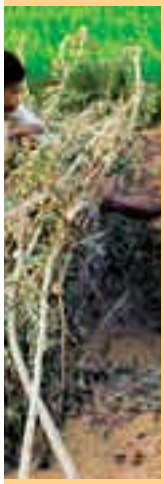
Biodiversity and Fisheries in the Mekong River Basin

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Foreword

The fishery of the Lower Mekong Basin is one of the most abundant river fisheries in the world. It is of vital importance to the 55 million people who live in the basin. Not only do millions of people earn much needed income from catching, preserving and marketing fish and other aquatic products, they also depend on the fishery as their main source of animal protein. Although MRC research has demonstrated that the fishery is still in good condition, this could change quickly if it is not well managed and developments in other sectors have adverse impacts on aquatic life.

In the report that follows, the authors propose that in the Mekong the importance of the fisheries is the major argument for protecting the biodiversity. They also discuss threats to biodiversity from within and outside the fisheries sector and measures that should be undertaken to sustain biodiversity.

This report, like others in the Mekong Development Series, is intended to present the findings of MRC research in a form that is easily accessible to general audiences. In publishing this series, MRC hopes to disseminate its research as widely as possible and contribute to greater recognition of the importance of water and related resources, and the need to develop these in ways that are sustainable.

Joern Kristensen, CEO
Mekong River Commission

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Summary

Relatively un-regulated tropical rivers support a high biodiversity, rivalling that of the most diverse marine systems. This is due, in part, to extreme ecosystem complexity. Such rivers traditionally support very important, but often under-valued, fisheries.

The fishery of the Mekong Basin is one of the most productive river fisheries in the world. High diversity of resources, in close proximity to large rural communities, leads to a high degree of participation in resource exploitation. Impressive large commercial fisheries occur in the basin, but because most people farm as well as fish, their involvement is largely part-time, using smaller fishing gears. The links between biodiversity and exploitation are immediately obvious. Reduced biodiversity will lead to decreased participation, loss of livelihoods and generally unfavourable socio-economic impacts.

Caution needs to be exercised when applying to river fisheries conclusions that have been drawn from marine fisheries. These function differently in several notable respects. Threats to biodiversity that arise from within the sector include over-exploitation and the use of destructive gears. However, the most severe threat to biodiversity in Mekong comes from outside the fishery, and result from activities which cause extensive loss of habitat, ecosystem simplification and reduced water quantity and quality.

Effective solutions to problems within the fishery sector involve co-management approaches which are already widespread and, in places, locally effective. The highly developed resource allocation systems (fishing lots) in use in the Mekong enable the control of open access to resources and demonstrate a potentially important tool in biodiversity conservation. However, conservation and social aspects of their use require further investigation before they are widely promoted.

Aquaculture should be managed to avoid impacts upon biodiversity. Chief amongst these are habitat loss due to conversion of wetlands into aquaculture operations, and the widespread introduction of exotic species and native strains/varieties that result in direct loss of genetic diversity. Effective remedies for the latter include the application of codes of practice for use in pre-introduction assessments.

The major conclusion to be drawn with regards to biodiversity in the Mekong is that the current benefits of river fisheries provide strong economic and social arguments for preventing and mitigating ecosystem degradation. Recognising this reality more fully in resource development polices would considerably strengthen the arguments for sustaining aquatic biodiversity in the Mekong.

Introduction

Within the Mekong River system there are flourishing fisheries that exploit a large number of species. Estimates indicate that approximately 120 fish species are commercially traded, although the bulk of the fishery is based on 10-20 species.

There is much current interest in biodiversity and the need to sustain it. Many people, however, often regard fisheries as a threat to biodiversity because of widespread over-exploitation of stocks, the use of destructive fishing gears, large by-catches (killing unused species) and general mis-management of resources. But is this true? This paper argues that fisheries are, in fact, not the villain but perhaps the most important ally in the quest for sustaining aquatic biodiversity in the Mekong.

Large tropical river ecosystems have immense value both in terms of high biodiversity and the numbers of people that depend upon that biodiversity for their livelihoods. Unfortunately, all too often, large rivers lose their biodiversity as the environment suffers from multiple demands for water and other resources. This is particularly true where fast-growing populations lead to rapid development of river basins.

The global trend with river environments has generally been depressing. Many river ecosystems have been undermined to such an extent that they fail to support decent levels of aquatic life. This has serious consequences for the people whose livelihoods depend on the abundance of living aquatic resources[1]. The perilous state of the world's freshwater resources has been well documented[2] , and many rivers have been modified to such an extent that they cease to be recognisable as rivers.

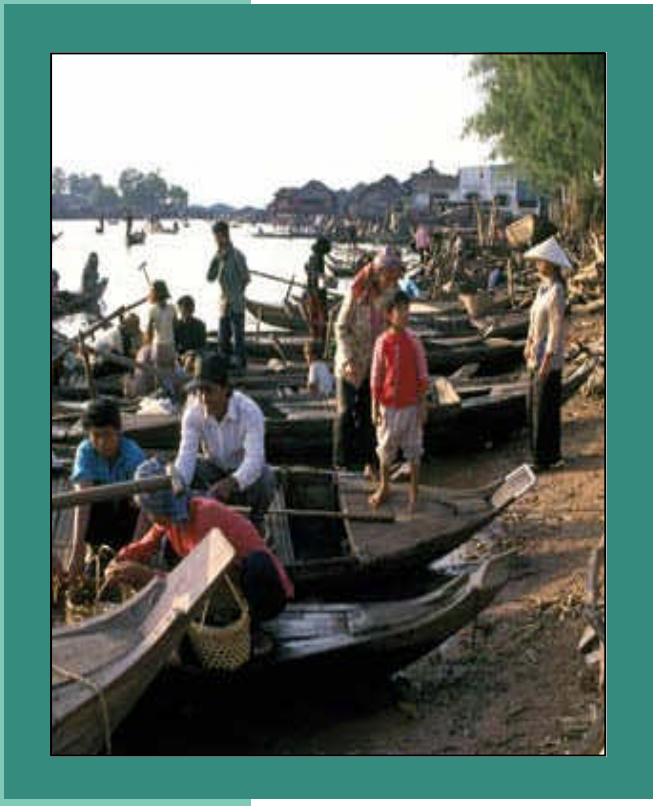
Popular belief is that amongst the world's aquatic environments, it is the sea, and in particular coral reefs, where biodiversity is threatened most. The facts, however, disprove this. The loss of species from freshwater is far greater.

What is "biodiversity"?

According to the Convention on Biological Diversity (1992): biological diversity (Biodiversity) means

"the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems".

It is, therefore, more than just the amount of visible variability amongst animals and plants and includes genetic diversity within a species (i.e., the diversity of genes held by populations of species of animals and plants) and the diversity of ecosystems (e.g., the range of habitats/environments available to support life).



The IUCN Red List for bony fishes, a database on extinct, threatened and vulnerable species, lists no marine species as extinct, in comparison with 96 freshwater species. Losses in other categories of fish confirm that the threat to biodiversity is much greater in freshwater environments (Figure 1). Interestingly, the Red List records one in five marine species as endangered through excessive exploitation, but only about one in 20 are categorised that way in the freshwater listings. It is environmental degradation (habitat loss and pollution), not over-exploitation, that is generally the major problem and one that is far worse in freshwaters.

There are some grounds for optimism though regarding freshwaters. Awareness is growing that freshwater biological resources can be sustained where they are still significant. This is not technically difficult, but it does require awareness and commitment. Serious efforts are also beginning to be taken to rehabilitate degraded rivers, and this is being met with considerable success. Central to this, in developing countries, is the growing appreciation of the importance of freshwater fisheries to the livelihoods of people in rural areas.

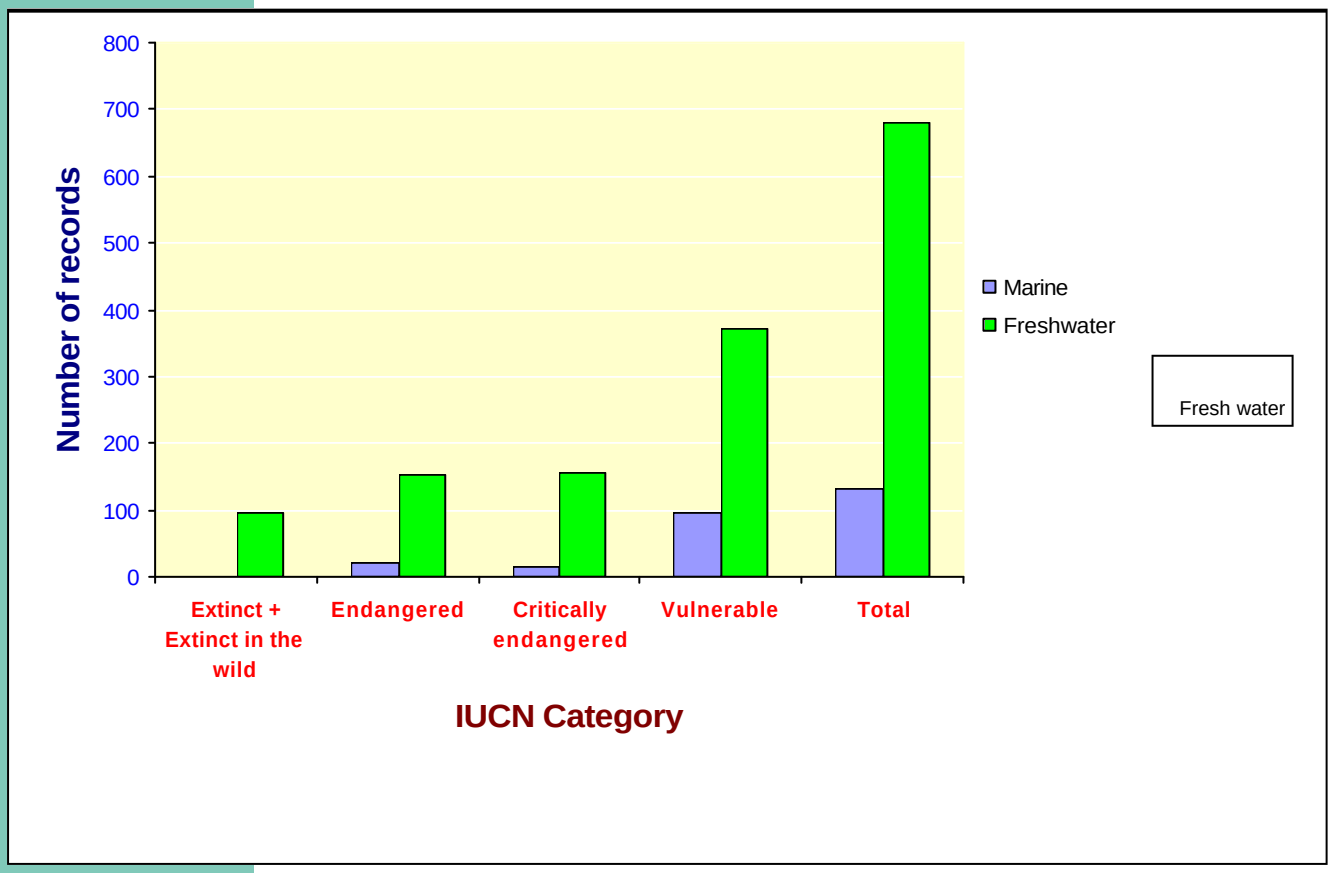


Figure 1: Number of fish species on the IUCN Red List from marine or freshwater environments (2001)

[1] Coates, 1995a

[2] For example, Dudgeon,1992

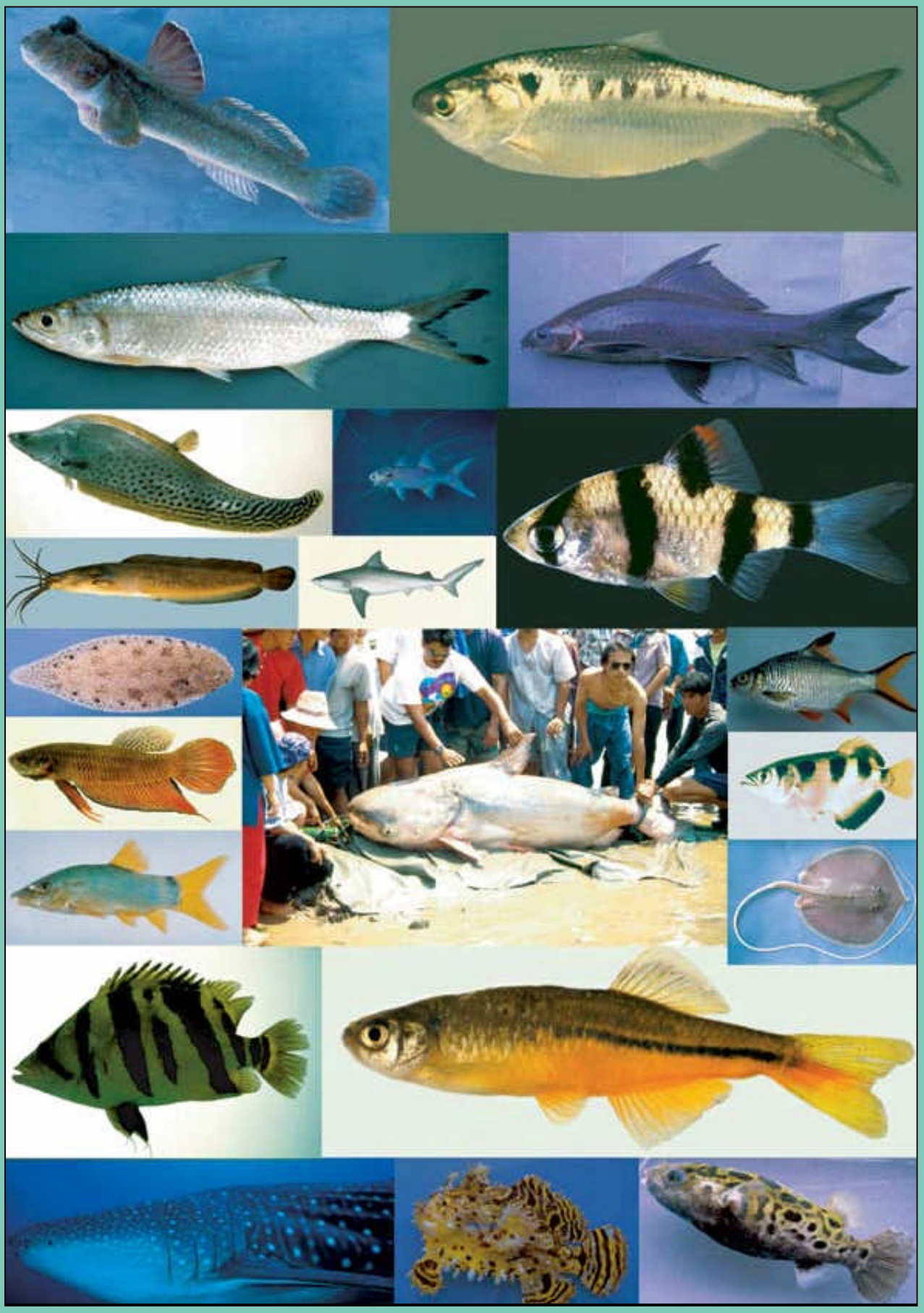


Figure 2: Examples of the many different types of fishes found in the Mekong River.

Aquatic Biodiversity in the Mekong

There are at least 1200 species of fish, and possibly as many as 1700, living in the Mekong Basin. This variety of species is illustrated in Figure 2. High diversity is also exhibited by other aquatic animal and plant groups. It is important to note that "fisheries" in the Mekong are based upon much more than just fish and include the multitude of other animals and plants that are exploited. Possibly as much as 30 percent of production from the fishery comes from non-fish sources. Although poorly studied, this group of miscellaneous animals and plants is very diverse and important.

This high degree of diversity is largely due to the complexity of the Mekong's ecosystem. The river and its tributaries originate high in mountainous areas and flow through a wide variety of landscapes as they wind their way to the sea. Variations in climate, geology, terrain and water flow result in river habitats of an almost unlimited variety. Seasonally-flooded forest represents a type of habitat that is particularly rich in life. This diversity even rivals that found on tropical coral reefs.

In rivers such as the Mekong, which have monsoon climates, tremendous seasonal changes also drastically increase the range and nature of habitats available. These are most marked on the river's floodplain. Every year, the spread of the Mekong's floodwaters drives production of much of the basin's aquatic life. This flooding also produces different habitats, in different places, at different times within the year. Changes occur as well between years through differences in the timing, extent and duration of flooding. Natural variations in river hydrology, both within and between years, are very important in sustaining ecosystem diversity.

Understanding the role of ecosystem variability (including hydrology) in sustaining the Mekong's rich biodiversity is crucial. Development activities in a river system almost always result in the simplification, or even obliteration, of ecosystem diversity. These disturbances appear to be by far the greatest threat to sustaining aquatic biological resources in the Mekong Basin.

Considering the importance of tropical rivers, the lack of attention paid to sustaining freshwater biodiversity is puzzling. Perhaps it is because research and conservation is much more difficult and inordinately less glamorous in freshwaters than it is in marine ecosytems[3].

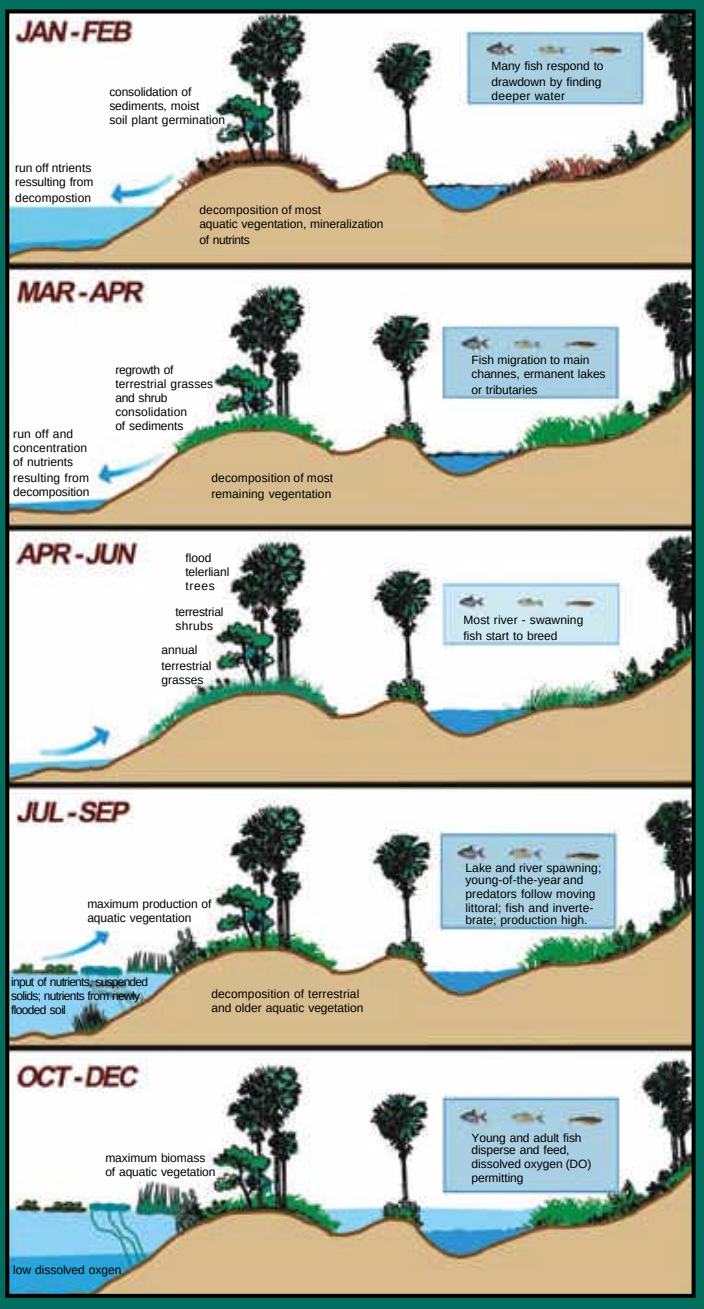
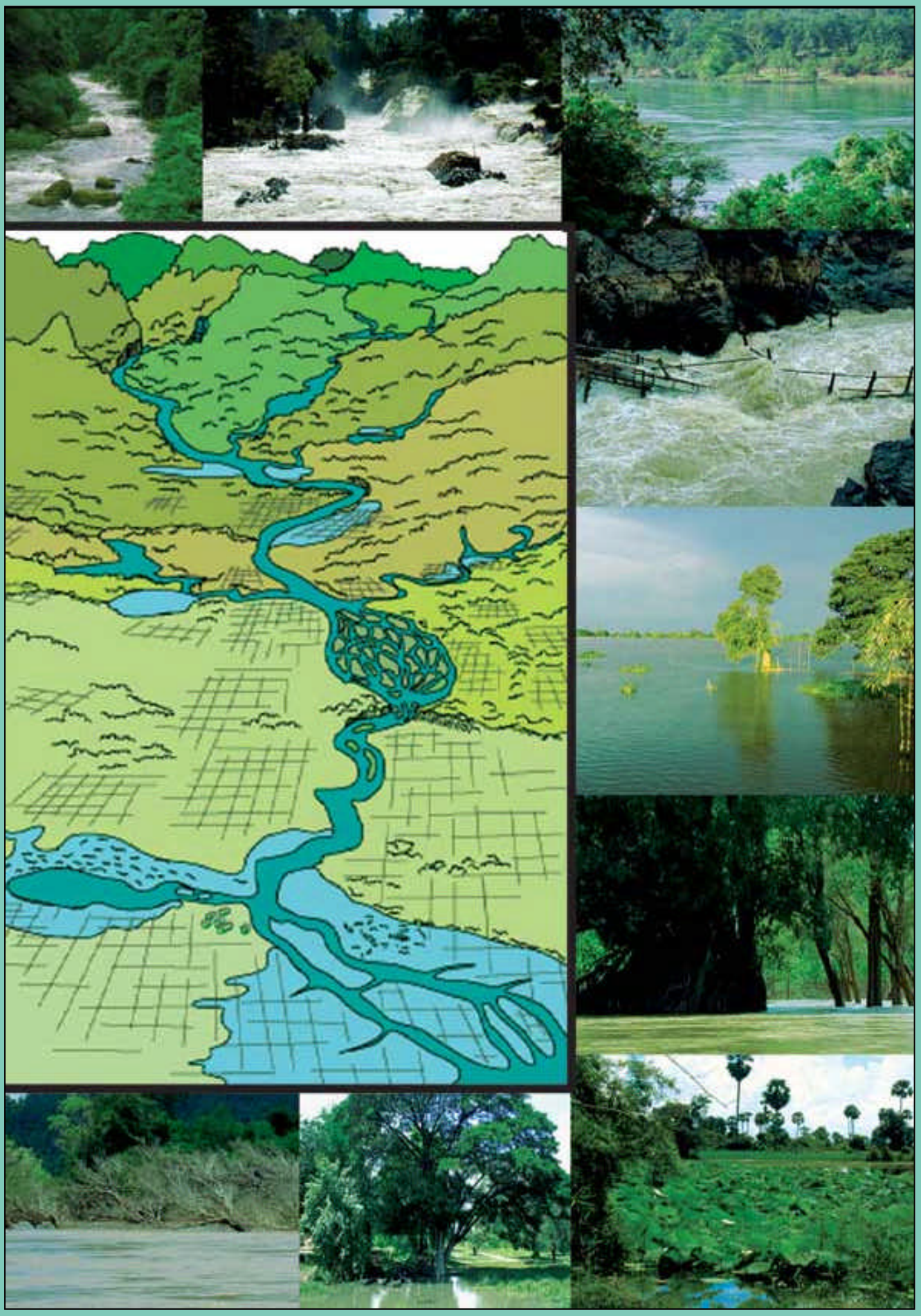


Figure 3: An example of how seasonal changes in ecology greatly increase the diversity of habitats available for aquatic animals and plants over the flood-cycle.

[3] Coates, 1995a



A few examples of the Mekong River Basin's diversity of landscapes, river environments and aquatic habitats

Why is biodiversity important?

Biodiversity is important for several reasons:

- **Direct use value**

  Biodiversity is used directly as food and goods produced from natural resources; and as the basis of tourism activities.

- **Indirect use value**

  Biodiversity supports ecosystems and the way they function. This in turn supports the people that depend upon these ecosystems. These services can be regarded as 'free' in that they are not traded in markets. For example, many kinds of organisms contribute to the success of fisheries because they are eaten by fish (Figure 4); insects pollinate agricultural crops and other plants; and forests help maintain soil cover and water balance. In rivers, the contribution of biodiversity to nutrient spiralling is also important (for an explanation of nutrient spiralling, see the box on the following page).

- **Option value**

  Once extinct, species are lost forever. This robs future generations of the ability to benefit, in whatever way, from their existence.

- **Intrinsic and artistic/visual value**

  Biodiversity and nature are often regarded as 'good things' in their own right with intrinsic or inherent value. This represents a non-use value for humans through enrichment of culture, religion or art. Many people, or cultures, regard biodiversity as important for its own sake.

Of those uses listed above, the direct use value of aquatic biodiversity for food, income and socio-economic benefits is the most obvious, and arguably the most important, in the Mekong. This is illustrated with the example of fisheries here.

A serious decline in biodiversity is an indicator of unsustainable development. And in this regard, the fisheries are unquestionably of paramount importance. Maintaining biodiversity must be a key goal in the quest for sustainable development of the Mekong.

Nutrient spiralling - an example of biodiversity and ecosystem function

Rivers transfer water from upland areas, through lowlands, to the sea. Nutrients are picked up from the surrounding land and move along with the water. These nutrients are captured (used) first by various small to large plants and then by various animals feeding upon them. Through complex food webs, the nutrients and energy are transferred amongst animals and plants within the river. When they die, the nutrients are transferred again to organisms lower in the food chain (which decompose the dead tissue) or are released into the water to be quickly absorbed again whereby the cycle starts over again. There is normally a slow shift of nutrients downstream through constant absorption, use, decay and recycling through these linkages. That is, the flow of nutrients through the system is much slower than the flow of water. This is called nutrient spiralling, as in the illustration.

But if the links in this complex chain are broken or removed (that is, if biodiversity is reduced) the cycle is interrupted and the nutrients get washed downstream rapidly. This results in serious losses in productive capacity because the full potential of the ecosystem is not realised. In rivers, this means that other species will not be able to make up for the lost production due to the reduction in biodiversity because they are unable to access the surplus nutrients made available (because they get washed downstream). Thus this small example illustrates how reducing biodiversity can undermine ecosystem function.

This is only one example of how maintaining biodiversity is important for maintaining biological production from river ecosystems.

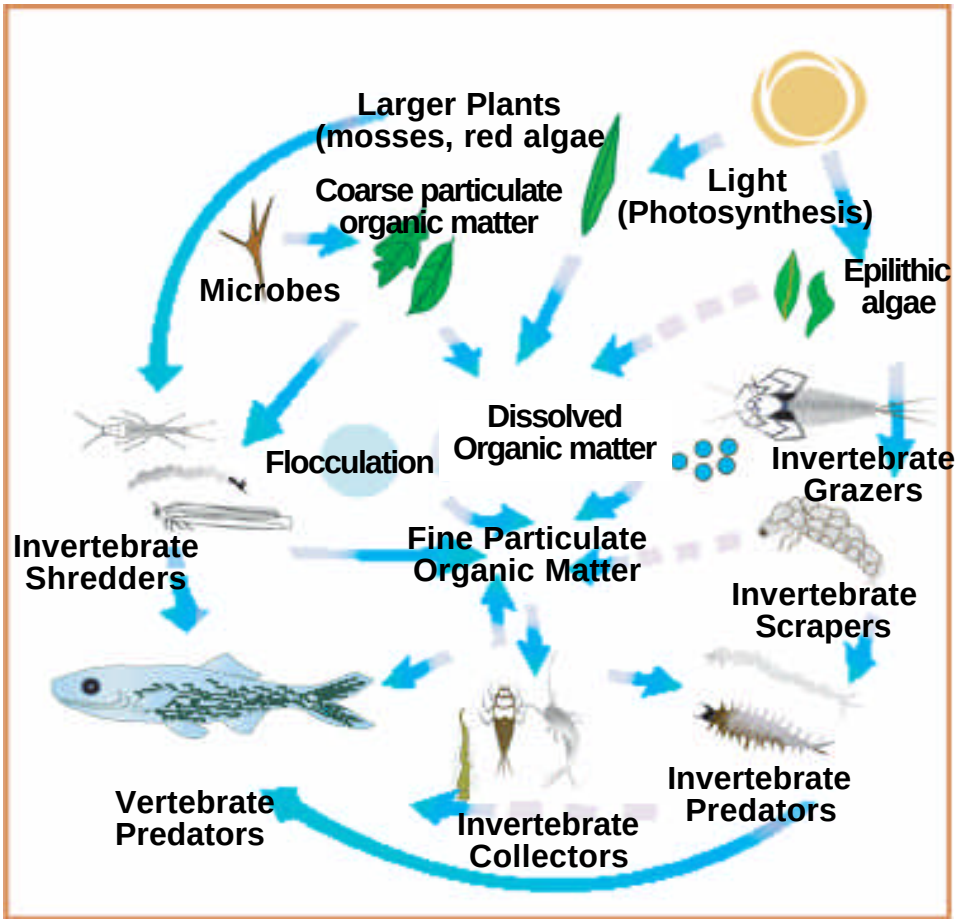


Figure 4: A simplified example of a food web in aquatic ecosystems illustrating how various animals and plants are dependent upon each other. Removing animals or plants from the ecosystem (reducing biodiversity) has impacts upon other animals and plants. (Courtesy of MRC, Hatfield Group, David Dudgeon/Cesare Tatarelli).

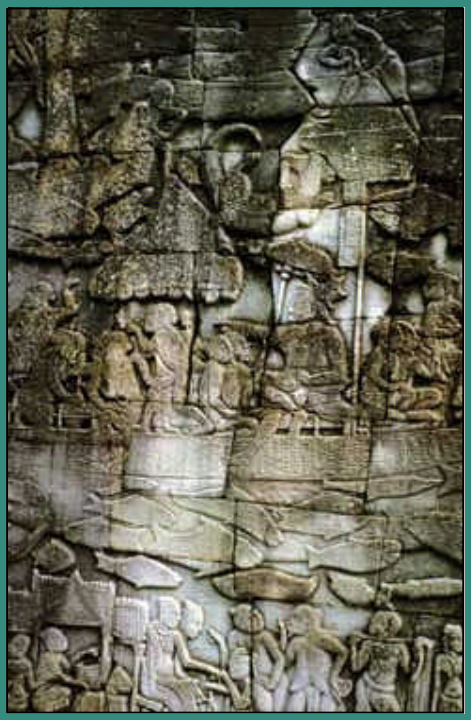
Some Important Comparisons Between Inland and Marine Fisheries

Perceptions about fisheries, and their impacts upon biodiversity, are heavily influenced by what is happening globally with the larger and more prominent sea fisheries. There is a tendency to regard all fisheries in the same way and, in particular, to perceive the impacts of fisheries on the environment as negative. But fisheries in the oceans are very different from freshwater (inland) fisheries. The vast bulk of sea fish are caught by large-scale commercial operations with relatively few employees.

Although large-scale commercial fisheries do occur in rivers, and particularly in the Mekong, the majority of the catch is taken by small-scale operators, and especially by family-based operations. Average catches per fisher tend to be low in rivers, but participation in the fishery is very high. Part-time fishing is the norm and invariably mixed with agricultural activities. Also, the communities living in river basins are located adjacent to or amongst the aquatic resources.

In contrast, oceans are fished by people who live a long way from the fishing areas. These characteristics lead to significant differences. For example: river fisheries are exploited largely by communities living along the river, and particularly so by those on floodplains; traditional systems for managing access and the amount caught are widespread. Community-based management systems are perhaps better developed for inland fisheries because entire communities are so dependent on them (because they are traditionally such an integral part of life). The low cost of most fishing gears, plus the part-time nature of most fishing, promotes great flexibility in the fishery. The number of people engaging in inland fisheries can expand and contract very rapidly in response to natural variations in fish abundance (seasonally and between years).

Another important characteristic of floodplain river fisheries is their ability to sustain themselves in spite of very intense



fishing pressure. The huge changes in ecology that occur seasonally in tropical rivers results in high natural mortalities of adult fish (for example, as floodplains dry out, fish become stranded and die, or they concentrate in dry season pools where they become overcrowded). Because freshwater stocks are already adapted to high mortality rates, they are more resilient to heavy exploitation in comparison to those in more stable ocean areas.

The fact that river communities can adjust their fishing effort, depending on the abundance of fish, also helps sustain river fisheries. When stocks become less available, many people will switch to other activities. When the stocks recover, fishing increases again. In contrast, sea fisheries involve a high degree of capital investment in expensive gears and vessels that force operators to keep fishing, even where stocks are in serious decline. Government economic subsidies also encourage sea fisheries to exploit stocks well beyond the level economically feasible, let alone biologically sustainable. Such subsidies, fortunately, are unheard of with river fisheries. Sea fisheries also result in a large discarded by-catch (waste composed of the large variety of animals and plants that are not wanted).

The main problems with sea fisheries are over-exploitation, over-capacity, distorted economic incentives and vested capital interests. Although over-exploitation is a problem in rivers, it has yet to lead to collapses of fisheries (with the exception of certain vulnerable species). Environmental degradation is the threat instead. Also, in general, the socio-economic benefits of fisheries are far higher in inland waters (because of the higher number of people involved per unit of produce).

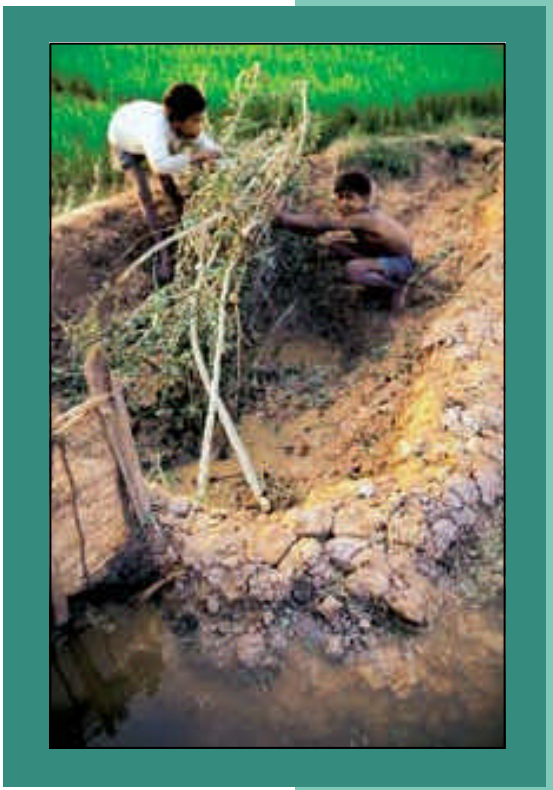
A major concern with fisheries world wide is their impact on non-target species. However, in contrast to many marine fisheries, for river fisheries in general, the entire catch from any gear is normally utilised. In the Mekong, there are only two known examples of unwanted species being caught. The first is the accidental by-catch of freshwater dolphins (*Orcaella brevirostris*) in gillnets from below the Khone Falls[4]. The second occurs with the *dai* fishery for juvenile pangasiid catfish, which occurs primarily in Cambodia and the delta in Viet Nam. Less than 15 percent of the *dai* catches are target species, the remainder (the larvae of at least 160 species), are discarded due to their very small size.

[4] Baird and Mounsouphom, 1997

The Fishery Resource and its Exploitation

Official government statistics still significantly undervalue the Mekong's fishery and production in the four Lower Mekong Basin countries. It is between 2.6 and 21 times higher than official statistics suggest[5]. The Lower Mekong Basin produces an estimated two million tonnes of fishery products each year[6]. Of this, less than 10 percent arises from aquaculture.

While finfish dominate the overall catch in the Mekong, other aquatic species are also important, especially with the small-scale fisheries. In Lao PDR, for example, approximately 30 percent of the catch is composed of molluscs, crustaceans, insects, amphibians and reptiles[7]. The region also has a cottage industry producing dried "seaweed" (algae gleaned from rocks in clearer mountain streams).



Throughout the basin, rice fields are another important source of fish and aquatic species, unless these are impacted by excessive pesticide use[8].

Fisheries vary greatly from region to region, depending on availability and access to markets. In areas with more abundant resources and greater human population (e.g., the Thai Mekong and central and southern Cambodia), larger commercial fisheries are dominant. In the delta area of Viet Nam, which has the highest population density, the fishery is likely the most heavily exploited. In some areas, the fishery takes on industrial proportions, especially in the Tonle Sap in Cambodia.

At peak times, single gears in the bagnet or *dai* fishery in Cambodia and Viet Nam can land up to 0.5 tonnes of fish per 15-minute period. Scenes here are reminiscent of the days of plenty in ocean fisheries, although catches are highly seasonal and influenced greatly by the lunar cycle. There are up to 68 units of *dais* located along the Tonle Sap River alone, with large numbers operating also in Viet Nam. Over 40 species can be found in a single catch.

[5] Coates, 2002

[6] Sverdrup-Jensen, 2002

[7] Sjorslev (*Editor*), 2001

[8] Balzer *et al.*, 2002

Other spectacular fisheries include the large barrage systems which use fences to channel fishes towards various traps or holding pens. This seasonal abundance means that large numbers of people are employed in fisheries and associated activities such as gear making, transportation, fish processing and marketing.

In Cambodia, the best fishing grounds are allocated through a bi-annual auction of fishing lots. Lot "owners" not only have fishing rights, but they protect the supporting environment with security staff. The revenue earned from fishing lots makes the Fisheries Department in Cambodia one of the most prominent agencies in the country. Similar systems occur to a lesser extent in Thailand and also in Bangladesh, India, Pakistan, Indonesia and many countries of West Africa. In Myanmar, the fishing lot system is even more extensive[9]. There is much interest in these resource management systems as mechanisms for conserving the environment and biodiversity.

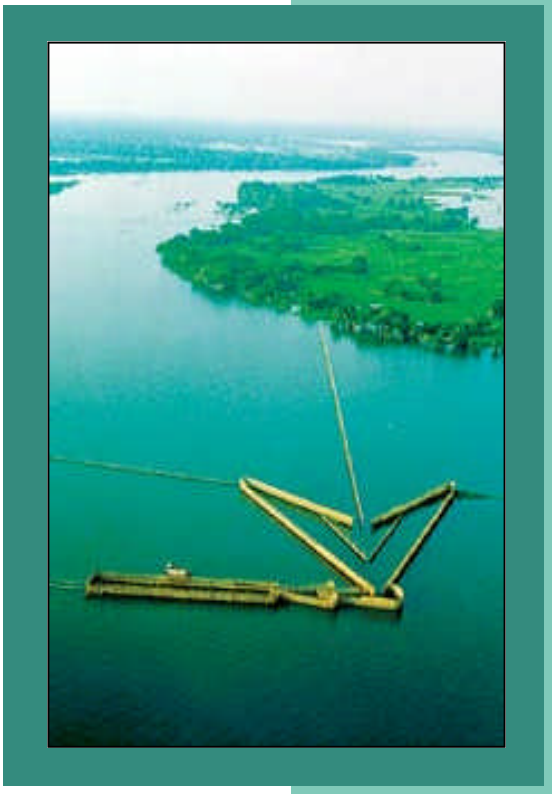
Unfortunately, the current fishing lot system is criticised for being socially unjust. The more wealthy individuals can afford to purchase lots, while the poor are often excluded. Conflicts are exacerbated by an auction system that is less than transparent. The Government of Cambodia has recently attempted to improve this system. This is being achieved, in part, by abolishing some of the lots, and again allowing public access in those areas.

An interesting question then emerges - will the resulting access by poor people result in resource destruction? And, if so, what is the balance between rights of poor communities and losses to biodiversity? It is argued here that the two considerations (poverty and biodiversity) are in fact closely related. Poor people are stakeholders in sustaining biodiversity too - in fact, they are the most dependent upon it. The solution to such problems rests not so much in access to resources but in *empowerment* to manage them. Fishing "lots" offer a management system with considerable proven benefits for biodiversity. Many countries are interested in adopting similar approaches to resource management. The requirement, therefore, is to find a way of making the system more just and socially acceptable.

[9] Coates, 2002

Much of the industrial/commercial fishery in the Mekong is based upon exploitation of fishes that are migrating from flood season feeding grounds to their dry season habitats as flood waters recede. The resulting seasonal peak in catches means that far more fish are caught than local communities can consume. In response, a low-input technology industry has developed which turns surplus fish into fish paste, fish sauce and other products. Production of these products spreads the benefits of seasonal production over the full year, and caters to demand in seasons when fish are less plentiful. Remarkably, catches along the Tonle Sap River can be so high in the peak season, that when prices drop due to oversupply, fishing actually ceases. This is quite possibly the world's last remaining example of oversupply in a fishery.

Impressive as industrial fisheries are, the fishery is still dominated by individual small-scale operations. Survey results have shown that from 64 to 93 percent of rural households in the Lower Mekong Basin are involved in fisheries, both for their own consumption and for sale. Women and children are very active in the fishery, in both catching and processing/marketing. Gender and age also influence where and when fishing occurs and what is caught. Women and children are perhaps responsible for harvesting the highest proportion of "biodiversity" caught in the fishery and are therefore heavily dependent upon it. Fish, and other aquatic animal products, are the main source of animal protein in rural communities. Fishery products are crucial to local and regional food security.



The Mekong has perhaps the most diverse array of fishing gears known anywhere in the world. At least 160 varieties of gear have been identified in Cambodia alone and they are very diverse also in Lao PDR, Thailand and Viet Nam. Many of the gears are used only in certain habitats and their use is highly seasonal. Some gears are unspecialised (e.g., barrage fences, *dais*) and catch a wide variety of species; others target specific species.

Some fishers, particularly those in the commercial sector, use only one gear type, but most fishers use a range of gears according to a complex suite of seasonal, gender, ethnic, social, economic and environmental factors. Most of the smaller gears are inexpensive. People use such a wide range of gears because the resources are so complex - being made up of a huge variety of species in an equally huge range of habitats and at different times of the year. This variety is an advantage - it enables many more people to be involved in the fishery and increases participation, equity and the sharing of benefits.

The Role of Aquaculture

Aquaculture is currently dwarfed in comparison to capture fisheries, although it is more prominent in some areas than others. Commercial aquaculture (including industrial production for the luxury and export markets) is increasing. In the delta of Viet Nam, cage culture of pangasiid catfish is a growing industry, as is the culture of snakeheads (*Channa micropeltes*).

Much of the production of higher-value fish relies on the provision of feed made from lower grade fish that are caught from the river and other wetlands. Thus some aquaculture activities are net consumers of fish (they use up more fish than they produce). Culture and capture are further linked because much of the stock (seed) for commercial aquaculture is taken from the wild. The motivation for aquaculture tends to be profit rather than food.

Smaller-scale aquaculture mixed with farming is particularly prominent in the Thai part of the Mekong Basin, and in the delta in Viet Nam. Not surprisingly, small-scale aquaculture tends to develop best in areas that are away from the main fishing grounds and from the floods.

Fisheries and farming are combined when fish are raised in the waters that cover rice fields. Traditionally this practice relies on recruiting wild stocks of fish and other animals. This is a very significant activity in the Mekong. Only recently has production been enhanced through stocking of fish into fields. The intensification of rice farming, particularly the excessive use of pesticides is, however, undermining this additional source of income and food for rural farmers. Modern agricultural practices significantly reduce the biodiversity of products obtained from rice-growing areas.

While aquaculture will clearly play an increasingly important role in the Mekong, there are serious misconceptions about its ability to increase total fish production. The ability of aquaculture to do this will depend primarily upon whether the capture fisheries themselves are sustained. Without appropriate management, capture fisheries are likely to decline much faster than aquaculture can expand, obliterating gains made from fish farming. But another misconception about aquaculture is that it is somehow more environmentally appropriate than catching fish in rivers and other wetlands. Unfortunately, this is not the case.

The aquaculture sector itself is very diverse in the Mekong, but it is exhibiting the usual characteristics that have occurred in agricultural development - that is, simplification of the production system through increasing control over and modification of the environment. Aquaculture can also cause major environmental disturbances. In the Mekong, major impacts of aquaculture include habitat degradation (especially so for coastal shrimp farming), over-exploitation of wild stock for seed and the poor, or sometimes non-existent management of the use of exotic species and biodiversity of native species.

A recent global review concluded that (for inland waters) aquaculture presented the greatest threat to biodiversity, not capture fisheries[10]. Aquaculture development can be very beneficial, but it should be based upon the same principles required for capture fisheries development and management. These concern sustaining livelihoods, reducing poverty and sustaining ecosystem integrity (and hence biodiversity). Unfortunately, all too often, aquaculture is regarded as a panacea for solving all the problems of the fisheries sector - often at the expense of investments in inland capture fisheries.

[10] Blue Millennium: Managing Global Fisheries for Biodiversity. IDRC, UNEP, World Fisheries Trust. Victoria, Canada.

Threats to Aquatic Biodiversity in the Mekong

Threats arise from two sources: the impacts of fisheries activities themselves and impacts arising from outside the fisheries sector. The direct threats to biodiversity posed by the fisheries sector include: the use of destructive fishing methods (explosives, poisons and electrocution); exploitation of fish at vulnerable stages, such as at spawning times; and fishing in sensitive areas such as spawning grounds.

The highly migratory fish stocks are more vulnerable to over harvest. Large numbers of these fish migrate at the same time, making them vulnerable to intensive fishing, and especially to large-scale commercial operations. Examples include the *dais* on the Tonle Sap River in Cambodia. Because licenses have a short duration, this encourages many fishers to over-exploit the fishery. Fish migrations are often associated with spawning, and concentrations of fish at spawning sites also make stocks vulnerable to over-fishing at the critical spawning period.

Unless properly managed, the release of live animals into the wild can have serious impacts upon biodiversity. This happens primarily through aquaculture when animals are either deliberately released into the wild through fish stocking activities, or when they "escape" from fish farms (a common problem when ponds are flooded seasonally). Biodiversity can be adversely affected when exotic (non-native) species compete with native species in the wild.

But caution must also be exercised when using native species. The natural range of native fishes can be quite limited within the basin - they do not all occur everywhere. Some species of Mekong native fishes are in fact "exotic" (i.e., naturally foreign) to many parts of the basin. In addition, fish stocks can be composed of a number of distinct populations living in different areas, each with significantly different genetic characteristics. This phenomenon is an example of genetic diversity and it is important. It is probable, for example, that several species have different stocks above and below the Khone Falls.

Problems with the release of farm-raised native species are well documented in other rivers, particularly for highly migratory species (as occur in the Mekong). Therefore, the determination of whether particular animals are "exotic" to any particular area can only be made by considering diversity at the genetic level, not at the species level. This requires much more research on the genetic diversity of native species and how it might be impacted through

fisheries and aquaculture management practices.
Impacts upon aquatic biodiversity arising from outside the fisheries sector include changes in the environment and habitats in rivers, brought about by the impacts of development. These can have significant impacts upon biodiversity and include:

1) destruction of local spawning grounds or dry season refuges as a result of stream bed dredging, removal or alteration of vegetation, and bank modification;

2) local changes in the quality (e.g. pollution) and quantity of water available as a result of storage in dams and abstraction for irrigation; and

3) the construction of barriers (dams, weirs, diversions) which, apart from the local environmental disturbances they might cause, act as physical barriers to fish migrations.

Cambodian fisherman at Stung Treng, near Lao border. He lost his arm when an explosive device intended for fishing went off in his hand.

Essentially, these influences undermine ecosystem integrity. They invariably lead to a simplification of the river ecosystem and a significant loss of ecosystem area. The loss of river floodplain (through flood control and/or modifications in river hydrology) is a significant cause for concern. These changes result in significant reductions in both aquatic productivity and biodiversity.

Because industrialisation and urbanisation are still quite limited, by comparison to some areas, these have had little impact on the Mekong so far, except locally. But as populations grow and development pressures increase, aquatic life will likely be affected. The negative consequences of deforestation, inappropriate agriculture, road construction, hydropower and other forms of development are already evident. But in the Mekong, the most pressing problem is one of water quantity, not water quality. A second major concern is the loss of riparian vegetation cover, and, in particular, the rapid loss of flooded forests, which provide crucial aquatic habitat for fishes.

In 1997, the MRCS[11] listed the impacts of fishing on biodiversity as "slight", but the activities of most other sectors as "high" (through their impacts on the environment). Most commentators on the state of river fisheries agree that the major threats are environment based[12].

[11] MRCS, 1997

[12] For example, FAO, 2000

Status and Trends in Target Species

The common perception of the Mekong fishery is certainly one of decline. But is this view justified, and if so, what does it mean?

First, and most important, there is no actual evidence to support the widely held view that the fisheries are actually declining[13]. It is true that many fishers report declines in their catches but the problem is that the numbers of fishers are increasing. Total catches may therefore be maintained (or be increasing) even if average catches per fisher are getting smaller. An analysis of historical data for the Tonle Sap ecosystem in Cambodia came to the same conclusion[14]. More importantly, recent data dispel the common myth that there is limited potential for increases in fish production. Even if in heavily-populated areas fish catches have reached their limit, there are still extensive areas with lower population densities where there is room to increase catches. In addition, habitat restoration and fisheries enhancement approaches to river fisheries management have demonstrably and dramatically increased production where they have been used.

But the consideration of gross production can mask more discrete changes within the fishery at the species level. Very likely there are serious declines in the stocks of some species because rivers cannot be fished at any degree of intensity without the loss of the larger, slower growing species. This is already happening in the Tonle Sap fishery where the larger migratory species are declining significantly (although the catches of smaller species appear to be as abundant as ever). All of the "Giant" Mekong fishes - *Pangasius sanitwongsei, Probarbus jullieni, Catlocarpio siamensis* and the endemic *Pangasiandon gigas* - may be in serious decline. However, available information indicates that for at least *P. jullieni,* and likely the others also, the decline, especially throughout Thailand, may be more due to river impoundments (dams and flood control embankments) rather than a result of fishing[15]. Two of these giant species, *P. gigas and P. jullieni,* are on the IUCN Red

List, both as endangered; but neither are listed specifically due to over-exploitation and the latter is listed because of habitat loss.

The fisheries in many over-exploited rivers elsewhere in the world have now lost their larger, migratory fish and catches are totally dominated by very small species. In these terms, the Mekong is notable because giant fishes are still caught fairly regularly. This suggests that the fishery is still in reasonably good shape, and investments in proper management are worthwhile.

Adverse changes in biodiversity of fishery resources are undeniable. The underlying causes, however, are far from clear. Fishing pressure is certainly increasing, but environmental changes are occurring even more rapidly. Thus, it is often not possible to identify the root cause for the decline of individual species. It is obvious, however, that fisheries cannot withstand both current exploitation levels and environmental degradation. It is also unwise to assume all the elements of the fishery resource are equally resistant to fishing pressure. A sensible approach is to identify the most vulnerable aquatic fauna and promote appropriate management within the fishery. Even more important though, is attention to the major threat to biodiversity - that is, environmental degradation.

[13] Coates, 2002

[14] Van Zalinge, 2003

[15] Rainboth, 1996

Have biodiversity concerns been incorporated into fisheries management?

In general, individuals, communities, and government agencies in the fisheries sector in the Mekong do not distinguish between the management of "biodiversity" and fisheries. There are, however, some examples where fisheries management does address biodiversity concerns.

These include:

- The recent official ban by Viet Nam on the use of small *dai* for catching juvenile catfish (imposed over fears of the impacts on catfish stocks, as well as on other species).

- Widespread official bans on the use of destructive fishing practices such as electrofishing equipment (Cambodia and Viet Nam), poisons and explosives (all countries).

- Widespread restrictions on fishing effort, usually by gear type, mesh size, location, season and method of deployment, but sometimes by access.

More rare are restrictions on harvesting certain species, notably giant catfish.

Cambodia is currently considering closing down a number of the larger *dai* in the Tonle Sap River which are responsible for catching most of the giant fishes (especially giant catfish) which are migrating from the Great Lake.

By and large, government-imposed restrictions do not work effectively, except possibly for the larger, easily-monitored gears such as the stationary *dai*. There is widespread abuse of the regulations and little effective enforcement. For example, the recent official ban on small *dai* for juvenile catfish is thought to have had limited impact as many illicit operations continue.

Managing fisheries through the fishing lot system - as in Cambodia, for example - may have significant benefits for access within clearly demarcated boundaries and seasons. Lot owners, because of their investments, enthusiastically protect the resource, including the habitat within lot boundaries.

Another benefit of the fishing lot system is the revenue generated for the government. Worldwide, wherever fishery resources have been protected from open access and over-exploitation, the results represent a win-win situation: that is, both biodiversity and fisheries production improve.

Examples of community-based management initiatives are relatively widespread in the Mekong. Most of these have beneficial implications for sustaining biodiversity and include the efforts with dolphins mentioned earlier.

In a recent survey in northern Lao PDR[16], 52 percent of villages reported that they had effective traditional management systems which include: (1) conservation zones, such as deep pools in rivers where fishing is limited to certain times. These are often of local religious significance; (2) seasonal restrictions (especially at spawning times); and (3) gear restrictions, not only for poisons and dynamite, but also for gears used to obtain excessive catches, especially of vulnerable migrating schools. There are also occasional restrictions on species, which can be imposed by restricting the use of species-specific gears or the timing of their deployment.

Many of the aquatic species have significant cultural value, especially the giant fishes. For example, to celebrate the 50th anniversary of the ascension to the throne of the King of Thailand in 1996, Thai fishermen decided to send all the Mekong giant catfish they caught to the Thai Department of Fisheries for breeding.

These management measures require much more support and promotion, but their existence bodes well for sustaining biodiversity. Since many management initiatives are aimed at migratory species, these activities will also have benefits internationally. However, for this management to be successful, it must be supported by reciprocal management measures in the other areas to which the species migrate. Regional coordination of management systems is therefore very important. Regional proposals to improve the management of trans-boundary fish stocks, particularly for the more prominent "giant" species, have much to contribute to improving international cooperation within the basin.

For the migratory fishes, there is need for conservation measures at both the national and the international levels. A number of international agreements already exist under which biodiversity conservation can be promoted. These include:

- The Code of Conduct on Responsible Fisheries which FAO developed in 1995
- The Convention on the Conservation of Migrating Species of Wild Animals (CMS)
- The Convention on Biological Diversity
- The 1995 Agreement on Cooperation for the Sustainable Development of the Mekong River Basin

National and international arrangements are particularly important with respect to the use of exotic species and varieties of native species in aquaculture.

In terms of fisheries regulations and legislation, the picture in the Mekong is much the same as elsewhere. Top-down, government-centred approaches are generally not effective, especially for the majority of fishers who use smaller gears. Community-based management systems are much more effective, especially when supported by government. While this approach is being promoted in the Mekong, biodiversity conservation is still not firmly on the agenda of most fisheries management agencies. Management efforts need to be directed specifically at those species, areas and communities where biodiversity concerns are the greatest.

Management approaches in the fisheries sector in the Mekong, in general, have not acknowledged the need to manage environments. This can be seen in most community-based management systems, which focus solely on the management of problems arising from within the fishery - that is to say, on managing fishing effort.

However, fishing communities are almost unanimous in their assertions that the major threats to their fishery resources arise from "outside" influences, and especially from environmental degradation. Unless fishery-dependent communities can manage influences from other sectors, these important fisheries may be doomed. Yet local communities, and often even relevant government agencies, have little influence over managing the environment upon which the fisheries depend. They must begin to be much more involved in managing the environment. This is even more crucial where major trans-boundary environmental impacts are concerned.

The current healthy state of the Mekong Basin's aquatic environment can be attributed more to the slowing of development as a result of years of conflict, than to rational resources

management. More recently, however, attitudes and policies are showing signs of significant change. Several policy shifts towards sustainable development in rivers have been stimulated by fisheries considerations. Many of the recommendations made by the World Commission on Dams[17], for example, were stimulated largely by the impacts that dams have had upon fisheries. The recommendations include approaches to development that centre more on sustaining livelihoods, as opposed to "cost-benefit analysis" which focuses on investment profits. This is a major leap forward in natural resources management. In addition, recent shifts by both donors and governments towards more socially just policies centred on sustaining livelihoods are significantly raising the profile of inland fisheries. The fisheries sector is, therefore, finally playing a major role in ecosystem diversity and complexity, and hence in biodiversity management.

Effective intergovernmental cooperation to manage major environmental threats will be fundamental to the success of biodiversity management in the Mekong region. For the Lower Mekong Basin countries, the 1995 Agreement establishes the principle of environmental integrity being fundamental to sustainable development, poverty alleviation and protection of livelihoods. Conserving biodiversity as such is not explicitly mentioned, but is implicit within the concepts adopted.

The 1995 Agreement also presents a framework to help implement the international conventions relating to biodiversity in the Mekong context. These instruments, in particular the Convention on Biological Diversity, need to be much more clearly identified and promoted.

[16] Sjorslev (Editor), 2001

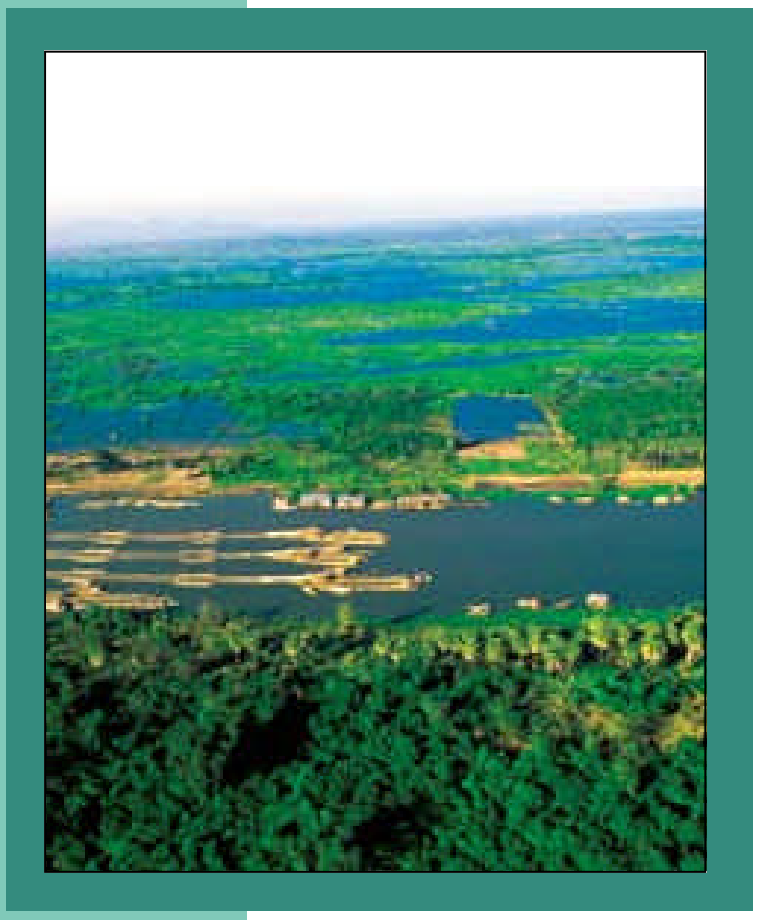
[17] World Commission on Dams, 2000

Examples of Best Practice

Management of internal fisheries problems

By far the best examples of fisheries management systems in the Mekong are the community-based initiatives. Where human communities are stable, and able, resource users have traditional and sometimes contemporary management systems that improve sustainability and biodiversity. Unfortunately, communities cannot always cope with the pressures of development, especially pressures created by increases in population. Without internationally coordinated efforts, communities also may not be able to address the requirements for sustaining trans-boundary resources. The combination of community-based systems, operating in collaboration with government, appears to be the best means of managing the use of resources.

Another example of fisheries management in the Mekong is the fishing lot system used in Cambodia. This system is very effective in galvanising users to protect the resource. Because the government earns revenue from the system, it has an increased stake in protecting the resource. The system also helps, at least potentially, to share the profits from the resource with the larger community, through taxes. The system also demonstrates three other important points: (a) given the will, that access can be controlled, (b) that the resource has significant value, and (c) that governments actually recognise the value of the resource.



The lot system also creates a relatively wealthy "elite" of resource users with the potential to be a positive influence. In practice, the extent to which lot "owners" manage their operations for sustainability is debatable, but the system at least shows the beginnings of some environmental protection, and provides a basis for further work.

Another good example of progress in management approaches in the Mekong is the use of local ecological knowledge in research and policy formulation[18]. This has led to cost-effective means of obtaining information and to a much greater recognition of the value, extent and

relevance of local knowledge. This includes knowledge about natural history and biodiversity. This approach, if developed fully, should lead to improved management. The approach is also laying better foundations for the participation of resource users in future resource management systems.

In relation to managing the potential impacts of exotic species, and of strains or varieties of native species, the only documented approach to be successful is that of using a code of practice[19]. Such guidelines should be based on consideration of the potential impacts of introductions or transfers at the genetic level, that is, impacts upon genetic diversity. It is essential, however, that such codes be developed with the participation of the relevant stakeholders, at regional and local levels. The current constraints are not the absence of improved tools, but the lack of motivation to use them.

Management of environmental factors

Perhaps the most important need in the Mekong is to adequately manage aquatic resources in the context of balancing the needs of multiple users - particularly for water resources. Included in this is the need for better management of trans-boundary environmental impacts. The most valuable natural resource in the Mekong is not the fishery, nor rice, but the water itself. Sustainable development of the Mekong River Basin, which encompasses sustaining the aquatic habitats and the biodiversity they support, will ultimately depend upon the ability of the relevant riparian countries to appropriately manage water resources, both nationally and in cooperation across borders. At the technical level, this requires sound policies on water resources utilisation and also basin-wide planning.

Consideration of the needs of the fisheries sector, and the biodiversity upon which it is based, will contribute significantly towards achieving these larger goals. The primary consideration here is that it is the fisheries sector that provides the strongest arguments on social economic and biodiversity grounds, for more rational water resources management. Those promoting biodiversity conservation in the Mekong region need to recognise this reality more fully. In the quest for sustainable development, considerable benefits are on offer through partnerships between "fisheries", "environment" and "biodiversity" specialists. Better still would be to acknowledge that there should be no boundaries between them.

[18] Bao *et al.,* 2002

[19] Coates, 1995b

Conclusions and Recommendations

1. Capture fisheries are not the major threat to biodiversity in rivers - environmental degradation is.

2. The important role that river fisheries play in maintaining aquatic biodiversity must be promoted more widely. Emphasising the importance of fisheries to livelihoods and food security provides the strongest and most relevant argument for improved management of the aquatic environment.

3. There are considerable differences between river fisheries and marine fisheries in methods of exploitation, participation, spread of economic benefits and impacts on biodiversity. Conclusions drawn from marine fisheries are therefore often not applicable to inland fisheries.

4. Fisheries activities can have negative impacts upon biodiversity. Improved management of exploitation, by moderation the use of unsustainable fishing practices, should centre on the promotion of co-management approaches. Management initiatives need to be prioritised, focusing on those species and habitats under greatest threat.

5. The fishing "lot" system should be properly and scientifically evaluated to determine if it is an effective tool for sustaining biodiversity. Studies should include consideration of whether social equity and sustaining biodiversity are necessarily mutually exclusive. There is considerable interest internationally in this system as a way of improving environmental management.

6. The use of local ecological knowledge as both a research tool and a mechanism for improving participation in management should be promoted more widely. There should be increased recognition of the importance of this knowledge base for biodiversity-related subjects.

7. Management measures for the introduction or transfer of exotic species or strains should include consideration of

genetic diversity and, in particular, the biodiversity of wild resources. This can be achieved through the development and, more importantly, implementation of workable codes of practice using pre-introduction assessments of the movement of exotic species of strains.

8. Aquaculture should be managed to avoid significant negative impacts upon biodiversity. Negative impacts can result from the escape of exotic species, and from practices that destroy productive habitat (such as converting mangrove forests to shrimp ponds).

9. There should be more widespread recognition and use of existing instruments for promoting sustainable management of fisheries, including attention to biodiversity needs. In addition to the 1995 Agreement on Sustainable Development of the Mekong River Basin, these instruments include the Code of Conduct for Responsible Fisheries which FAO prepared in 1995, the Convention on Biological Diversity (in particular, promotion of its implications for fisheries management), and the Convention on Migratory Species.

10. Reviews, guidelines and promotional materials should, where necessary and appropriate, be written and disseminated in a language and medium that can be easily understood by target audiences (including resource users). This includes references to what biodiversity is, why it is important and how it can be affected, negatively or positively, by management actions.

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