6.52	**35.34**
Dec	4	0.91	3.64	422.40	5.63	**20.04**

Table 3: Fisheries data (1997) from F2 sampling sites

Month	No fishermen per day **(f)**	Catch per fishermen per day (Kg/day) **(CPUE)**	Daily Yield in sampled Area (Kg/day) **(CPUE * f = Catch)**	Monthly Yield (Kg/month) **(Catch *days)**	Sampled **Area** (Ha)	**CPUA** (Kg/ha/month) **(Catch/Area)**
Jan	9	0.74	6.66	206.46	11	**18.77**
Feb	0	0.00	0	0	11	**0**
Mar	0	0.00	0	0	11	**0**
Apr	0	0.00	0	0	11	**0**
May	0	0.00	0	0	11	**0**
Jun	0	0.00	0	0	11	**0**
Jul	5	0.56	3	86.80	11	**7.89**
Aug	15	0.72	11	334.80	11	**30.44**
Sep	13	1.25	16	487.50	11	**44.32**
Oct	9	2.57	23	717.03	11	**65.18**
Nov	15	0.85	13	382.50	11	**34.77**
Dec	3	1.50	5	139.50	11	**12.68**

Table 4: Average annual yields of the different habitats in CPP (kg/ha/yr or kg/km/year)

	F_3 (kg/ha/year)	F_2 (kg/ha/year)	F_1 (kg/ha/year)	River (kg/km/year)	Canals (kg/km/year)
92/93	116	16	1	33	16
93/94	241	67	9	101	315
94/95	137	60	4	n.a.	n.a.
95/96	136	35	3	n.a.	n.a.
96/97	155	85	10	136	98
97/98	179	112	10	42	93
98/99	311	228	31	296	266
Average	**182**	**86**	**10**	**87**	**112**

Table 5: Catch per year (Mt) per habitat type in the CPP area

	F3	F2	F1	Lohajong river	Canals	Total
92/93	36	42	5	1	2	**86**
93/94	76	176	33	3	29	**317**
94/95	43	158	15	n.a.	n.a.	**216**
95/96	43	92	12	n.a.	n.a.	**147**
96/97	48	223	39	4	9	**323**
97/98	56	292	38	1	9	**396**
98/99	97	596	119	8	25	**845**

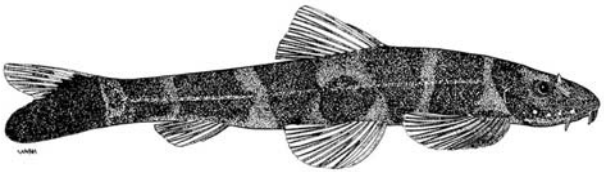
communicate with GIS-experts their wishes concerning more complex analyses.

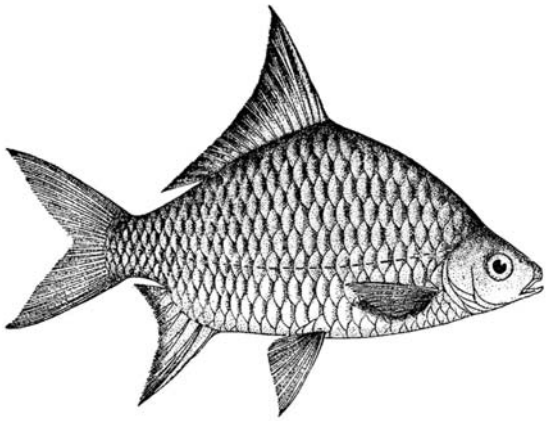
A programme to address these needs should deal with:

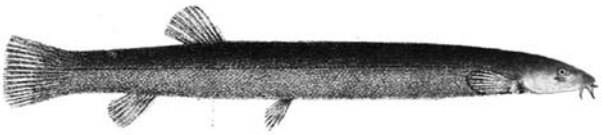
1) Increasing the knowledge of GIS techniques among fisheries biologists, for instance, using the manual on the use of GIS in fisheries management and planning (de Graaf, *et al*, in preparation).

2) Building a global network of GIS users in fisheries biology so they can communicate their problems and newly developed techniques.

3) Investigating limitations concerning the use of GIS (software, hardware, internet access, and data exchange limitations).







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CASE STUDY

"The sustainability of many government statistical programs in agriculture and fisheries is threatened by resource shortages."

Agriculture Census: A new prospect for inland fishery information

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While the collection of agricultural statistics has a long tradition in most countries, the importance of inland fisheries data collection may have been overlooked by line ministries. Inland fishery activities are often not monitored due to their dispersion and the large subsistence component in many communities, which makes their social and economic contribution less evident and the task of data collection more difficult than for other activities.

An agriculture census is a large scale, periodic, national statistical operation for collecting quantitative information on the structure of a country's food production sector. Acknowledging the interrelation of agriculture and fishing in mixed-type farms in areas endowed with water bodies, some census related statistical activities could be further exploited to collect more information. This would improve listings on which inland fisheries sample surveys may be based and increase the availability of socio-economic data related to households engaging in fishing.

The sustainability of many governmental statistical programs in agriculture and fisheries is threatened by resource shortages. The way forward is to promote an integrated approach to sector data collections, to identify ways to expand the scope of long established agricultural data collection programmes that are regularly supported by government budgets and that would optimize, with some additional input, the use of limited resources.

This paper advocates the expansion of the array of information collected through agricultural censuses and associated statistical activities to include inland fisheries. It complements methodological approaches outlined in other case studies for improving the quality and reliability of inland fishery production estimates, and increasing the availability of the type of socio-economic data required by policy makers.

Basic objectives

The basic objectives of undertaking an agriculture census are:

- To provide aggregate totals for fundamental agricultural data to use as benchmarks for inter-census estimates
- To provide a frame for other agricultural sample surveys
- To provide data for small administrative units (local-level estimates are necessary for making policy decisions at local level) and detailed cross-classifications of farm structural attributes

Countries with developed statistical systems and sufficient resources may add one or more of the following objectives:

- To obtain benchmark data for improving current production estimates
- To obtain detailed data on characteristics of the agricultural population and on various inputs used for agricultural production, particularly those relevant to the environment (such as type and quantity of fertilizers, pesticides, source of irrigation water and credit)

Defining holdings and households

An agricultural holding is an economic unit of agricultural production under single management, without regard to title, legal form, size or location. Single management may be exercised by an individual or household, jointly by two or more individuals or households, by a clan or tribe, or by a juridical person such as a corporation, cooperative or government agency.

The household concept is one of the basic elements of a national statistics system. According to the United Nations, the concept of 'household' is based on the arrangements made by persons, individually or in groups, for providing themselves with food or other essentials for living. The persons in the group may pool their incomes and have a common budget; they may be related or unrelated persons or a combination of both. In rural areas, particularly in developing countries, a one-to-one correspondence between a household and a holding is quite common. Thus, households (complex socio-economic units) serve to identify holdings (simple economic units).

For national accounts purposes, further clarification is needed of the economic activities of the agricultural production units, particularly in cases where the holdings are also engaged in secondary or ancillary non-agricultural activities. Ancillary activities are considered part of agriculture in national accounts. A typical example of an ancillary activity in an agriculture holding is the harvesting of fisheries products from waters on the holding or accessible to the holding. In rural areas, such waters are most likely freshwaters and contribute to inland fishery production. Criteria that may be used in differentiating between secondary and ancillary activities of agriculture production units are the size of the activity and its purpose. As a general rule, non-agricultural activities which are small in scale or which are generally for the use of the holding (for subsistence) rather than for sale in the market, are considered ancillary. Inland fishing is often a seasonal activity and even fishing households with fishing as the largest source of income may engage in non-fishing activities to integrate the income.

Conducting a census

A census is usually conducted every ten years. It is best suited to collecting data on characteristics relating to agricultural holdings that change slowly over time. Since inland fisheries are known to change relatively slowly, a census would be suitable to collect structural data associated to holdings and households engaging in them. A census aims to understand the structure of the agricultural production sector (*e.g.* number and size distribution of agricultural holdings by type of enterprise, the purpose of production and the factors of production). Other structural items may relate to the educational level of the holder and farm labour inputs, the legal status of the holder and other social and demographic characteristics of holders and

households. Structural data do not allow for any analysis of the performance of the sector. This requires data on quantities of inputs and outputs, enterprise costs and returns and farm income, as well as complementary data on variables such as food prices, consumption and nutrition. These change rapidly over time and are best monitored through more frequent sample surveys.

A census of agriculture is based on an extensive or total[1] coverage of holdings and potentially provides a sound frame for sample surveys to estimate performance. The census also provides structural data for individual small areas (e.g. communities, administrative units, agro-ecological zones), which are needed in the preparation of plans and policies for rural development. The agricultural census is also useful in identifying disadvantaged groups such as subsistence farmers and female holders who need to be assessed separately in policy formulation to ensure that their living standards have improved.

Enumerating all[2], (or a large sample of) agricultural holdings in a country without omission or duplication is a critical step that requires several sources. These include maps, topographic charts, aerial photographs or satellite images. Where these are not available, the agricultural census is undertaken on a complete list of villages or other identifiable geographic units or even on a sample enumeration basis. The lists generally include identification or classifier variables such as size of villages or units such as agricultural population or people engaged in agriculture, population of ethnic groups, total area and agricultural land area, main agricultural practices and facilities including water availability for irrigation. These data are useful for stratification purposes to improve the efficiency of the sample design and are of particular significance for identifying households engaging also in inland fisheries in relevant areas.

Census frame

The census is generally undertaken in one of three ways: using a list of agricultural holdings, a list of households or an area frame.

Listing all the agricultural holdings to be enumerated requires screening the entire population within an area using a short questionnaire requesting information such as area cultivated, number of animals and responsible persons. Lists of holdings or holders available at administrative offices are frequently incomplete and out of date and unsuitable for census enumeration. A population census taken shortly before the agricultural census is an important source to provide a first draft listing. Countries without maps and other independent sources generally include a few screening questions on the population census questionnaire. Countries lacking these sources may have to prepare a new listing of households and holders within households to identify the holdings for each selected enumeration area.

Whereas inland fishing activities can be easily accommodated in listings of households and area frames, the identification in a listing of holdings would require refinements to take into consideration that a significant land area is not an indispensable input in inland fishery production.

Many countries use the annual-households approach for establishing listings of economic units and keep them up-to-date before conducting an agricultural census. The success of any census or survey depends to a large extent on the quality of the frame used to identify the statistical units in the population. The ideal situation would be to have a complete list of all statistical units, with prior information for each of them on particular characteristics of interest, before starting.

Based on emerging requirements for alternate aggregations, the splitting of existing class 0500 (Fishing, fish farming and related service activities) was recently approved[4]:

0501 -Fishing
0502 -Fish farming

This distinction between capture fisheries and aquaculture (fish farming) is relevant in view of their different structure, resource basis and technology. However, neatly separating the two

information for each of them on particular characteristics of interest, before starting the census or survey. Registers of statistical units (*e.g.* agricultural holdings, agricultural service establishments, or households, administrative records of fishers groups and licence holders) are not generally available in most countries. Consequently, many surveys are based on multi-stage sampling schemes due to insufficient prior information on sampling units.

Economic activities in agriculture and fishing

The scope of an agricultural census includes fishing and related activities if carried out on the holding, although economic units engaged solely in fishing are not considered agricultural holdings and are therefore generally excluded from the census[3].

In connection with the FAO WCA 2000 programme, special guidelines were developed to expand the scope of the census to collect structural information on aquaculture and assist countries in improving their current aquaculture surveys or provide a framework for those countries intended to develop an information base on aquaculture. A similar approach may be used for inland fisheries.

The essential features of the economic activities carried out by agriculture production units can be outlined with reference to the UN International Standard Industrial Classification of All Economic Activities (ISIC), which also provides a framework for the international comparison of national statistics. ISIC Rev. 3 separates fishing from agriculture and forestry:

A -Agriculture, hunting and forestry

- 01 - Agriculture, hunting and related service activities
- 02 - Forestry, logging and related service activities

B - Fishing

- 05 - Fishing, fish farming and service activities incidental to fishing

activities may pose particular problems in inland fisheries where activities may be integrated and interrelated (*e.g.* stocking, fertilization, predator removal etc.).

ISIC is activity-based and at present does not provide for a subdivision between marine and inland fishing. Whereas in landlocked countries all capture fisheries are from inland waters, in countries adjacent to marine waters, the expansion of one digit to provide for a sub-division between activities undertaken in marine and inland waters may be relevant if countries have important freshwater bodies, either entirely owned or shared, that sustain fishing activities.

The ILO International Standard Classification of Occupations (ISCO-88) was developed to serve as a model for countries revising their national classifications and to facilitate international comparisons of occupational statistics. It provides for reporting employment according to the following categories[5]:

- Aquatic-life Cultivation
- Inland and Coastal Waters Fishing
- Marine Deep-sea Waters Fishing

National occupational classifications where fisheries are of significant economic importance should retain such categories and also consider the separation between inland and marine coastal fishing as appropriate[6].

The FAO WCA 2000 recommends that the following information should be collected in identifying the economic activity of a holding and the main purpose of its production:

ECONOMIC ACTIVITIES

Whether holding is part of an enterprise engaged also in other economic activities
Other economic activities of enterprise

- Agricultural services
- Hunting, trapping and game propagation
- Forestry and logging
- Fishing
- Manufacturing

PURPOSE OF PRODUCTION

- Producing mainly for home consumption
- Producing mainly for sale

Fishing - as a producer of food commodities and as a provider of food and income to agricultural households - is relevant to food and agricultural decision-making of agricultural production units.

In eliciting the purpose of production, "mainly" means more than half of the production of the holding. Essential and desirable census items related to inland fisheries may be identified similarly to those for aquaculture in the category "other activities" as proposed below:

Other Activities: (identifies holdings carrying out forestry, fishery and other activities simultaneously with agricultural activities).

FISHERIES

Existence of Fisheries Activities On Holding

Whether fish or other aquatic animals and plants are taken from the waters within the holding or accessible to the holding

- Source of fishing
  - Lake, rivers, canals
  - Reservoirs
  - Ponds
  - Other (specify)
- Method of fishing (Boats/Gear)
- Kind of product
- Value of sales

Aquaculture Installation

Indication of type of aquaculture installation used for fisheries

- Pond
- Rice fields
- Other (specify)
- Kind of products
- Value of sales

Based on the environment definition, freshwater fisheries would include activities undertaken in water bodies of constantly low salinity[7] and include, for example, reservoirs, rivers, canals, lakes, and paddy fields. With the inclusion of such items, after the census is taken, the tabulation programme would provide the number of holdings, which undertake inland fisheries activity and hold cultural installation, according to their type, kind of product (and as a desirable item, the annual value of sales). A programme of cross tabulation for holdings that carry out fishery activities may also include the area of the holdings, the purpose of production and may be cross tabulated with holders legal status, age and sex. Further reference may be with the use of freshwaters on the holding for irrigation.

Refining the household concept to accommodate inland fishery concerns

In most countries issues like taxes, subsidies, price control and programs related to poverty alleviation are being decided in isolation without studying their direct and indirect effects on different sectors of the economy. A more in-depth analysis of the economics of agricultural households, which are at the same time consumers and producers, is in order.

As fishing and agriculture are primary activities often seasonal in nature, households may undertake other economic activities to secure their income. It is important to understand the inter-relationship between farm activities and eventual non-agricultural activities and the data that need to be generated. Such data are essential for the successful implementation of plans and also to assess the impact of governmental policy decisions related to the levels of living of households dependent on agriculture and fishing. The required data can be collected through household surveys after appropriate consideration of concepts and definitions.

The need to consider all types of activities in an integrated frame has been recognised by the 1993 System of National Accounts (SNA), putting greater emphasis on the use of the accounting macro-framework for organising the database, rather than as a tool for compiling macro-economic aggregates. While studying economic aspects of an institutional unit or an establishment it is rarely

feasible to find in real life a unit that is solely devoted to the farm activity as defined in the ISIC. Most likely, income of the unit will cover income derived from primary, secondary and ancillary farming activities as well as non-farming income. This is mainly because it is not often feasible to separate inputs, labour and assets according to the individual economic activity.

Where the focus is on agricultural and fishery households, it is necessary to go beyond the macro-framework given by the SNA and attempt sub-sectoring of the households. In this respect, ISIC Rev. 3 states that: "Ideally the principal product of the unit should be determined by reference to the value added of the goods sold or services rendered. In practice, it is generally not possible to obtain such information for individual products. It is therefore recommended that the principal kind of activity be determined by the gross output of the unit that is attributable to the goods or services associated with these kinds of activities. Where this method is not applicable, the principal kinds of activity should be determined from the proportion employed in these activities".

Interest should first be focussed on households whose income and resources are derived primarily from their own agricultural and fishing production. Thus, a fishery-dependent household should be defined as a household that derives its largest source of income from fisheries.

Using the approach of classifying households according to the prevailing product or prevailing source of income would permit a post-stratification of households where fishing activities are known to be prevalent or contribute significantly to the household livelihood. This economic concept should be cross-checked with spatial stratification based on the location of villages (*e.g.* proximity to lakes, large reservoirs, rivers etc.).

After clustering villages according to their location, a post-stratification of the production units is required, based on the relative number of people doing fishing activities and relaying on fishing for their livelihoods according to the relative proportion of fish sold to that of fish consumed. This listing would be the frame from which samples can be drawn to study in greater depth aspects of inland fishing activities through small cost-efficient surveys.

The information requirements of the inland fishery sector are often neglected by national statistics offices.

Main issues and considerations for future action

The information requirements of the inland fishery sector are often neglected by national statistics offices as well as by core statistics units of Ministries of Agriculture. Although logistical and operational problems may increase the cost of the systematic collection of inland fisheries data, it is recognized that biological, social and economic information is becoming increasingly critical for policy assessment and when environmental issues are locally emerging.

Since the sustainability of many government statistics programs is threatened by resource shortages, efforts should be made to better co-ordinate national statistics programmes to ensure the appropriate coverage of inland fisheries in agricultural censuses and rural household surveys between responsible units (typically the Department of Fisheries and the National Statistics Office). This will result in substantial improvements in the availability of data.

It is important to establish suitable frames for undertaking inland fisheries sample surveys. Where fishery censuses are conducted or where licensing and pond ownership is compulsory, the listing of economic units may originate from administrative registers (*e.g.* fishers co-operatives, license registers). However, even if listings can be obtained as by-products, their year-to-year maintenance may be costly. In countries where farmers extensively engage in fishing, population census and agriculture census frames are already integrating some fishery concerns, however not to the level of differentiating between marine and inland environments.

A population census may provide a frame of agricultural households for the agriculture census, and the latter provides an updated frame for other surveys whose statistical units are agricultural holdings. In mixed-type farms, agricultural censuses collect information on secondary and ancillary activities of the holding, including fishing. In countries where inland fishing is an important source of food the census may generate relevant socio-economic information on the activity of fishery households. There is a need for better exploiting census related activities that can be beneficial to inland fisheries and aquaculture surveys.

Annual household surveys and the analysis of household farm income permit post-stratification of villages where fishing is of economic relevance.

Annual household surveys and the analysis of household farm income permit post-stratification of villages where fishing is of economic relevance. Further work is required by agriculture and fishery statisticians to identify concepts and data requirements suitable to inland fisheries in ongoing surveys.

Due to the nature of inland fisheries there is no single method of data collection to be efficiently used, but a combination of methods according to specific needs. Inland fishery data collection methodology through objective area-measuring and yield-estimation would benefit from the agriculture experience.

Improvements to data quality and reliability may come from the systematic use of sample techniques in collecting commercial capture inland fisheries data and the use of occasional surveys for estimating the semi-commercial and subsistence components.

The validation of fishery production statistics may, from time to time, benefit from the conduct of consumption surveys. These surveys do not permit validation of data such as seasonality and method of production unknown to consumers. Market survey data are bound to produce reliable trend indications of production but under-coverage of total production due to self-consumption. Household socio-economic surveys may provide valuable information from the demand side.

In planning for the implementation of an improved information system it must be recognized that every country has a statistical system in place to begin with and which is generally considered adequate to meet perceived data needs (national and international) and commensurate to the resources available to implement it. Therefore, the implementation of a new system or a new component should not be a question of scrapping what already exists but rather a transition from one system to another.

It must be equally recognized that a fishery information system is but a subsystem of a national information system. Statistical problems exist in different countries with differing degrees of severity and with emphasis on different causes and effects. The roots of the problem lie with inadequate national efforts of an interdisciplinary, inter-ministerial and continuing nature in the development and operation of an information system to support effective government interventions in the sector.

Future challenges include the maintenance of an information system to sustain decisions for improvement of rural livelihoods, farm incomes and food security (especially in food-deficit and marginal areas) to address increasing relative poverty of the resource-poor areas which are more favourably endowed with fish resources and an improved information basis for conservation and management decisions concerning inland fisheries and their interactions with the ecosystem.

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Footnotes

[1] Although complete enumeration is the predominant method in agricultural censuses, it is sometimes replaced by sample enumeration when resources are limited.

[2] Ideally a census should include all holdings; however for practical reasons it may be necessary to limit the enumeration to holdings that conform to certain recognized criteria and fall above prescribed minimum size limits. In expanding the scope to fisheries there should be no minimum limits on the land area.

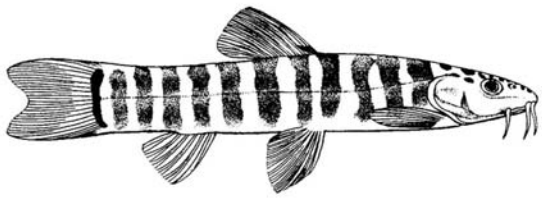
[3] Increasingly, some countries, notably small island countries, integrate fisheries in the Census of Agriculture.

[4] Technical Sub-group of the Expert Group on International and Social Classifications, New York, 26-30 March 2001.

[5] Minor Group 615 of Major Group 6 "*Skilled Agricultural and Fishery Workers*". The sub-division into *market-oriented* and *subsistence* workers reflects differences in the degree of market orientation, correlated to e.g. differences in the organization of the work, credit, technologies, types of marketing arrangements for the products. Subsistence workers may market a part of their produce to obtain cash.

[6] This would trigger information in population censuses, which generally include "occupation" as a variable

[7] Or any other national definition of inland fisheries as applicable.



CASE STUDY

"The current top-down approaches to manageing fisheries resources in the three countries have met with great difficulties."

Improving Fisheries Catch Statistics in Lake Victoria

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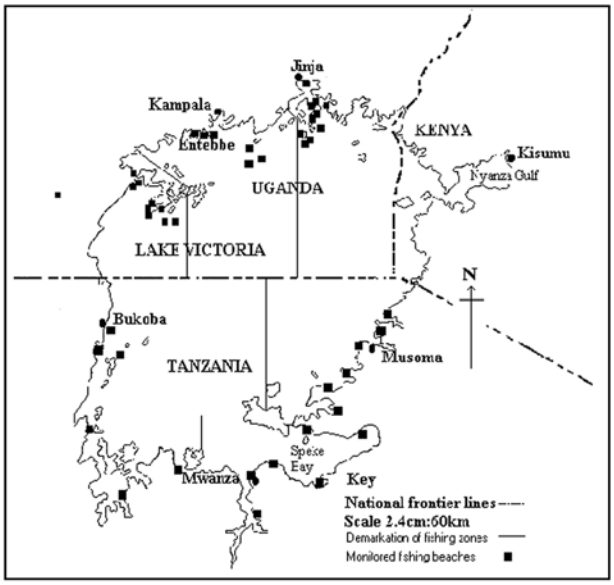


Figure 1. Lake Victoria showing international boundaries

Lake Victoria is one of the African Great Lakes and the second largest lake in the world covering 68 000 km^2. The lake is shared by Kenya (6% by area), Uganda (43%) and Tanzania (51%) (Fig.1). It has a mean depth of 40 m, maximum depth of 84 m, shoreline of 3 450 km, a water retention time of 140 years and a catchment area of 193 000 km^2 and extends into Rwanda and Burundi.

Over 30 million people live in the Lake Victoria Basin and depend directly or indirectly on the lake's resources. Fisheries contribute up to 3% to the GDP of the riparian states and they are major sources of income, food, employment and foreign exchange earnings. Fish from Lake Victoria is the most important source of affordable protein in East Africa and the most important source of freshwater fish on the African continent. The fishery is diverse and highly dispersed and fragmented with about 1 500 landing sites and more than 120 000 fishers. The lake is also important in conservation terms because of the great biodiversity of endemic fish species. Additionally, the lake is an important moderator of regional climate.

The lake fisheries are diverse, dispersed and catch information is inadequate for supporting management. The Lake Victoria Fisheries Research Project (LVFRP) was established in 1997 to assess the status of the fisheries and the strategies employed provide a good case history for comparison with the situation in the Mekong River. This paper describes the status of the fishery and data recording systems prior to the LVFRP programme and the strategies adopted to improve the monitoring of the fishery.

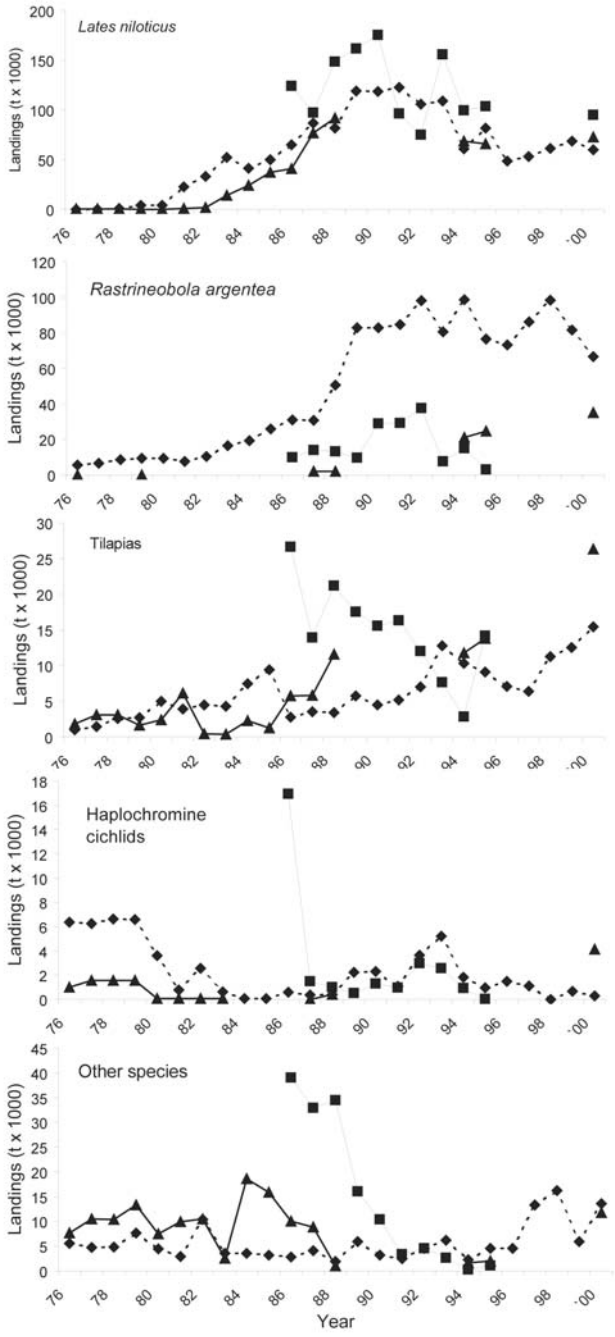
Production trends

Until the 1970s, Lake Victoria supported a multi-species fishery dominated by tilapiine and haplochromine cichlids. There were important subsidiary fisheries for more than 20 genera of non-cichlid fishes, including catfish (*Bagrus docmak* (Forskåll), *Clarias gariepinus* (Burchell), *Synodontis* spp. and *Schilbe intermedius* (Rüppell), the lungfish (*Protopterus*

aethiopicus (Heckel) and *Labeo victorianus* Boulenger (Kudhongania and Cordone, 1974).

Signs of overfishing were reported as early as the 1970s when catch rates for the native tilapiine fish of Lake Victoria, *Oreochromis esculentus* and *Oreochromis variabilis* were reduced by selective fishing and the failure to control fishing effort (Jackson, 1971). These fishes were originally the backbone of the commercial fishery,

Figure 2. Trends in landings (tonnes) of major fish species and species groups in countries of Lake Victoria (♦ Kenya; ■ Tanzania; ▲Uganda)



Stocks of most of these species further declined and others disappeared following the introduction of four tilapiines during the 1950s (*Oreochromis niloticus* (L.), *O. leucostictus* (Trewavas), *Tilapia rendalli* Boulenger and *T. zillii* (Gervais)) and Nile perch (*Lates niloticus* (L.), the contribution of haplochromines (cichlids) to fish biomass decreased rapidly from 83% during the 1970s to less than 1% by the mid-1980s (Fig. 2). This was due in part to predation by Nile perch. *Oreochromis niloticus*, on the other hand, hybridised and competed for food and space with *O. variabilis* and *O. esculentus,* leading to the decline of endemic tilapiines. It is believed that more than 60% of Lake Victoria's endemic fish species became extinct between 1970 and 1986, with the remaining species reduced to insignificant levels (Fig. 2). The establishment of the Dutch Government sponsored Fish Meal Plant in Mwanza in the 1970s also contributed substantially to the decline of the haplochromines in the lake since the factory targeted this fish group.

The Lake Victoria fishery has changed from the complex multi-species fishery of the late 1970s to one dominated by three species, namely the introduced *L. niloticus* and *O. niloticus* and the native cyprinid species, *Rastrineobola argentea* (Pellegrin) (Fig. 2). In Kenya, total fish landings increased from about 19 000 tonnes in 1977 to approximately 220 000 tonnes in 1992 due to increases in the contribution of Nile perch. Catches have now fallen to around 160 000 tonnes as a result of a fall in catches of Nile perch. In Uganda, total fishery yield increased from 11 000 tonnes in 1977 to 120 000 tonnes in the early 1990s. This was again due to an increase in the contribution of Nile perch. The data for the 1990s are fragmented and no discernible trends are possible, except landings in the year 2000 were in the order of 141 000 tonnes. In Tanzania, the quantity of fish landed increased from 72 000 tonnes in 1983 to 231 000 tonnes in 1990, again due to landings of Nile perch increasing from 274 tonnes in 1981 to 175 000 tonnes in 1990. Poor quality catch assessment data have prevented any evaluation of trends in yield in recent years.

It was the Nile perch fishery that created a remarkable stream of economic benefits. These benefits included an expansion of the artisanal fishing industry and availability of Nile perch to consumers in the region to the development of a multi-million dollar export industry for chilled and frozen fillets. In 1994, revenue from fish landings in Uganda was US$ 77.13 million, whilst in Kenya in 1998 it was US$ 80 million. For the same period in Tanzania, revenue was US $200 million (SEDAWOG, 1999).

However, since the mid-1990s, the dominant Nile perch has shown signs of decline. Changes in the efficiency of fishing gear, motorisation of canoes and an increase in total fishing effort to maintain production were observed. The intensity of the fishing pressure is evident from the results of a frame survey carried out in the year 2000 (Table 1). Extension of fishing grounds was also evident, but all against a continued decrease in catch per unit effort and mean size of fish caught (Mkumbo and Cowx, 1999).

This decline in the Nile perch fishery has been mirrored by an expansion in the less profitable *Rastrinbeobola* fishery. Recent studies have revealed that some species feared extinct (*e.g.* zooplankton-feeding haplochromines) are reappearing in the lake and posing a threat to *R. argentea* whose food requirements are similar.

Table 1. Summary of Frame Survey 2000 showing distribution of landing sites, crafts and gear (values in brackets are density by country per km^2)

Item	Kenya	Tanzania	Uganda	Total
Area km^2	4 080	34 680	29 240	68 000
Landing sites	297	596	597	1 490
Fishers	33 037	56 060	34 889	123 986
Canoes	10 014	15 489	15 544	41 047
Gillnets total	125 221	225 803	297 663	648 687
Long lines (hooks)	972 087	2 212 571	254 453	3 439 111
Beach seines	5 245	1 019	811	7 075
Cast nets	4 418	46	1 276	5 740
Hand lines	27 789	13 238	4 585	45 612
Traps	3 192	2 553	11 349	17 094
Scoop nets		807		807
Dagaa seines		22		22
Lift nets		315		315
Mosquito seines	11 265	3 267	2 452	16 984
Engines	494	1 530	2 031	4 055
Other gear	1 706	15	71	1 792

Attempts to manage Lake Victoria's fisheries date from 1927 when Graham (1929) conducted the first fishery survey. At that time it was noted that the gill net fishery was negatively affecting the stocks. Thus a minimum mesh size of 5 inches was set in 1933. In 1947, management and research of the lake's fisheries were placed under the Lake Victoria Fisheries Service (LVFS). LVFS was dissolved in the early 1960s. With the collapse of the East African Community (EAC) in 1977, the Food and Agriculture Organization of the United Nations (through the CIFA sub-committee for Lake Victoria) continued to co-ordinate the activities of the riparian states on Lake Victoria's fisheries. FAO also assisted the three riparian states to establish the Lake Victoria Fisheries Organization (LVFO) in 1995.

Strengths and weaknesses of data collection system

At first glance, the trend analysis provided in the previous section suggests that the fishery is well monitored and adequate information is available on catch statistics. Closer examination of the data reveals numerous weaknesses with the output, most notably the lack of realistic statistical data for Uganda and Tanzania, the two countries that represent 94% of the lake surface area. The situation in Kenya is slightly different because all landing beaches are monitored by KMFRI and total estimates of catch are available, although the quality of the data is variable (see later). The weaknesses in data collection and their root causes are as follows.

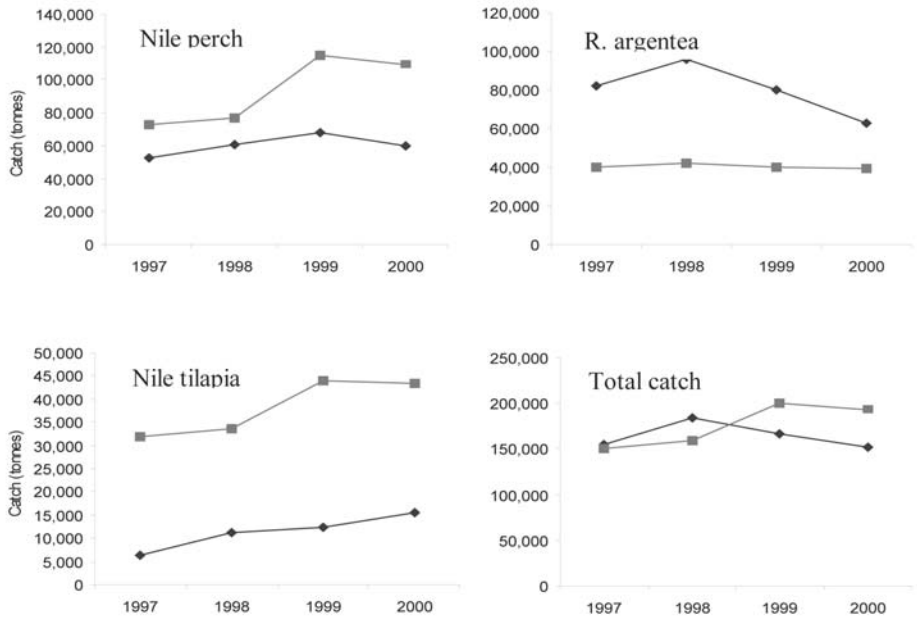
Catch assessment surveys

It is impossible to make a total count of the fish catches in a highly diverse and dispersed fisheries such as found in Lake Victoria, and indeed the Mekong. The very nature of a fishery with many landing sites and use of semi-commercial and subsistence fishing prevents such an enumeration. The traditional way of assessing a fishery in these circumstances is to promote either a representative or random sampling strategy of the landing sites (catch assessment surveys) to obtain estimates of catch per unit effort and then raise the sampled catches by a value of overall fishing effort (frame survey data). In Lake Victoria, until recently, this has failed for a number of reasons and no reliable catch statistics have been available in Uganda or Tanzania since the mid 1990s.

Catch recording

With the exception of Kenya, site recording has been inadequate or non-existent. In Uganda, decentralization of the local fisheries staff to the districts in 1995 resulted in loss of control of their duties by the central Fisheries Department. As a consequence, no beach recordings have taken place since that time. The only records are for fish that pass through the larger beaches and are usually destined for the processing factories. These records remain at the district offices and are not collated nationally. In Tanzania the situation is somewhat different but with the same outcome. Here a beach recording is operational and records are centrally collected by the Fisheries Department. However, the quality of the records is dubious, the overall output is unreliable and no national report is produced. This is somewhat surprising because the Tanzanian Government imposes a 6% levy on catches so they are losing revenue through poor recording. However, the imposition of the levy means fishers tend to avoid traditional landing beaches. In Kenya, a comprehensive beach recording system is carried out by the Kenya Marine Fisheries Research Institute (KMFRI) and duplicated by the Fisheries Department, although not on the same scale. The results from the two sources are conflicting (Fig. 3), instilling little confidence in the results. In all three countries the main problems with the beach recording systems are lack of financial resources and poor motivation of staff. The staff have no incentive to record information accurately because they are poorly paid, if they are paid at all.

Figure 3. Comparison of Kenyan catch statistics from the Fisheries Department (■) and KMFRI (♦)



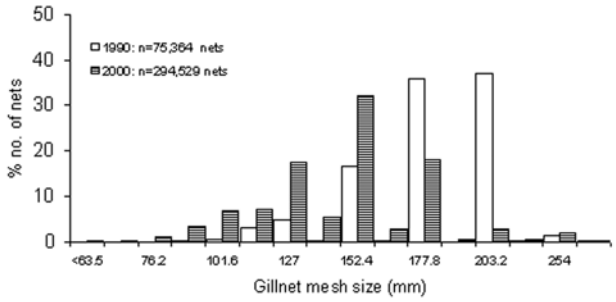
Estimation of fishing effort

One of the key elements for assessing a complex fishery such as found on Lake Victoria is an estimation of the effort expended. This is usually done through a frame survey, which must be updated at regular intervals to ensure changes in fishing effort are known (Sparre and Venema, 1998). For a dynamic and rapidly changing fishery such as in Lake Victoria, a biennial frame survey is deemed necessary. Prior to the start of the LVFRP the last frame survey in Uganda was in 1990 (Tumwebaze and Coenen, 1991) and in Tanzania partial surveys were carried out in 1990 and again in 1995 (Mkumbo and Cowx, 1995).

These surveys were poorly conducted and the results were never fully analysed because of the lack of resources or suitably qualified personnel. In Kenya, the need for a frame survey is less prominent because of the total coverage of the beaches. The frame surveys carried out are also considered weak because they were not harmonised between countries and are conducted at completely different times. This is an important issue because the fisheries in each country do not abide by national boundaries. Kenyan fishers in particular fish extensively in both Ugandan and Tanzanian waters. This is patently obvious from stock assessment surveys carried out under the

LVFRP where the annual catches for Kenya exceed the total fish standing stock by some 50% (Cowx *et al.* 2002). The main reasons for regular frame surveys not being undertaken or reported were lack of financial and human resources,

Figure 4. Changes in the numbers and mesh sizes of gill nets in Ugandan waters between 1990 and 2000 to illustrate the increase in fishing effort with time and change in gear usage.



inadequately trained staff and poor motivation. The upshot is that estimates of catches in the late 1990s were based on outdated frame survey data (Fig. 4) and do not account for the major shifts in the fishery that have evolved because of overcapacity within the fishery. This would include changes in types of gear used (types as well as mesh sizes of gill nets) and their modes of operation (*e.g.* active versus passive use of gill nets; see for example).

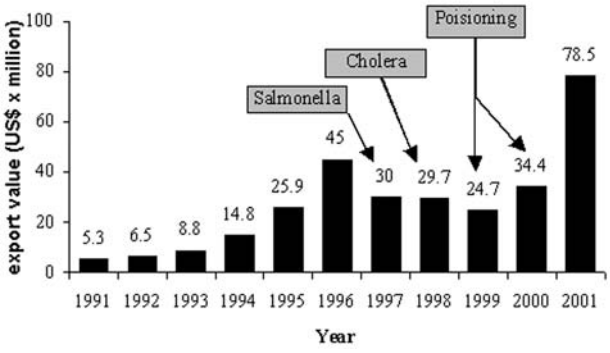
Export market chain

Export figures are one source of information that can provide potentially reliable capture statistics. In the past this has created problems because the processing factories are reluctant to reveal their revenues or indeed give an accurate picture of their export volume. Since the majority of the export is freighted out of the region by air as chilled fillets, volume can be determined from shipping company records (Fig. 5). The problem arises from conversion factors from fillets to whole fish and the records only refer to the most valuable species, Nile perch. However, a percentage take of 41% of the flesh was determined from work in the factories so the volume exported can be converted to wet weight of fish. Notwithstanding these problems, export figures are potentially a valuable source of accurate data.

Illegal fishing

In recent years the catches of Nile perch in Lake Victoria have declined. This is coupled with a declining catch per unit effort (Cowx *et al*. 2002). One of the traditional responses in a poorly regulated fishery is for the fishers to move towards smaller mesh nets and use illegal gear which exploits smaller fish. Such a response is in progress on Lake Victoria. There is now a high proportion of illegal gear types being used on the lake, both in form of illegal sized meshed nets and banned gear types. Some 17% of gill nets are below the legal mesh size of 5 inches and some 30 000 seine nets, a prohibited type of gear, are being used around the lake. Until recently, some 15 trawls were also being illegally operated in Kenyan waters, but these have been outlawed. Part of the problem stems from the processing factories attempting to meet demands from export markets. These markets are highly

Figure 5. Total value of Uganda annual fish exports from 1991 to 2001. The grey boxes indicate the major reason for the EU ban of fish imports from Uganda in 1997 to 2000.



lucrative but are now demanding fillets from smaller fish because they are less fatty. As a consequence, the factories are supplying smaller mesh sized nets to fishers tied into financial and supply agreements. Much of the very small fish caught in these nets is not recorded and is siphoned off to other markets (see below).

Unreported or unrecorded catch

International demand for Nile perch is the engine driving the fishery (Fig. 1). The huge quantities being exported from the region have undoubtedly

pushed up the beach price for fresh fish and made the product too expensive for the local populace. Waste and small sized fish rejected by the processing factories find their way into the local markets, but all too often this supply chain is unrecorded. In addition, a large proportion of the fish not accepted by the processors is being exported to the DR Congo, Rwanda and other countries. These fish are usually small and caught with illegal gear so bypass any recording system. It has been estimated that this component could represent up to 20% of the total catch. These fish are transported by road and do not pass major urban centres where some control could be made.

Dried, smoked and fried fish products provide the basis of an extensive trade in low cost fish protein that find their way into low income households. There is also an extensive subsistence fishery around the lake especially for households living close to the shore. These fish are not counted in traditional recording systems. Finally, one component of the catch that is not considered is for bait for the extensive longline fishery for Nile perch. There are an estimated 3.5 million longline hooks (Table 1) continuously being used, which need baiting on a regular basis. The modes of operation and bait species used vary between countries (haplochromines in Tanzania and Uganda, and *Clarias* in Kenya) but it was estimated by Cowx *et al.* (2002) that some 5 700 tonnes of fish are caught by hook and line or in seine nets to support this extensive fishery. This catch is not recorded.

Management has been command driven from central government departments or agencies and this has in part led to many of the problems within the fisheries, including the poor quality of statistical data collection.

Catch recording and administration

Until recently it has been the responsibility of national governments to coordinate data collation and reporting. As reported above, this has proved ineffective and the recently established LVFO (2000) has been charged with coordinating the data collection on a regional scale. However, without the raw material it is difficult to see how this could be achieved. The problem is made worse because there is no national or regional database in which to store and process the data. To date, all data are held in paper form and only secondary processing is carried out on computers. This inevitably leads to transcription and calculating errors. Again this is evident from the Kenyan problem where the Fisheries Department and KMFRI report different catches.

Role of the fishing communities

One underlying factor that previously has been ignored with respect to the management of the fisheries of Lake Victoria is the role of the fishing communities. Management has been command driven from central government departments or agencies and this has in part led to many of the problems within the fisheries, including the poor quality statistical data collection. The lack of involvement of the fishing communities can only be seen as a retrograde step because they are the source of the information. The central control driven management has led to general distrust and non-cooperation with the fisheries departments, and therefore the communities provide no support for the statistical collection procedures. Overfishing and the use of damaging or illegal fishing gear is only in part a reflection of the failure of centralised management strategies on the lake and the lack of feedback from 'research results'. The communities themselves recognise that the fishery is overexploited but unless they are informed of the status of the stocks in relation to catch statistics they cannot be expected to respond to vague calls for them to reduce the amount of fish harvested. There is thus a clear need to address problems in data and research dissemination, and consideration must be given to exploring ways of relaying such information to stakeholder groups. The trends described above represent a grave threat to the sustainability of Lake Victoria's fisheries. It will only be with the support of the fishing communities that sustainability of the fishery is an achievable objective.

The way forward

As can be seen from the above description, fisheries statistics for Lake Victoria are both inadequate and unreliable. It is imperative that these statistics are improved because the resources represent a valuable commodity to the riparian states both in terms of export earnings from the Nile perch trade and as a source of income, employment and protein for the local people. If the current decline in the fishery is allowed to continue it could lead to considerable social hardship for the people dependent on the fishery for their livelihoods and source of protein. The need to manage the fishery on a sustainable basis is therefore paramount but this cannot be achieved if information on the exploitation patterns is not forthcoming. To resolve this issue the LVFRP has put into place, coordinated, or collaborated in a number of actions. These include improved fisheries data collection systems, a regional fisheries and environmental database and co-management initiatives to manage the fishery.

Fisheries data collection systems

The institutions in the region charged with management and research on fisheries are all under-funded. In most cases the funds received from the central government pay only the salaries of employees. This leaves no funds to undertake research and management activities including monitoring, control and surveillance (MCS). There are no funds to purchase equipment or to employ additional research and management personnel. Consequently, any fisheries monitoring programme has to function on limited resources and be cost effective. Under the LVFRP, simple cost effective data collection systems were designed that provide the minimum of data to support management initiatives and meet the statistical reporting requirements of the countries. The programme is multifaceted to allow cross validation of the outputs.

Fisheries dependent survey programme

With the exception of Kenya, the existing catch assessment surveys are woefully inadequate. Consequently, one of the primary objectives was to promote efficient catch assessment data surveys linked to regular frame surveys. This was achieved on two fronts.

A regional task force was established to set up a frame survey of the lake to assess patterns in fishing effort. This involved setting up an appropriate questionnaire that was sufficiently comprehensive to provide the information required but not too complex to make it unmanageable to complete in a short time or extract the data.

Ultimately, accurate fisheries catch statistics are fundamental to the sustainable management of any fishery.

Several workshops were conducted to train regional representatives and then enumerators, who were often senior members of the local fishing communities. The frame survey was conducted lake-wide over two days in March 2000 and repeated in June 2002. A summary of the output of the 2000 frame survey is given in Table 1 and was considered to be the most comprehensive survey of the fishery carried out to date. The lake-wide coverage over a very short time reduces possible double counting of boats and gear types, especially because there is considerable cross-border fishing. The biggest problem was accounting for the fishers and gear that stays permanently on the lake and is not returned to the landing beaches. This was partially overcome by involving the local communities who were able make best estimates. Notwithstanding the success of the frame surveys they were carried out at considerable cost. The initial set up costs were high and funded from regional development projects, although the cost of training staff and implementation of the 2002 survey was much lower.

The frame survey was carried out in conjunction with a dedicated catch assessment survey. This was set up from scratch in Uganda and Tanzania because the existing surveys were defunct, whilst the Kenyan survey was formalised to improve the reporting procedures. In Tanzania and

Uganda, a stratified random survey was difficult to implement because smaller landing beaches change over time. The surveys were therefore based on a set number of fixed beaches in each country, which could be surveyed appropriately on a regular basis. Each country was divided in three zones (Fig. 1) and a number of landing beaches were surveyed in each zone each month. In total, 18 beaches were surveyed on a three-monthly basis in Tanzania and 25 in Uganda (Fig. 1). Thus six beaches were surveyed per month in Tanzania and eight in Uganda. Although the number of beaches was small, this was the minimum that would provide coverage of the fishing patterns. The beaches were selected to represent:

- Fishing in the major ecological zones, from shallow inshore waters to deep offshore waters
- Landing sites specialised in either of the major commercial fisheries, i.e. Nile perch, Nile tilapia or *R. argentea*
- Landing sites with a wide variety of fishing gear and methods including beach seining, long lining, hand lining, cast netting, mosquito seines for *R. argentea*, and gill netting by both large motorised boats and small paddled boats

Neyman allocation was not used to select the beaches as this proved unrealistic. During each survey the catch per species was recorded in relation to the boat type and gear and number of boats operating. At each beach, approximately 100 fish of each of the major commercial species were measured to assess the population dynamics. The surveys took about 10 days each month. The output for Nile perch in Tanzanian waters is given in Table 2. Similar data were available from the Tanzanian Fisheries Department, the official agency responsible for data collection.

In addition to the regular CAS, it is proposed that observers are placed in the 27 processing factories situated around the lake. These persons can record both the volumes of fish entering and leaving the factory. These data will provide valuable insight into production trends and help validate the outputs from the catch assessment studies. They will also be able to collect basic biological information on the fish populations (*e.g.* length distributions, reproduction characteristics), which can be used to support management decision-making. They will also monitor whether the factories are complying with regulations on harvestable sized fish. Recently a regulation was passed whereby only fish of a slot size between 50 and 85 cm could be processed in an effort to reduce fishing pressure on juvenile fish and large mature adults. It is recommended persons enforcing the regulation should be changed regularly so they cannot be corrupted in their duties.

The efficiency of the catch assessment surveys was tested by comparing the outputs from the surveys against estimates derived from virtual population analysis and processing factory outputs adjusted for fish passing through other marketing channels in Uganda (Table 3). The similarity between the CAS and VPA outputs suggests that the former is a viable, cost effective approach, but it must be recognised that the work was carried out by a dedicated, highly motivated researcher. It is likely that less motivated, poorly-paid enumerators will not carry out the surveys with the same level of dedication and thereby compromise the accuracy of the results.

This is what happened in Tanzania, where the researcher lacked motivation and the quality of the output was weaker, despite intense supervision. Involvement of local fishing communities could help resolve this problem. The poor conformity of the processing factory data were because the EU imposed an export ban on Nile perch into Europe for most of 2000 because of problems with fish poisoning and the factories were operating at very low throughput (Fig. 5).

Fisheries independent survey programme

The research carried out has been mostly concerned with ecology and biology of fish species including limited stock assessment and limnology, which provides information only on trends in stock size and composition. There has

Table 2. Nile perch catch statistics from Tanzanian waters in the year 2000

Type of Fishery	Number of boats examined	Proportion fishing	CPUE (kg boat^{-1})	Estimated catch (t)	95% CL
Gillnet/motorized	1 217	0.78	73.19	25 359	8 870
Gillnet/sails	2 682	0.8	39.26	30 746	31 663
Gillnet/paddle	2 682	0.83	35.62	28 942	12 027
Longline/sails	1 790	0.78	46.40	23 646	22 357
Longline/paddle	1 074	0.78	51.50	15 747	6 543
Beach seines	994	1	29.94	10 864	14 858
Tilapiine fishery by catch	1 493	0.76	4.12	2 088	2 473
Dagaa fishery by catch	3 245	0.75	0.4	212	94
Total				**138 324**	

been very little attention to socio-economic criteria or methodologies in developing strategies proposed to tackle the issues of declining stock size and adverse species compositional changes. This shortcoming has contributed to managers being ill equipped and exacerbating problems associated with the failure to regulate and manage the lake fisheries. To overcome these problems, a set of research projects dealing with assessment of stock abundance and fish population characteristics as well as the socio-economic dimensions of the fishery were undertaken under the auspices of the LVFRP and in conjunction with the fishery dependent surveys. The biological surveys included regular trawl surveys in the riparian countries to estimate standing stock biomass and population characteristics such as population size structure, growth rates, mortality rates, size at maturity, plus six-monthly lake-wide hydroacoustic surveys to assess stock biomass and distribution. These surveys provided valuable support information on which to base policy decisions on fishery regulations. The socio-economic studies concentrated on marketing, poverty, nutritional status of the lakeside communities and the feasibility of introducing co-management initiatives for the lake fisheries. The latter studies were fundamental to establishing future management initiatives for the lake and the role the fishing communities could make to support assessment of the status of the fisheries.

Table 3. Comparison of the estimates of total annual catches of Nile perch and Nile tilapia from catch assessment data and length structured VPA in the Ugandan partof Lake Victoria in 2000

Species	Estimates from catch assessment (t)	Estimates from length structured VPA (t)	Processing factories
Nile perch	72 632	81 989	56 000
Nile tilapia	29 959	29 278	
Total	102 592	111 267	

Data dissemination and database management

Recent research programmes on Lake Victoria (LVFRP and LVEMP) have considerably improved the knowledge of fish stocks. It is essential that this information flow is maintained and continually upgraded if the resources are to be managed on a sustainable basis. Financial and human resources must therefore be made available to continually monitor the status of the stocks and to allow management processes to respond to changes in a timely and appropriate manner. Consequently, fish stock assessment, including analysis and timely reporting, is now a programmed activity by the research institutions in collaboration with the Fisheries Department and answerable to the Lake Victoria Fisheries Organisation (LVFO). The

LVFO is charged with producing reports to collate all available information on the status of the stocks, exploitation patterns and socio-economic indicators to aid formulation of policy. Reports are made accessible to all stakeholders and written in a language that both the layman and professional stakeholder can understand.

One of the key problems was the lack of an appropriate database management system. Consequently, a Database Management System for the Lake Victoria fisheries (SAMAKI) was developed under the auspices of the LVFRP. The system contains the following items:

- Publications database
- Frame survey database
- Fish-processing database
- Socio-economic database
- Catch assessment database
- Additional tables facilitating data entry and security

The core software is implemented in Access 2000. The Access platform was adopted because the computer facilities available in the region would not support a more complex system such as UNIX and it was recognized that continuous donor funds would be required to update a more complex system. The development of the system follows the common Windows approach for design of database systems. Attention has been paid to user friendliness of the system. All features and capabilities of the system are put under one user interface and there are no hidden or misleading facilities. The decision support system is designed in such a way that it gives full access to the entire dataset to the lowest level. Data mining is part of the same software that supports data entry and the user does not need to explore the data using separate software. There are several export facilities available to facilitate data transfer from the database to other popular applications like Excel and Word. One characteristic of the system is the spatial component of all the data entered into the system. The design enables the exploitation of the data using Geographic Information Systems. The system is designed to support the national level of the Lake Victoria Database Management System and is currently being extended to a Regional Database Management System.

Partnerships: Co-management

The current top-down approaches to managing fisheries resources in the three countries have met with great difficulties. These have included understaffing and poor motivation among others. Relationships between the lakeside communities and the fisheries departments also need to be improved. In an effort to address the problem, the riparian governments are looking to empower local communities to actively enter the management process, especially in the areas of the monitoring (data collection), surveillance and control of all activities associated with the fisheries economy. There is also interest both at the centre of government and the lake communities to take on the challenge of security and the fisheries management process. The proposed institutional framework to address this scenario is given in Fig. 6. The government of

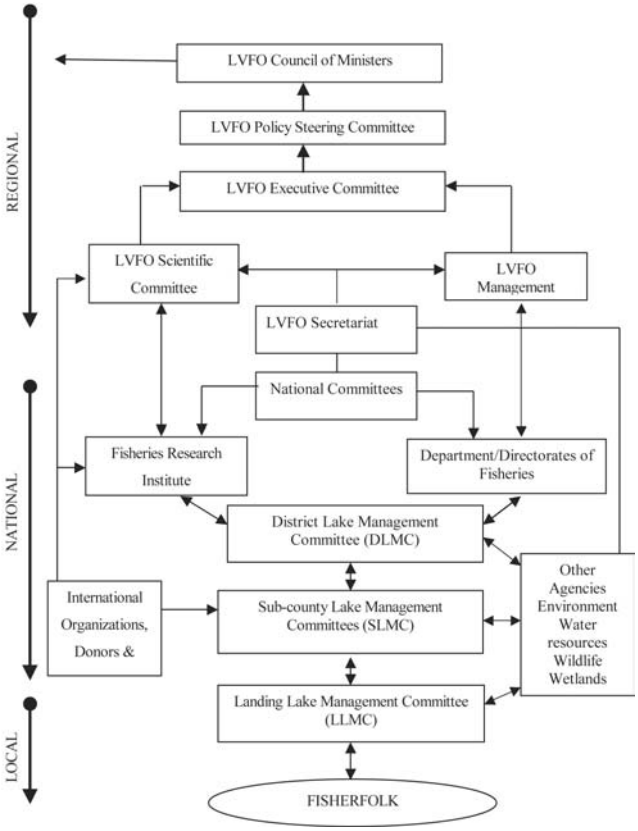


Figure 6. Proposed institutional framework for management of the Lake Victoria fisheries

Tanzania has set up Beach Management Units (BMUs) empowered to take on management functions at a local level. Similarly in Uganda there is interest in devolving powers to Landing Management Committees (LMCs). These interventions are at an early stage of development. So far in Kenya there has not been any measurable progress in either decentralising or devolving power to the lakeside fishing communities. It is important to note the government still remains central within any system of co-operative fisheries management since it is an effective source of legitimacy in rule making and enforcing. The co-management approach is expected to lead to lower transaction costs at the planning and implementation phase because fishers can provide information on fishing patterns, catches and the status of the resources (Sen & Nielsen 1996). The success of co-management will depend on political commitment on the part of the governments to fisheries management. This commitment would require support by appropriate legislation and adequate technical and financial resources. Under co-management, new institutions would have to be developed and this is a long-term process.

Conclusions

Lake Victoria is a valuable case study for assisting and improving inland capture fisheries statistics in the Lower Mekong Basin because the fishery characteristics are similar. Fisheries are diverse and dispersed and both regions face similar problems collecting data. Comparisons with the situation on Lake Victoria could provide valuable lessons for resolving some of the problems faced in the LMB and elsewhere. Ultimately, accurate fisheries catch statistics are fundamental to the sustainable management of any fishery.

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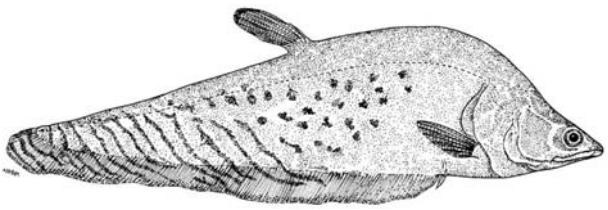

CASE STUDY

"Inland fisheries in most countries of tropical Asia are not managed scientifically."

New Approaches to Inland Capture Fisheries Statistics In Sri Lanka

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Fisheries statistics in most inland reservoirs of Sri Lanka are not accurate. However, some reliable data are accumulated in a handful of reservoirs through various research activities. Potentially these data could be used to revise official fisheries statistics in some reservoirs. In reservoirs where middlemen are involved in fish marketing, logbooks can be consulted to improve data on catch and effort. However, over 90% of the total fish landings in Sri Lankan reservoirs are comprised of *O. mossambicus* and *O. niloticus*, which usually do not have price differences and these logbook records are not maintained species-wise. Despite this limitation, reasonable estimates on total fish production in reservoirs and catch per fisher can be collected from these books. Also, fisheries co-operative societies are functioning effectively in some reservoirs. It might be possible to obtain participation of these fisher communities in scientific data collection. One effective method is to use G.C.E. (Advanced Level) qualified youth in each reservoir to collect data on fish production and fishing effort.

Empirical yield predictive models based on catchment features of reservoirs quantified by Geographical Information Systems (GIS) have high predictive power. In these models, the ratio of catchment land use patterns to the reservoir area or reservoir capacity is used as a predictor variable. Using these models, it might be possible to predict fish yields of individual reservoirs with some accuracy. As fish yield is linearly related to fishing intensity expressed as boat-days/ha/year, fishing intensity corresponding to fish yield predicted by GIS-based empirical models can be determined.

Introduction

Inland fisheries in most countries of tropical Asia are not managed scientifically. One of the greatest problems in the development of inland fisheries in Asia is the lack of sufficient knowledge of sustainable use of fisheries resources, possibly due to lack of reliable data (De Silva, 1987). Inaccuracy in fisheries statistics is a common problem in developing countries (Marr, 1982). It has been suggested that *fabricated returns* are

important to show that the policy pursued by the government for the development of the fishery is a success. Unfortunately, some statistical returns seem to be produced in this manner. Accurate catch and effort statistics are important for fish stock assessment and for planning social welfare programmes, economic analysis and human nutritional studies (Caddy and Bazigos, 1985). In this paper, published information on the inland fisheries of Sri Lanka is synthesized with a view to identifying new approaches for the improvement of inland capture fisheries statistics.

It has been suggested that fabricated returns are important to show that the policy pursued by the government for the development of the fishery is a success.

Brief review of the inland fishery of Sri Lanka

The inland fishery in Sri Lanka is essentially a capture fishery based on reservoirs. This is a relatively new development since the introduction of exotic cichlid species *Oreochromis mossambicus* into Sri Lankan freshwaters in 1952. The growth of the fishery and its recent trends have been detailed by Fernando and Indrasena (1969), Fernando and De Silva (1984), De Silva (1983, 1988) and Amarasinghe (1992, 1994, 1998). Reservoir fisheries are characterized by: (a) the use of non-mechanized fibreglass canoes, (b) use of gill nets and (c) the predominant catch is exotic cichlid species, *O. mossambicus* and *O. niloticus*.

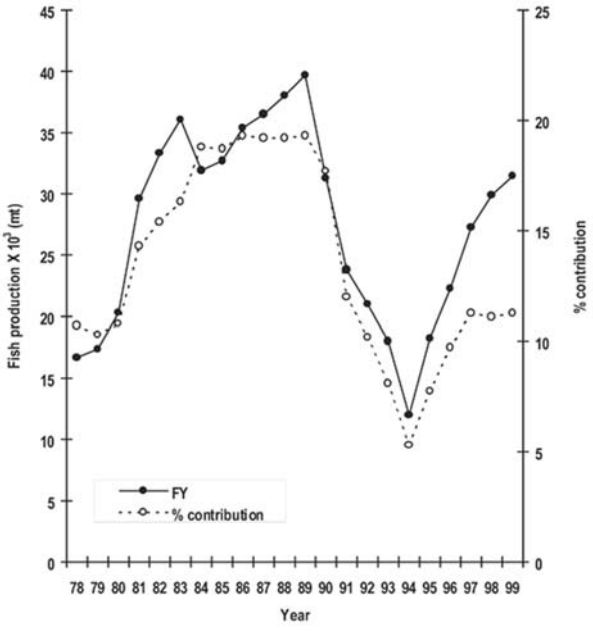

Figure 1. Trends in the inland fish production in Sri Lanka from 1978-1999. Percent contribution of the inland fishery to the total fish production is also indicated here (After Nissanka, 2001).

From 1979 to 1989, the government developed the capture fisheries in reservoirs by providing fishers with fibreglass canoes and gill nets under a subsidy scheme. De Silva (1988) has shown that as a result, fishing effort considerably increased. The fisheries authorities have imposed regulations to control fishing effort and size of fish landed. Use of mechanized boats and any kind of shore seine nets is forbidden in perennial reservoirs and the minimum permissible mesh size for the gill net fishery is 8.4 cm. However, gill nets of mesh sizes smaller than minimum and beach seines are operated in some reservoirs sporadically (Amarasinghe and De Silva, 1992).

The dramatic increase of inland fish production from negligible levels before 1952 to very high levels (about 283 kg/ha/year in the 1980s (Fernando, 1984; De Silva, 1988) is said to be due to the ability of exotic cichlid species to colonize lacustrine habitats of reservoirs. Indigenous fish are riverine and marsh-dwelling fish species and cannot sustain dense populations in lacustrine habitats (Fernando and Holik, 1991). During the early 1980s, fisheries cooperative societies (FCS) functioned effectively for the simple reason that fishers had to be members to be eligible to receive boats and gill nets under the state-sponsored subsidy scheme. Under well-functioning FCSs, fishers tended to arrive at collective agreements regarding a complete stop in beach seining and an increase in the minimum mesh size of gill nets. These community based management strategies brought about considerable increase in fish production. The highest annual production, 39,300 tonnes, was reported in 1989 (Amarasinghe and De Silva, 1999). Production declined markedly after 1990 when the state discontinued patronage for a four-year period. During this period, government funding for

monitoring and stocking programs was interrupted. In the absence of state monitoring programs, fishers began using smaller mesh gill nets that resulted in "growth overfishing". However, the fisheries have nearly fully recovered since the state renewed its support to these fisheries after the mid-1990s. Trends in inland fish production in Sri Lanka from 1978-1999 are shown in Fig. 1. Overall, fish production in most reservoirs has stabilized close to the optimal level or zero net-economic-revenue-level due to the open access nature of the reservoir fishery.

Reservoir fish yield (FY in kg/ha/year) and fishing intensity (FI expressed as boat-days ha/year) are linearly related according to the following equation (Fig. 2).

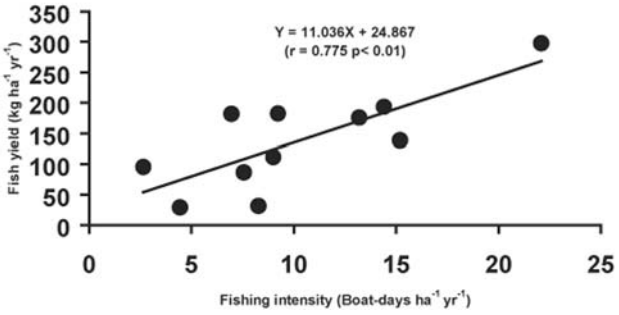

Figure 2. Relationship between fish yiedd and fishing intensity in reservoirs of Sri Lanka
(Source: Nissanka, 2001).

FY = 11.036 FI + 24.867 (r = 0.775; p< 0.01)

Methods of inland fisheries statistics collection

In Sri Lanka, inland fisheries statistics are collected by Aquaculture Extension Officers (AEOs) employed by the National Aquaculture Development Authority of Sri Lanka. AEOs are required to visit fish landing sites in the areas assigned and collect catch and effort data and information on species composition of landings. This procedure is unsatisfactory due to the lack of transport facilities and lack of incentives for field staff. Amarasinghe and Pitcher (1986), Amarasinghe (1992) and Pet *et al*., (1995) have shown that the pattern of overestimated yield in official statistics is a general trend in reservoir fisheries.

More reliable data on inland fisheries production are accumulated in a handful of reservoirs through various research activities (Amarasinghe and Pitcher 1986; Amarasinghe *et al*.;1987, 2002; Amarasinghe *et al*. 1989; Amarasinghe and De Silva, 1992; Pet *et al*., 1995). Of course, these data include comprehensive information on catch.

Various research teams have collected these data monthly (about 5 days a month at each landing site). Potentially, these data can be used to revise official fisheries statistics in some reservoirs. For this purpose, there would need to be a national level scheme to develop databases. These databases could be developed through the existing institutional mechanisms in research coordinating and monitoring agencies such as the National Science Foundation of Sri Lanka, Council for Agricultural Research Policy and National Aquatic Resources Research & Development Agency.

In some reservoirs, middlemen play a major role in the fish marketing process. Amarasinghe (1988) observed that over 95% of the daily landings in Pimburettewa reservoir (830 ha) had been purchased by the Secretary of the Fisheries Cooperative Society (FCS). These were taken to urban areas for retail and wholesale marketing. As the middleman maintain logbook records of daily catches of individual fishers, daily fish production data could be extracted for fish stock assessment (Amarasinghe, 1987). However, the total fish landings in Sri Lankan reservoirs consist of *O. mossambicus* and *O. niloticus*, which usually do not have price differences and these logbook records are not maintained species-wise. Despite this limitation, reasonable estimates on total fish production in reservoirs and catch per fisherman can be collected from these logbooks. Through a survey of fishing gear in each fishing household it is possible to gather information on the variations of fishing methods (*i.e.* number of net pieces and mesh sizes used),

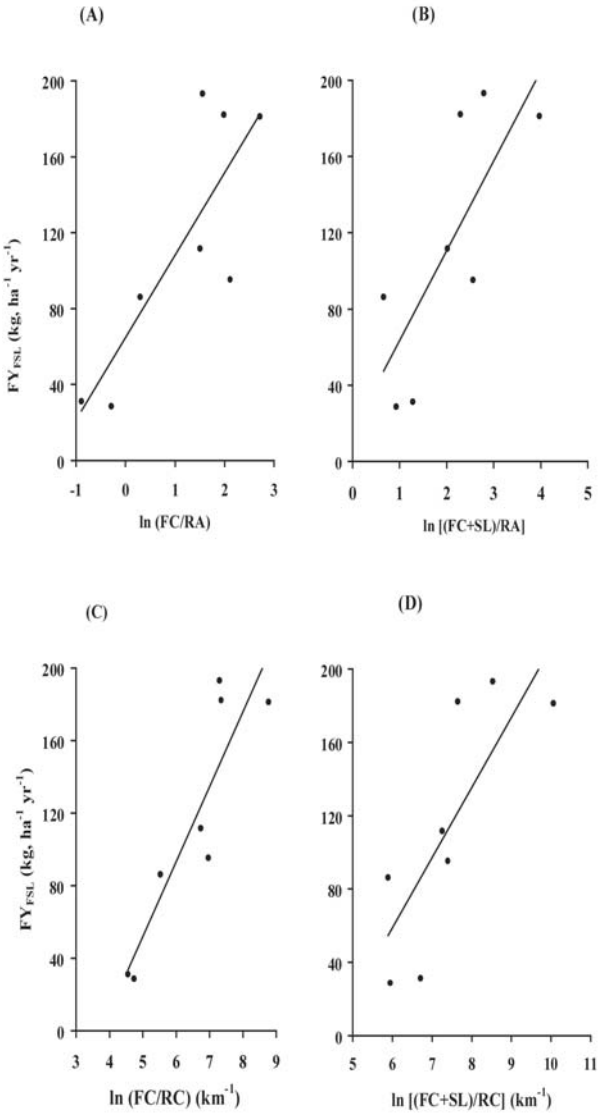

Figure 3. Relationships between fish yield (FY_{FSL}) and ratios of different catchment land-use types to reservoir area and reservoir capacity.

Relationships between fish yield (FY) and ratios of different catchments land-uses to reservoir area (RA) and reservoir capacity (RC). FC – Extent of forest cover; SL- Extent of shrub land. All extents are expressed in km^2. R^2 = Coefficient of determination. (Sources: Nissanka 2001; Amarasinghe et al. 2002).

which in turn can be used to standardize the fishing effort.

In the Muthukandiya reservoir, there is a well-functioning FCS (Amarasinghe and De Silva, 1999) and fishers arrive at collective agreements on fisheries management and environmental protection. This co-management procedure in which the centralized administration authority of the Ministry of Fisheries and the fishing community share responsibility has been useful for preventing over-exploitation even during the period of non-state-sponsored monitoring procedures from 1990 to 1994 (Berkes 1994; Pomeroy 1995; Sen and Raajaer-Nielsen 1996; Amarasinghe and De Silva 1999). In this reservoir, the FCS collects one Rupee per kilogram of fish landed from those fishing to provide a welfare fund for the society. The FCS maintains a receipt book and issues a proper receipt to each fisher every day for the money collected. Using the records of the welfare fund, daily data on weight of fish landed by individual fishers can be collected. Through this procedure, total enumeration of fish production is possible. However, data on species composition are not available in these records.

Nissanka *et al*. (2000) and Amarasinghe *et al*. (2002) adopted a completely different procedure to collect reliable data in 11 other reservoirs. They assigned G.C.E. (Advanced Level) qualified youth in each reservoir to collect data on catch and effort from June 1997 to May 1999.

Accurate catch and effort statistics are important for fish stock assessment and for planning social welfare programmes, economic analysis and human nutritional studies.

Detailed identification guides were provided to all data collectors and there were regular meetings with project personnel. G.C.E data collectors visited landing sites at least 20 days a month to record information on total fish catch in each boat and species composition of the landings. Length frequency data of the most abundant species (*O. mossambicus* and *O. niloticus*) were also recorded by these data collectors. This procedure sets a new norm in reservoir fishery statistics collection.

In Sri Lankan reservoirs, small-sized indigenous cyprinid species such as *Amblypharyngodon melettinus*, *Puntius chola*, *P. dorsalis* and

P. filamentosus are abundant and can be differentially exploited by using small-mesh gill nets (Amarasinghe, 1985; De Silva and Sirisena, 1987). Due to the mesh restrictions these species are not exploited on a commercial scale. As the use of fishing gear other than gill nets is virtually impossible in most reservoirs due to the presence of impediments such as decaying tree stumps, these small cyprinids are not caught as a by-catch. Low consumer preference is another reason for not exploiting this resource. Amarasinghe (1990) reported small-scale fisheries operations for indigenous small cyprinids in some reservoirs that remain unreported in official fisheries statistics. Harmful fishing methods such as dynamiting and use of plant-derived poisons are negligible.

Use of fish yield predictive models

Amarasinghe *et al*. (2002) have shown the robustness of yield predictive models based on catchment features of reservoirs that were quantified by Geographical Information Systems (GIS). In these models, the ratio of catchment land-use patterns to the reservoir area or reservoir capacity is used as a predictor variable of fish yield. Of the various reservoir catchment land-use patterns, forest cover and shrub cover either singly or in combination had significant influences on yield. These relationships are shown in Fig. 3.

Amarasinghe *et al*. (2002) have shown by comparing actual yields with the yields predicted that the predictive power of these models is very high. As indicated by Meaden and Kapetsky (1991), GIS can be an effective means for data gathering and processing for a wide range of planning and management procedures. It might be possible to predict fish yields of individual reservoirs with considerable accuracy using the models, extents of different land-use types in catchment areas of reservoirs that can be determined from GIS methodologies and area and capacity of individual reservoirs. Also using the relationship between FI and FY presented in Fig. 2, it is possible to determine the FI corresponding to fish yield predicted by the above models. When the information on the fishery in question is hard to determine for standard stock assessment procedures, empirical yield predictive models provide an alternative method (Troadec, 1978).

Figure 3 shows the relationships between fish yield (FY_{FSL}) and ratios of different catchment land-use types to reservoir area and reservoir capacity.

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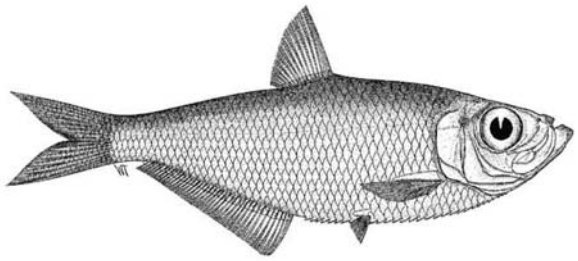
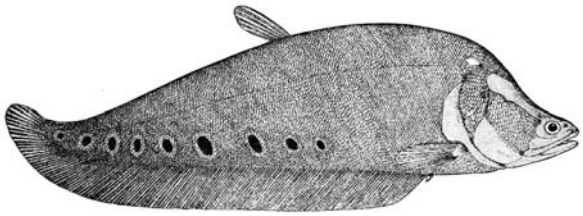
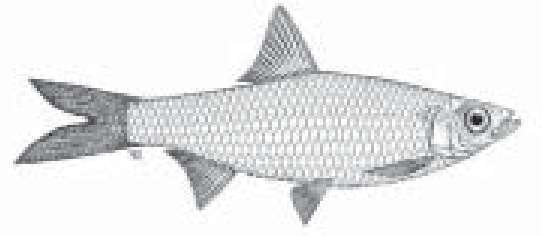






Agenda

New approaches
for the improvement of
inland capture fishery statistics
in the Mekong Basin

Ad-hoc Expert Consultation
Charoensri Grand Royal Hotel
Udon Thani, Thailand
2 to 5 September 2002

appendix 1

Monday, September 2, 2002

09:00 – 09:30	**Opening Ceremony and Welcome**
09:30 – 11:00	**Session 1: Country Reviews**
09:30 – 09:45	Introduction to information needs for inland capture fisheries *Devin Bartley*
09:45 – 10:00	General Discussion: Workshop Goals
10:00 – 10:15	Cambodia *Sam Nouv*
10:15 – 10:30	China *Shuqi Xie*
10:30 – 11:00	*Coffee Break*
11:00 – 11:15	Lao PDR *Somphan Chanphengxay*
11:15 – 11:30	Thailand *Oopatham Pawaputanon*
11:30 – 11:45	Viet Nam *Thai Tanh Duong*
11:45 – 12:30	Discussion of common issues, opportunities and problems
12:30 – 14:00	*Lunch*
14:00 – 17:30	**Session II: Thematic Reports and Case Studies**
14:00 – 14:20	Inland fishery review in Southeast Asia *David Coates*
14:20 – 14:40	Rapid collection methods for inland fishery information *Theo Visser*
14:40 – 15:00	Gender issues in small-scale inland fisheries in Asia: Women as important sources of information *Kyoko Kusakabe*
15:00 – 15: 20	Women as sources of information on inland fisheries *Ubolratana Suntornratna*
15:20 – 15:50	*Coffee Break*
15:50 – 16:10	Geographic Information Systems (GIS) and inland fishery management: Stratified inland fisheries monitoring using GIS *Gertjan de Graaf, Felix Marttin José Aguilar-Manjarrez*
16:10 – 16:30	Data requirements for inland fishery management *Robin Welcomme*
16:30 – 16:50	SEAFDEC initiatives on inland fishery statistics *Suriyan Vichitkekarn and Mao Sam Oon*
16:50 – 17:10	Consumption in the LMB as a measure of fish yield *Kent Hortle*
17:10 – 17:30	*Discussion*

Tuesday, 3 September 2002

09:00 – 10:20	**Session III: Case Study**
09:00 – 09:20	Fisheries co-management in Lake Victoria *Ian Cowx*
09:20 – 09:40	Fishery management in Tonle Sap *Niek van Zalinge*
09:40 – 10:00	Agriculture surveys: A new prospect for inland fishery information *Adele Crispoldi*
10:00 – 10:20	Reservoir fisheries *Wolf Hartmann*
10:20 – 10:40	*Coffee Break*
11:00 – 11:40	Discussion of Case Studies
11:40 – 12:30	Plenary Discussion
1330 – 14:00	*Lunch*
14:00 – 17:30	**Session IV: Working Groups**
14:00 – 14:20	Instructions for Working Groups
14:20 – 15:30	Working Groups
15:30 – 16:00	*Coffee break*
16:00 – 17:30	Working Groups continued

Wednesday, 4 September 2002

09:00 – 12:00	**Session V: Working Group Reports**
09:00 – 12:00	Working Group Draft Reports
12:00 –	*Lunch and field trip to Huay Luang Reservoir*

Thursday, 5 September 2002

09:00 – 12:30	**Session V continued**
09:00 – 10:30	Working Group session for national experts
10:30 – 10:50	*Coffee Break*
10:50 – 12:30	Presentation and discussion of national Working Group conclusions
12:30 – 14:00	*Lunch*
14:00 – 16:00	Summary presentation, discussion and closing

Statement on SEAFDEC Initiatives on Inland Fisheries Statistics in the ASEAN Region

New approaches
for the improvement of
inland capture fishery statistics
in the Mekong Basin

Ad-hoc Expert Consultation
Charoensri Grand Royal Hotel
Udon Thani, Thailand
2 to 5 September 2002

appendix 2

Statement on SEAFDEC Initiatives on Inland Fisheries Statistics in the ASEAN Region

Mr. Chairman, Ladies and Gentlemen,

First and foremost on behalf of SEAFDEC, I wish to extend our appreciation to the organizers of this expert consultation for extending an invitation to attend this meeting. I also wish to congratulate FAO, MRC and the Thailand Department of Fisheries for your contributions and successes in the promotion of inland capture fisheries statistics in this region. Thanks also to the Government of The Netherlands for your active participation and support.

Over the past 35 years SEAFDEC has developed its competence mainly in marine capture fisheries and aquaculture development. Due to the increasing importance and growing concerns of SEAFDEC member countries on inland capture fisheries, it is in fact just recently that SEAFDEC started to develop its competence and initiatives in this area. On behalf of SEAFDEC, I wish to extend our invitation for collaboration on the issue particularly to FAO and MRC. I am certain that this expert consultation will provide an opportunity for SEAFDEC to exchange ideas and information on the issues.

As part of our efforts to promote sustainable fisheries development in the ASEAN region, SEAFDEC and ASEAN, in collaboration with FAO and hosted by the Thailand Department of Fisheries, organized a Conference on Sustainable Fisheries for Food Security in the New Millennium: Fish for the People in November last year. The Conference objective was to analyze fisheries issues and problems, develop common fisheries policy frameworks and agree on actions to be taken on important fisheries topics. Inland capture fisheries management and improvement of fishery statistics were highlighted.

The Conference concluded with a Resolution and Plan of Action on Contribution of Sustainable Fisheries to Food Security in the ASEAN Region. The Resolution and Plan of Action are regarded as a common regional fisheries policy framework and list of prioritized actions to ensure sustainable fisheries development in the region. To assist all SEAFDEC member countries to successfully implement the Resolution and Plan of Action, SEAFDEC has developed a follow-up program. The program, entitled the Special 5-year Program on Contribution of Sustainable Fisheries to Food Security in the ASEAN Region, also addresses the issue of inland capture fisheries management and improvement of national fishery statistics systems.

As far as inland capture fishery statistics are concerned, SEAFDEC is in the process of developing project details on improvement of national fishery statistics systems through human capacity building. The project aims to develop standard training packages for improvement of national fishery statistics that can be used for human capacity building in the ASEAN member countries. In line with the ASEAN policy to reduce the gap of technical disparity among the ASEAN member countries, the project will initially focus on Cambodia, Lao PDR, Myanmar and Viet Nam. The standard training package will also serve as a regional reference to facilitate national plans and actions to improve national fishery statistics.

The preliminary structure of the standard training package is composed of four main modules. They are 1) an overall national fishery statistics system module which addresses objectives, purposes and minimum requirements of a fishery statistics system; 2) marine capture fisheries module; 3) aquaculture module; and 4) inland capture fisheries module.

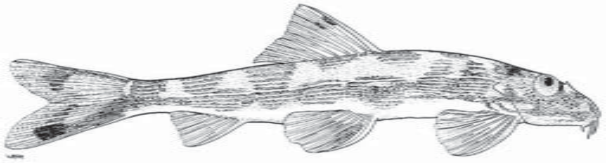
Through a regional consultation process, the standard training package will be developed by mobilizing expertise and experience from international and regional organizations and the member countries in the ASEAN region. The outcome will be used to further support human capacity building in the region. In the initial stage, on-site-training will be conducted in the four target countries where the standard training package will be further adjusted to suit the country specific situation and requirements

through consultation with main policy makers, managers and other stakeholders in each country. It is expected that this project will generate practical approaches for improvement of fishery statistics in the ASEAN region.

SEAFDEC has been compiling fishery statistics (including inland capture fisheries) over the past years and is currently promoting a regional program on Regionalization of the Code of Conduct for Responsible Fisheries (CCRF). The program aims to develop regional learning processes to implement the CCRF at the national level. The program strongly addresses regional fisheries covering all sub-sectors of fisheries including inland capture fisheries.

At present, the program is developing regional guidelines for responsible fisheries management based on Article 7 of the CCRF through regional consultations, which are seen as joint learning processes. It is expected that by the middle of next year, the regional guidelines for responsible fisheries management will become available for circulation to all ASEAN member countries and anyone else who may be interested. I wish to also inform the meeting that SEAFDEC now has available similar regional guidelines for responsible fishing operations (based on Article 8 of the CCRF) and responsible aquaculture development (based on Article 9 of the CCRF).

Finally, SEAFDEC is very pleased to collaborate with international and regional organizations on areas of mutual interest, particularly on inland capture fisheries statistics. Although SEAFDEC is still new to the topic, we wish to share our expertise and experience developed in the areas of marine capture fisheries with this expert consultation.



I look forward to a fruitful consultation and thank you for your kind attention.

Suriyan Vichitlekarn
Program Manager
Secretariat of the Southeast Asian
Fisheries Development Center

Chronology (1997-2002)
Events in fishery statistics in Asia and the Pacific Region

appendix 3

Chronology of important events on fishery statistics in Asia and the Pacific Region (1997-2002)

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1997

3 June 1996 – 2 June 1997

Project: *Reformulation and Strengthening of Fisheries Statistics System in Myanmar:*

TCP project: TCP/MYA/4553
Main activities were as follows:

- Established a framework for data collection.
- Identification Guide to the Commercial inland fishes of Myanmar
- Identification Guide to the Proposed Marine Fishery Statistical Units of Myanmar
- Formulation of frame survey Staff training

19-21 August 1997 (Bangkok, Thailand)

Workshop: *FAO/SEAFDEC Regional workshop on Fishery Statistics*

National fishery and aquaculture statistical systems in the region were reviewed. A draft of the supplement on aquaculture for the World Census of Agriculture programme for 2000 (WCA 2000) was reviewed. Series of recommended actions at national and regional/Global level were formulated.

22-23 August 1997 (Bangkok, Thailand)

Meeting: *APFIC Joint Working Party on Fishery Statistics and Economics*

Convened in conjunction with FAO/SEAFDEC regional workshop on fishery statistics. The meeting recommended that APFIC and FAO prepare guidelines on methodologies and standards for collection of production and structural statistics for capture fisheries.

25-28 November 1997 (Rome, Italy)

Meeting:*ACFR meeting*

The meeting concluded that:

- Current statistics collection system is limited to primary landings and commodities statistics, whereas there is a critical need for data relevant to fleet capacity, participation in Fisheries, economic performance and distribution.
- Data management is being modernized and there is a need to integrate the entire fisheries statistics system in light of modern information technology.
- Information quality criteria and quality assurance protocols are increasingly required.
- Regional bodies and experts should be involved in the assessment of status and trends.

Based on the discussions above, WP/STF was established.

30 November – 3 December 1997 (Rome, Italy)

Meeting: *WP/STF Meeting*

Report of the WP/STF, ACFR/99/2. The meeting called for an IPOA-Status and Trends.

Publications

Guidelines on the Collection of Structural Aquaculture Statistics
Inclusion of aquaculture in the World Census of Agriculture prompted to establish guidelines on collection of aquaculture data.

Definitions, concepts, standards and guidelines for collecting internationally comparable data were provided in this publication.

Status of Fishery Statistics in Asia
This publication contains the report of the 1st session of JWP on Fishery Statistics and Economics of the APFIC held in Bangkok 19-23 August 1997. See summary of the meeting above.

Status of Fishery Statistics in the South Pacific
Current status of fishery sector of the region is summarized. Important problems with fishery statistic are:

- The statistical basis of the data is weak in view of methodological and practical constraints
- The coverage shows serious gaps and inaccuracies particularly in artisanal and subsistence subsectors.
- Insufficient species or boat/gear detail or coverage to be useful

1998

2-6 November 1998 (Hobart, Australia)

Meeting: *APCAS meeting (17th session)*

Progress on the incorporation of aquaculture into the WCA 2000 Programme was reported. Although there were few countries to uptake the supplement, the need for including aquaculture in the programme was acknowledged and the supplement provided important guidelines for harmonizing the definitions for the fisheries questions used.

1999

6-9 July 1999 (Luxembourg)

Meeting: *CWP meeting (18th session) 7-9 September 1999*

APFIC Ad Hoc Working Group of Experts in capture fishery data collection RAP 1999/35. Its main task was to discuss implementation of the guidelines for the routine collection of capture fishery data prepared during the FAO/ DANIDA expert consultation in Bangkok May 1998. The meeting was specially tasked to:

- Provide advice on priorities for implementation of the guidelines in order to improve the quality of statistics
- Consider how sample survey data collection methodologies can be utilized to optimize data collection with limited resources
- Prepare the necessary follow-up action to promote common approaches and sustainable data collection systems
- Advise APFIC on the status and the needs for further strengthening of fishery statistical programmes

Recommendations made during meeting were:

1) The guidelines should be distributed widely to promote awareness of their purpose and importance to policy makers.

2) Countries should compare their existing systems with the recommended systems in the guidelines and undertake pilot case studies to examine applicability of the guidelines. APFIC should convene a follow-up consultation to review the results of national pilot projects (feed-back).

3) An Ad hoc working group should be convened to review the methods of non-routine data collection for small-scale fisheries and propose alternative approach for management of inland fishery systems.

4) Basic courses on designing surveys should be developed and training of personnel involved in designing surveys and socio-economic analysis should be conducted.

5) Common approaches should be developed for sustainable data collection in the region. Such approaches include: harmonizing concepts, methodologies, classifications and codes, development of database and data exchange, socio-economic and environmental research and collection of data on the changes in fishing communities and exploited stocks.

6-9 December 1999 (Rome, Italy)

Meeting: *ACFR meeting (2nd session)*

Called for the development of a proposal for an IPOA-Status & Trends.

Publications

Guidelines for the Routine Collection of Capture Fishery Data

This paper was prepared at the FAO/DANIDA Expert Consultation Bangkok Thailand, 18-30 May 1998. These guidelines aim to help those who design routine data collection programmes, focusing on the relationship between typical questions asked by policy makers and managers, and the data required for providing reliable answers.

Report of the Working Party on Status and Trends of Fisheries

ACFR/99/2

28 February – 3 March 2000 (Hat-Yai, Thailand)

Workshop: *Workshop on Census of Agriculture 2000: Structural Aquaculture Statistics (NSO-FAO/CA2000)*

The workshop was organized by ESS and FIDI in close collaboration with the National Statistics Office of Thailand as part of the process of promoting inclusion of structural aquaculture statistics on WCA2000.

Participants were stimulated to explore further the mechanisms for including aquaculture questions on structure, or strengthen the questions already planned within the WCA2000 programme to obtain a frame for detailed aquaculture survey.

6-10 November 2000 (Bali, Indonesia)

Meeting: *APCAS meeting (18th session)*

Reviewed issues of regional nature concerning the reliability of inland catch and aquaculture production statistics. Some suggestions were made to improve nationally and internationally collected statistics:

- Better coordination of national statistical programmes to ensure the appropriate coverage of inland fisheries in relevant agricultural and rural household surveys.
- Systematic use of sample techniques in commercial capture fisheries and aquaculture and the use of occasional surveys for estimating the semi-commercial and subsistence components.
- Provision of well-focused technical assistance programmes at sub-regional and/or national level.
- Provision of sub-regional projects with a strong component for inland fisheries monitoring and management.
- Projects at national level need to include substantial inputs for training and technical assistance in order for statistical programmes to be self-sustaining.

5-8 December 2000 (Rome, Italy)

Meeting: *ACFR meeting (3rd session).*

A proposal for an IPOA-Status & Trends was finalized.

26 February-2 March 2001 (Rome, Italy)

Meeting: *COFI meeting (24th session)*

The approach of using an IPOA to improve information on status and trends of fisheries was considered. It recommended that a technical consultation be held to consider how such information should be improved.

10-13 July 2001 (Noumea, New Caledonia)

Meeting: *CWP meeting (19th session)*

CWP-19 recommended that the Secretariat investigate the following areas:

- Summarize and prioritize reports from recent meetings where specific data needs were identified and calls made in support of data collections
- Identify examples and reasons for success of successful projects/programmes where an improvement in the quality of statistical data has led to improved science and better fishery management.
- Identify specific problems which require immediate attention and action

An advanced draft of the new version of the Handbook of Fishery statistic was submitted. This book will be called as CWP Handbook of Statistical Standards for Fisheries.

16-18 July 2001

Workshop: *Regional workshop for pacific countries Support for Improvement of Statistics on Coastal and Subsistence Fisheries and Aquaculture (GCR/RAS/183/JPN)*

Future efforts have to concentrate in the areas where data collection is weak such as small-scale fisheries. In this field, there is a need for promoting the use of well-defined, cost-effective and sustainable sampling methods and techniques for collecting basic fishery data. SPC will initiate a project for ACP countries (Vanuatu, Fiji, PNG, Solomon Is., Samoa, Kiribati, Tonga and Tuvalu) to look at the coastal fisheries information, which is sponsored by EU. It will feature occasional scientific surveys and community-based monitoring of indicator species and areas. ADB has commissioned a project to look at methodologies used to calculate the contribution of Fisheries to the GDP.

Remarks in country status reports:

- Fiji started the implementation of a new statistics system. Surveys were conducted to collect data on artisanal fishery.
- Catch data from artisanal fisheries are monitored by reports required from licensed fish buyers in PNG.
- In Vanuatu, databases are established for artisanal fishery and deep-bottom fishery. The government provide incentive for fishers to provide data such as duty exemption privileges for fuel.

Recommendations required action for FAO/SPC

1. A regional forum should be established to ensure statistical coordination and cooperation in the region, and to discuss harmonization and standardization of approaches and definitions used.

2. A mechanism in the form of regular meetings should be put in place in order to facilitate exchange of experience between countries.

3. Skill development (computer and statistics) for statistical staff should be provided.

4. Assistance is needed for the design of methodologies for the coverage of subsistence and artisanal fisheries.

6-10 August 2001

Workshop: *Workshop on Improvement of Fishery Statistics in Asia and Pacific Countries*

This workshop was conducted as a part of activities of Improvement of Agricultural Statistics in Asia and Pacific Countries (GCP/RAS/171). Participants discussed the state of fishery statistics with special focus on constraints in developing sustainable national statistical systems. ARTFISH was also introduced during this workshop. It is recommended that:

1. A regional workshop or expert consultation be organized to address statistics on aquaculture and subsistence fishery.

2. FAO seek ways and means of providing technical assistance for the introduction and use of ARTFISH.

3. Countries increase support to fishery statistics and facilitate operations for data collection and processing.

2001

19-24 November 2001 (Bangkok, Thailand)

Conference: *ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium*

One of the technical panel sessions was devoted to discussions on fishery statistics. It noted that national fishery statistical systems should be strengthened as part of a national decision framework for policy-making, planning and monitoring by:

- Adapting the regional plan of action for the improvement of fishery statistics.
- Clearly determining the objectives and minimum requirements of fishery statistical data and information
- Taking measures to effectively coordinate the collection and use of data between the national fisheries authorities and other competent authorities.
- Capacity building
- Prioritizing statistical data and information needs with particular reference to practical indicators for fishery management.
- Applying internationally standardized methodologies where appropriate.

Resolutions adopted by the ministerial meeting include:
Strengthening national fishery statistical systems and maximize their use for fisheries planning and management and develop standard definitions and classifications to facilitate regional fishery statistics and information exchanges.

A Plan of Action was also formulated and adopted by the meeting. This includes:

- Formulate guidelines to promote the use of practical and simple indicators for multi-species fisheries.
- Coordinate and decentralize the collection and use of fisheries related statistical data between the national fisheries and other authorities including those responsible for food security, trade, vessel registration, aquaculture and rural development.
- Maximize the use of national fisheries statistical systems by focusing on clear objectives and timely results directly related to fishery management decision making and planning processes.
- Apply, where appropriate, regionally standardized definitions and classifications for statistical data to facilitate regional compilation, analysis and data exchange.

Publications

Status and Trends reporting in Fisheries FIDI/C967

This circular reviews recent progress and approaches made by FAO and other organizations to reporting on the status and trends of world fisheries. It comprises an edited compilation of papers prepared for the first session of the WP/STF, together with summaries of WP/STF inter-sessional activities in the preparation of a draft IPOA for Status and Trends reporting on Fisheries.

2002

25-28 March 2002 (Rome, Italy)

Meeting: *Technical Consultation on Improving Information on Status and Trends of Capture Fisheries*

The committee/ACFR noted that:

- There are concerns that reporting of fisheries statistics is not good enough and information quality is deteriorating.
- Existing process for assessing status and trends information lacked transparency.

- WP/STF recommended that global system of status and trends reporting be advanced by increasing completeness, expanding its scope, and enhancing quality assurance.
- It also recommended that an international action plan be drafted

Outputs of the consultation

- The need to improve information on the status and trends of fisheries, both from national and international perspectives, was confirmed
- The nature and content of the required actions were agreed.
- It is agreed that a strategy is an appropriate instrument, which is a document that sets forth objectives, policies, programmes, actions and decisions to define who will do what and why.
- A strategy for improving information on status and trends of capture fisheries was approved.
- It is noted that FAO and FAO members need to elaborate programmes to implement the strategy and that COFI need to identify approaches to ensure the effective implementation of this strategy.

2002

2-5 September 2002

Workshop: *Workshop on New Approaches for the Improvement of Inland Capture Fishery Statistics in the Mekong Basin*

Organized by the MRC, FAO and the Department of Fisheries (Thailand), in collaboration with the FAO/Netherlands Partnership Programme (FNPP)

The outputs of this meeting from the contents of thsi report.

9-12 September 2002

Workshop: *FAO/SEAFDEC Workshops on the Use of Statistics and Other Information for Stock Assessment*

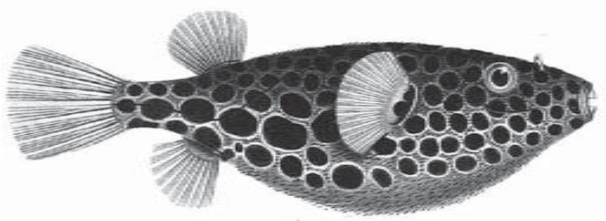
Publications

Sample-based Fishery Surveys Fisheries Technical Paper 425

This paper provides planners and users of fishery surveys with simple step-by-step guidance for developing and implementing cost-effective and sustainable fishery survey.

Inland Capture Fishery Statistics of Southeast Asia: Current status and information needs

This report assesses the quality and relevance of existing statistics on inland capture fisheries and the extent to which the statistics meet management objectives. The report suggests ways in which the existing statistics might be improved through cost-effective means and explores the information needs for inland capture fisheries.



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New approaches
for the improvement of
inland capture fishery statistics
in the Mekong Basin

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2 to 5 September 2002

appendix 4

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