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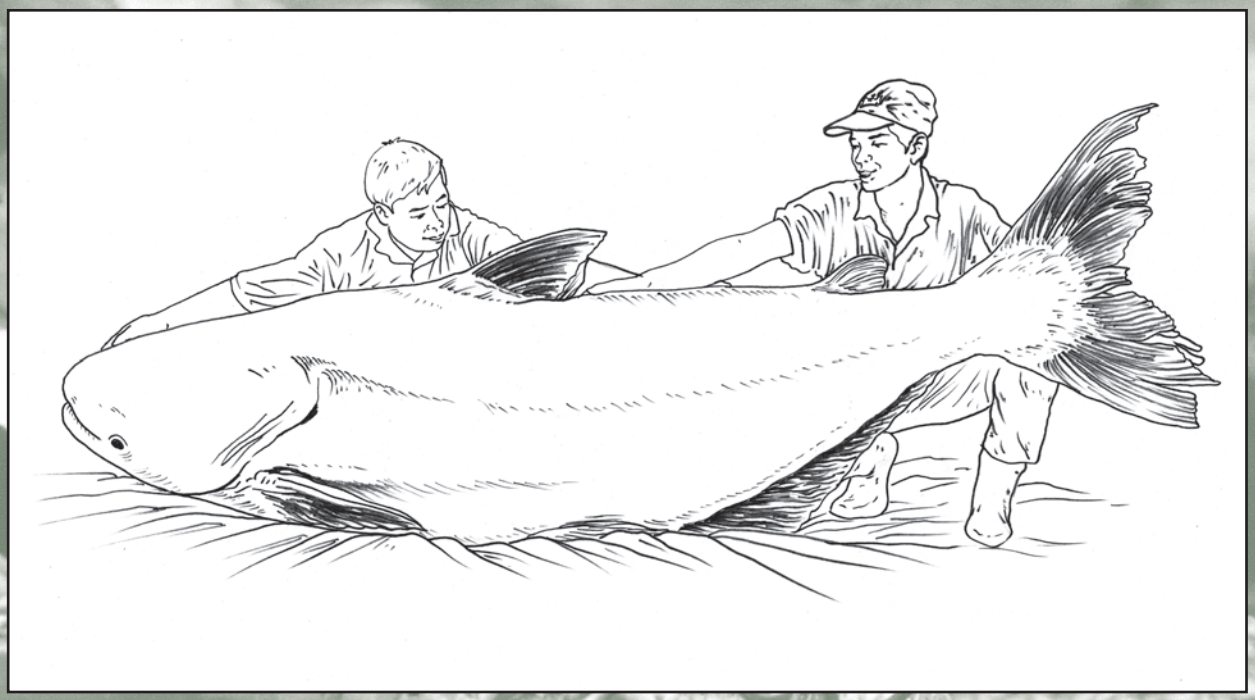

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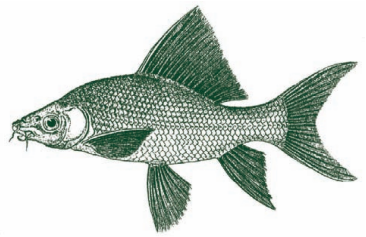
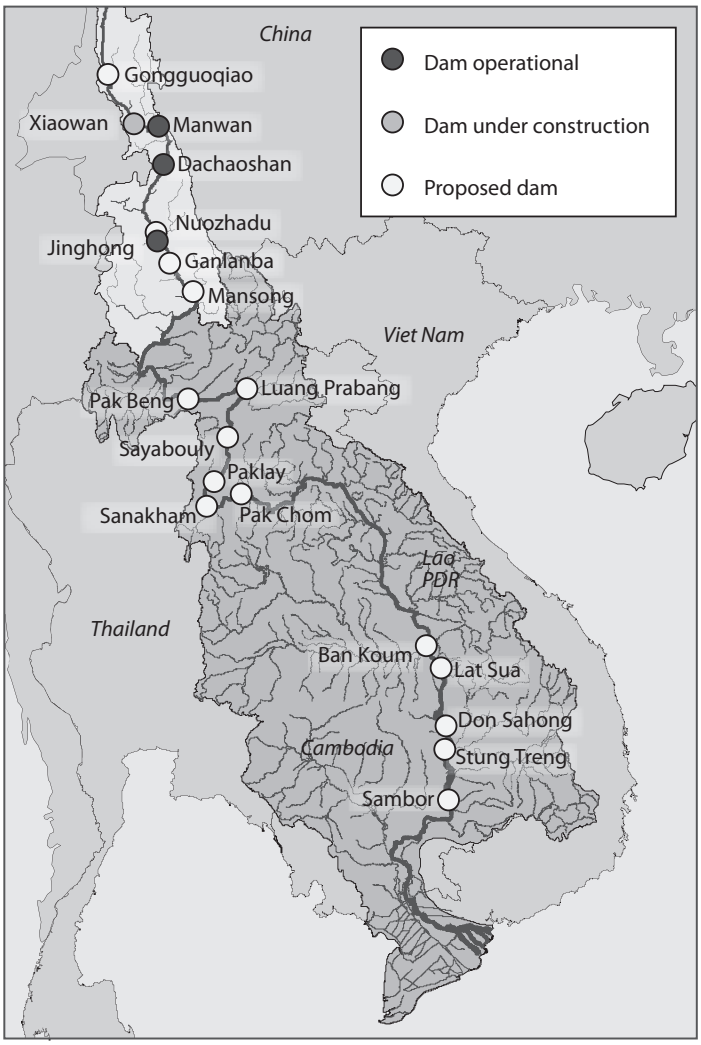
Editorial

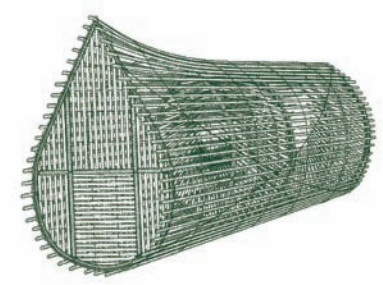


In this issue, our biggest ever, we look at how fisheries emerged as a key issue at a regional conference on hydropower development convened by the MRC in Vientiane in September. We also review a meeting of independent experts that immediately preceded the conference to examine the barrier impacts of dams on fish migration in the Mekong. The group of 17 experts from various disciplines found that mainstream dams in the Lower Mekong Basin would adversely affect the migratory fish, especially in the lower part of the basin where fish production is highest. A separate article looks at three different approaches to estimating the size of migratory fish resources in the lower basin. Another article discusses the possible impact of mainstream dams on the Mekong giant catfish, one of the region's flagship species.



We also feature the final article in our three-part series on the hydrology of the Mekong system which examines the magnitude of flooding in the Lower Mekong Basin and whether extreme floods are becoming more common. Among recent developments in member countries, we look at Cambodia's move to establish the Tonle Sap Basin Authority and the promotion of gender issues in Thailand, where the Department of Fisheries was awarded earlier this year as an outstanding government agency in the field.

We would like to take this opportunity to wish all our readers a happy, healthy and prosperous New Year.



Fish migration emerges as **key issue** at regional **hydropower** conference

With preliminary information on most mainstream dam proposals already available, stakeholders are now seeking an integrated basin-wide approach to the sensitive issue of hydropower development in the Lower Mekong Basin

Senior officials from the Cambodian, Lao, Thai and Vietnamese governments gathered in Vientiane in September for a two-day conference on the MRC's new Hydropower Programme. Officials from China also took part along with engineers, bankers, ecologists and members of civil society. Financed by Japan's ASEAN Integration Fund, the "regional multi-stakeholder consultation" was the first of its kind with almost 200 delegates attending. Chaired by Lao National Mekong Committee Director General Chantavong Saignasith, the conference featured speakers from all MRC governments as well as the International Hydropower Association, the WorldFish Centre, the World Bank, the Asian Development Bank (ADB), the World Wildlife Fund (WWF) and the United States Army Corps of Engineers. Presentations were also made by China's Sinohydro Corp, France's Compagnie Nationale du Rhône, the NGO Forum of Cambodia and International Rivers, an advocacy non-governmental organisation based in California.

In addition to helping to design the new Hydropower Programme, MRC Chief Executive Officer Jeremy Bird told delegates that the consultation aimed to raise awareness of different perspectives and common interests related to hydropower development. Above all, however, it was an opportunity for stakeholders to meet and build trust. "This will be important in the future when inter-governmental discussions on mainstream dams will need to ensure their contribution to the sustainable use of resources in the basin," he said in an opening address. Mr Bird acknowledged that dams were sensitive. "Sensitivity, however, is not a reason to avoid engagement on the subject," he added, noting that greater openness and discussion could improve outcomes. "Many of the good-practice examples being implemented on the Nam Theun 2 project, for example, are a direct result of a more open planning process which involved listening to a broad range of views."

Mr Bird said that preliminary information on most of the proposed mainstream dam projects had already been shared among the four MRC countries, and that notification and prior consultation would begin in the coming months. "As notification of projects will be made at different times, it is important to have an integrated basin-wide assessment framework," he said. As an example of such an integrated approach, Mr Bird noted that the MRC was already helping the Lao government to study ways to optimise the benefits of proposed dams in the upper part of the basin as a whole rather than letting developers maximise production from indivual projects independently. He also highlighted the role of the MRC's Fisheries Programme in examining technical options and likely survival rates for fish to migrate through dam obstructions. "The fisheries issue, let us be clear, goes beyond biodiversity," he said. "It is at the heart of people's subsistence livelihoods."

The main presentation on fisheries was delivered by Dr Patrick Dugan, Deputy Director General of the WorldFish Center who reported on a two-day meeting of independent experts to examine the barrier effects of mainstream dams on fish migration in the Mekong. Held immediately before the conference, this separate meeting convened by the MRC in Vientiane brought together 17 biologists, ecologists and engineers who have been working to reduce the impacts of dams on fisheries in various river systems around the world. In his presentation to the broader conference, Dr Dugan

Dr Patrick Dugan of WorldFish Center
Photo: Lem Chamnap

discussed the importance of fish migration for fisheries production in the Lower Mekong Basin, the effects of dams on these migratory species, and the possible options for mitigation (for a detailed account of the expert group meeting, see Dr Dugan's article starting on page 9).

In a separate presentation, Dr Bolyvong Tanovan of the United States Army Corps of Engineers, highlighted the importance of integrating mitigation measures into projects at an early stage. Over the past two decades, he noted that power operations on the Columbia River had been constrained by conservation listings for several species of salmon and trout. As a result, energy production of 1,000 megawatts a year had been foregone in order to prioritise fish passage. Dr Bolyvong, chief of the water management power branch of the Army Corps of Engineers northwest division, also noted that the annual fish mitigation costs for the Columbia River had ballooned from $40 million in 1978 to $500 million in 2004, amounting to $9 billion to date. By 2004, fish mitigation costs represented 16 percent of the revenues of the Oregon-based Bonneville Power Administration, a federal agency under the Department of Energy. These costs were expected to range from $80 million to $130 million a year over the next five years.

The preparation of the MRC's new Hydropower Programme coincides with increased interest in hydropower development to meet rapidly-growing demand for energy in the Mekong region. Developers have been considering many potential projects and negotiations on several concessions are already at an advanced stage. In addition to dams on tributaries, these include projects across the mainstream of the Mekong River. Until now, the only mainstream dams on the river have been in the Upper Mekong Basin in China. Mainstream projects in downstream countries are, however, now more viable due to high oil prices and new dams in China which will result In increased water flows downstream during the dry season. Concern over climate change has also made hydropower more attractive as a source of energy. The proposed mainstream projects in the lower basin would have an installed capacity of more than 14,000 megawatts, similar to the combined capacity of existing mainstream dams or those either under construction or planned in China. That's equivalent to more than four times the capacity of existing hydropower projects on tributaries in the lower basin.

Dr Bolyvong Tanovan of the United States Army Corps of Engineers
Photo: Lem Chamnap

Recent efforts to formulate the Hydropower Programme follow the signing of a four-year agreement with Finland worth US$2.87 million late last year. The four MRC countries already have a regional Hydropower Strategy approved in 2001 and an outline for a Hydropower Programme approved in 2005. Under the outline, the Fisheries Programme has been learning more about the impact of dams on fish migration, spawning and production. The Environment Programme has been assessing environmental and social impacts, especially across borders. The Basin Development Plan Programme has been assessing the cumulative impacts of dams on water flows, sedimentation and water quality. And in a joint initiative with the ADB and WWF, the MRC last year published a technical report on environmental criteria for hydropower development in the Mekong region. The report found that Bhutan's sectoral guidelines for hydropower seemed to be suitable for preliminary screening in the Mekong region but would be difficult to use in comparing slightly different proposals. Of the three international environmental criteria frameworks reviewed, the sustainability guidelines of the International Hydropower Association were found to be the most comprehensive and possible best

Mainstream dams **proposed**

Project Name	Country	Province	Location[1]		Installed Capacity[1] (MW)
			North	East	
Pak Beng	Lao PDR	Oudomxay	19'52.7"	101'08.7"	1,230
Luang Prabang	Lao PDR	Luang Prabang	20'05.0"	102'10.4"	1,410
Xayaboury	Lao PDR	Xayaboury	19'15.1"	101'48.8"	1,260
Pak Lay	Lao PDR	Xayaboury	18'19.5"	101'31.6"	1,320
Sanakham	Lao PDR	Vientiane	17'57.3"	101'25.0"	570
Pak Chom	Lao PDR/Thailand	Vientiane/Loei	18'12.2"	102'03.0"	1,079
Ban Khoum	Lao PDR/Thailand	Champassak/Ubon Ratchathani	15'25.1"	105'35.2"	2,000
Lat Sua	Lao PDR	Champassak	15'19.2"	105'37.0"	800
Don Sahong	Lao PDR	Champassak	13'57.4"	105'57.8"	360
Stung Treng	Cambodia	Stung Treng	13'33.0"	105'57.0"	980
Sambor (0ption 1)	Cambodia	Kratie (Sambor)	12'35.0"	106'01.0"	2,600

Sources: Lao National Mekong Committee and MRC databases

[1] **Preliminary figures, subject to change**

in the **Lower** Mekong **Basin**

Status	Developer/*Promotor (Country)	Dam Height[1] (m)	Rated Head[1] (m)	Inundated Area[1] (km^2)
MOU signed 29/08/2007	Datang International Power Generation Co. Ltd. (China-Hong Kong)	62.1	20	110
MOU signed 14/10/2007	PetroVietnam Power Corporation (Viet Nam)	68	20	110
MOU signed 04/05/2007	Ch.Kanchang & PT (Thailand)	53	16.26	30
MOU signed 11/06/2007	CIEC & Sinohydro (China)	54.5/45.5	18	110
MOU signed 11/12/2007	Datang International Power Generation Co. Ltd. (China-Hong Kong)	38	18	
	*Department of Alternative Energy Development and Efficiency, MoE, Thailand (Thailand)	55	25.5	80
MOU signed 25/03/2008	Italian-Thai Development PLC & Asia Corp, Holdings Limited. (Italy-Thailand)	53	25.5	158
MOU signed 02/04/2008	Charoen Energy and Water Asia Co. Ltd. (Thailand)			
MOU signed 23/3/2006 PDA signed 13/02/2008	Mega First Corporation Berhad (Malaysia)	10.6/8.2/8.3		1.6
		22		640
		54		880

MOU = Memorandum of Understanding
PDA = Project Development Agreement

Dr Ma Chaode of WWF China
Photo: Lem Chamnap

starting point for the Greater Mekong Subregion. Before embarking on major investments, the report found advantages in moving away from assessing individual projects towards strategic environmental assessments of cumulative or basinwide impacts.

As the Hydropower Programme takes shape, the MRC has proposed a two-track approach. The first aims to improve understanding about the regional implications of hydropower development in the short term. The main focus will be on to what extent the negative impacts of the barrier effect of mainstream dams can be minimised or mitigated. According to a preliminary draft programme document circulated at the September conference, this is "one of the most important questions facing mainstream hydropower development." The conclusions of the meeting of 17 experts will therefore be valuable information for regional planning discussions regarding economic growth, poverty reduction and sustaining the environmental services of the river as hydropower projects are developed.

The second track will take a longer-term approach and will require more detailed work in areas ranging from environmental and social issues to the development of standards for navigation locks. Spread over two years starting in September, the second track will include various levels of dialogue between policymakers as well as private-sector developers, financiers and civil society. The MRC will also convene regular multi-stakeholder consultations similar to the conference in September and continue its dialogue with China as both an upstream partner and as a sponsor of projects in the lower basin.The programme is expected to be overseen by a Hydropower Advisory Board comprising representatives of National Mekong Committees and senior officials from line agencies. The estimated budget for the programme is between $6 and $7 million between 2008 and 2011.

Further reading

King, Peter, J Bird and L Haas (2007). *The Current Status of Environmental Criteria for Hydropower Development in the Mekong Region: A Literature Companion,* Asian Development Bank, Mekong River Comission Secretariat and WWF, Vientiane

Mekong River Commission (2008). *Draft Programme Document,* Hydropower Programme, MRC, Vientiane (www.mrcmekong,org/programmes/hydropower.htm)

Dr Sam Nuov, Deputy Director of the Cambodian Fisheries Administration, and Mr Nguyen Van Trong, Deputy Director of the Vietnamese Research Institute for Aquaculure No. 2, during a break in the conference.
Photo: Lem Chamnap

Mainstream dams as **barriers** to fish **migration:** international **learning** and **implications** for the Mekong

By Patrick Dugan*

Mainstream dams in the middle and lower reaches of the Lower Mekong Basin could affect more than 70 percent of the basin's catch. If such projects go ahead, experts agree that it would be better to build mainstream dams further upstream or relocate them to tributaries where they will have less impact on the dozens of fish species migrating over long distances.

The MRC Secretariat convened a regional stakeholder consultation on hydropower from 25-27 September 2008 in Vientiane in light of the growing regional interest in the construction and use of hydroelectric power dams on the Mekong mainstream. To help prepare for this consultation, the MRCS also convened an international expert group from 22-23 September to review the impact of mainstream dams on fish migration. The 17 group members (see box) brought together extensive expertise in fish biology and ecology, and in efforts to design and operate hydro dams so as to reduce their impacts on fisheries. The members have worked on these issues in a wide range of countries and river systems in Asia, Africa, Australia, Latin America, North America and Europe, and so brought to the Mekong a wealth of experience and comparative ability. Together they were able to provide an authoritative assessment of the issues and their conclusions were conveyed to the stakeholder consultation on the first morning.

The group addressed 14 frequently asked questions (see box on page 13), which together covered five broad areas of concern:

1. What is the importance and nature of fish migration in the Mekong?
2. What will be the impact of barriers to migration on fish and fisheries in the Mekong?
3. Can fish-passage facilities be used to provide effective passage for fish migrating upstream?
4. Can fish-passage facilities be used to provide effective passage for fish migrating downstream?
5. What can be done to compensate for losses in fisheries yield caused by dams?

Members of the Expert Group

Dr Patrick Dugan, Deputy Director General of WorldFish Center, Cairo, Egypt
Prof. Ian Cowx, Director of the University of Hull International Fisheries Institute, United Kingdom
Dr Miguel Petrere, Universidade Estadual Paulista, Brazil
Dr Angelo Agostinho, Maringa State University, Brazil
Dr Eric Baran, WorldFish Center, Phnom Penh, Cambodia
Mr Roel Schouten, Environmental Engineer, Lao PDR
Dr Tuantong Jutagate, Ubonratchatani University, Thailand
Dr Sinthavong Viravong, Living Aquatic Resources Research Centre, Lao PDR
Dr Martin Mallen-Cooper, Fishway Consulting Services, Australia
Dr Glenn Cada, Oak Ridge National Laboratory, USA
Dr Gerd Marmulla, FAO, Rome, Italy
Dr John Ferguson, Northwest Fisheries Science Center, USA
Dr John Nestler, US Army Corps of Engineers, USA.
Dr Robert Davidson, US Army Corps of Engineers, USA
Prof. Chen Daqing, Yangtze River Fisheries Research Institute, PR China
Dr Pratak Tabtipawan, Kasesart University, Thailand
Mr Garry Thorncraft, fisheries consultant, Lao PDR

The group's response to these areas of concern is summarised below.

What is the importance of fish migration in the Mekong?

The Mekong supports the world's largest inland fishery, with approximately 2.6 million tonnes harvested annually from the Lower Mekong Basin (LMB) (van Zalinge *et al.,* 2004; Hortle, 2007). The full economic value of this fishery is still being assessed, but most recent estimates exceed US$2 billion at first-sale value (Lymer et al. in press; Mekong River Commission, 2005; van Zalinge *et al.* 2004). To this should be added the value generated through processing, transport and marketing of the product; in Cambodia for instance, the value of raw fish on retail markets represents 2.8 to 4.7 times the first-sale value (Yim & McKenney, 2003; Rab *et al.,* 2004). Applying the same multiplier as a primary approximation, the total economic value for the Mekong fisheries is estimated at between US$5.6 and US$9.4 billion per annum. To this economic value should be added the many tens of thousands of enterprises that support the fishing communities, ranging from the shops and foods stalls that supply the fishing families, to boat builders and suppliers of fishing gear.

Underlying the dollar value of the Mekong fishery at the basin scale is the importance of fishing for household economies. In Lao PDR, more than 50% of people fish, and fishing provides 20% of household income; in the south of the country, fishing is even more important and here 80% of people fish. Of special importance is the linkage between fisheries and other sectors. For example, income from fisheries provides cash to buy rice seed at the end of the long dry season. In Cambodia, 80% of the 1.2 million people living around Tonle Sap use the lake and its rivers for fishing, and for 39% of these people fishing provides their primary income (Ahmed *et al.*, 1998). This importance is mirrored downstream in Viet Nam's Mekong Delta, where capture fisheries are crucial to livelihoods. In An Giang province, 60% of people are part-time fishers, 7% full-time fishers, and 5.7% fish processors (Sjorlev, 2001). In Tay Ninh province, 88% of the "very poor", 84% of "low income", 58% of "medium income", and 44% of "high income" households depend on fisheries (Nho and Guttman, 1999).

In addition to these income figures, the Mekong's fisheries also play a central role in feeding the 60 million people who live in the LMB. For them, fish is the main source of animal protein and a critical source of micronutrients, particularly amino acids, vitamins and calcium (Baran *et al.*, 2007). Consumption of fish and other aquatic resources in the basin ranges from 29-39 kg per person per annum (Hortle, 2007) with the upper rates of consumption being amongst the highest in the world.

What will be the impact of barriers to migration on fish and fisheries in the Mekong?

Fish migration in the Mekong is primarily for breeding and feeding. Because the river's annual hydrological cycle involves large floods (with a 30-fold difference between high and low season discharge), fish migrate upstream to breed, after which their eggs and larvae are carried downstream to the floodplains where they feed and grow. Fish also migrate to feed, normally moving from the main course of the river onto the highly productive floodplains at the beginning of the rainy season. In the Mekong, most species combine feeding and breeding migrations. But upstream migrations are dominated by larger adult fish moving up river to breed while downstream migrations are mainly feeding migrations undertaken by young fish and adults returning from the breeding areas. Movements also include lateral migrations between the mainstream or tributaries and floodplains. Poulsen *et al.* (2002) and Baran and Jutagate (in press) have used the approach of Lévêque and Paugy (1999) and Welcomme (1985, 2001) to characterise the fish groups (or "guilds") in the Mekong according to their ecology and migration patterns:

- "Black fish" are those species with limited lateral migrations from the river onto the floodplains and no longitudinal migrations upstream or downstream. These fish do not leave floodplains and wetlands, and spend the dry season in pools in the rivers or floodplains. This group includes Channidae (snakeheads), Clariidae and Bagridae (catfishes) and Anabantidae (climbing perch).

- "White fish" undertake long-distance migrations, in particular between lower floodplains and the Mekong mainstream. This group includes many cyprinids (e.g. *Henicorhynchus* spp.

and *Cirrhinus* spp.) but also most Pangasidae catfishes.

- "Grey fish" do not spend the dry season in floodplain pools, but do not undertake long distance migrations either. When the flood recedes they leave the floodplain and tend to spend the dry season in local tributaries. This group includes for instance *Mystus* catfishes.

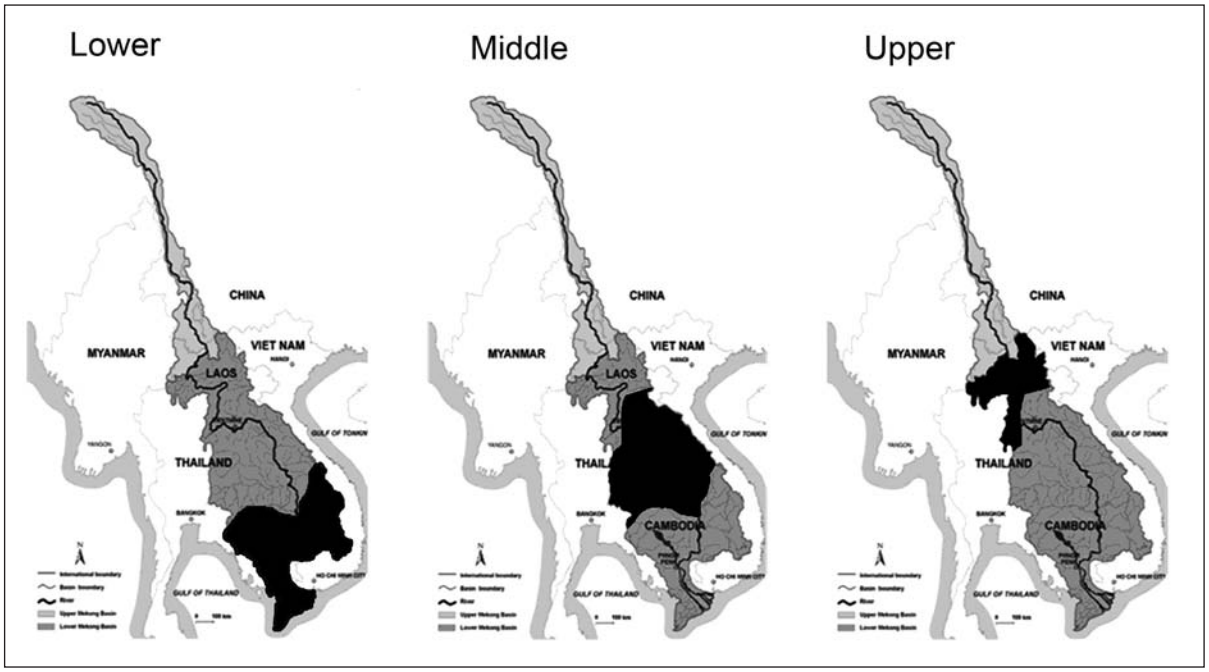
Dams are a barrier to fish migrations up and down rivers but the specific effect varies considerably depending on the groups concerned. The most important impacts will be on the long-distance migrants that move up the Mekong mainstream to breed, some as far as China. Critically, it has been estimated that more than 70% of the total fish catch in the Mekong Basin (i.e. more than 1.8 million tonnes worth US$1.4 billion at first sale) is dependent on these long-distance migrants. The effect of dams on fisheries production is also highly dependent on the location, design and operation of the dams (Baran *et al.*, 2007). The mainstream Mekong is a corridor for most long-distance migrations and most of the production originates from floodplains in the middle and lower part of the Basin (see map). Thus dams built on the mainstream will have a much greater impact than dams built on tributaries, while those located in the middle and lower part of the LMB will have a greater impact on fish production than dams located in the upper part of the basin.

'The effect of dams on fisheries production is highly dependent on the location, design and operation of the dams'

Can fishways be used to provide effective passage for fish migrating upstream?

Given the projected impact of dams on fish migration in the Mekong, and the consequent economic and social losses, there is great interest in the potential of engineering solutions to provide effective fish passage upstream across dams. The most commonly-used approach is fish ladders that provide a step wise flow of water through a series of small basins and waterfalls up which fish may pass. Other alternatives are fish lifts that physically lift fish up the dam in the same way that elevators lift people in buildings, and fish locks, which operate in a manner similar to, or are integrated into the operation of, navigation locks. Finally, in some rivers part of the flow may be diverted through an artificial river bypassing the dam along a gentle gradient, so providing an alternative route along which fish may move.

The three fish migration systems of the Lower Mekong Basin



Source: Baran & Jutagate (in press) after Poulsen et al. *(2002)*

Despite their diversity, the Expert Group concluded that there is currently no evidence that fish-passage facilities used in large tropical rivers in Latin America, Africa and Asia can cope with the massive fish migrations and high species biodiversity in the Mekong. Indeed, best evidence from South America (Oldani & Baigin, 2002) is that the success of fish ladders and lifts there is low even though the number of species and volume of migration there is lower than in the Mekong. Similarly, the group agreed that the technologies used on high dams in North America and Europe (mainly fish ladders and fish lifts) have been developed for a very limited range and number of fish species (generally about 5 to 8 species). Most of this experience has been with salmonid fish which have remarkable jumping abilities that enable them to scale waterfalls and fish ladders more successfully than any other group of fish. Biomass of fish involved is also

'Dams on the mainstream in the middle and lower part of the LMB will have a major impact on fisheries and serious economic and social implications'

relatively small, at around 3 million fish per year on the Columbia River in the USA. This experience from North America and Europe contrasts with the Mekong where there are at least 50 important migrant species, none of which are salmonids, and biomass is in the order of 100 times greater.

On the basis of this analysis of available information, the meeting concluded that current fish-passage technology would not be effective in maintaining the migration of the large number and diverse fish species found in the Mekong. In view of this conclusion and the assessment of the value of the Mekong's fisheries, the group concluded that dams on the mainstream in the middle and lower part of the LMB will have a major impact on fisheries and serious economic and social implications. It went on to conclude that because there is less fish migration into the upper part of the LMB, dams built on the mainstream higher up in the basin would have less impact on fisheries production than dams built further downstream.

Can fish passes be used to provide effective passage for fish migrating downstream?

Dams are also a barrier to fish migrating downstream, together with their eggs and fry. They therefore need to find a way across, through or around the dam. There is currently little evidence regarding the performance of such fish-passage facilities on the Mekong or any other tropical rivers. Most experience in developing technologies that allow downstream migration has been in North America and Europe, where a range of approaches have been used. These include spillway passages, louvers and other behaviour-guidance technologies to channel fish away from turbines and through spillways or fish by-passes; and surface collectors and barges that physically capture and transport fish past the dam. These are all dependent on knowledge regarding the size and age of the specific fish species being targeted, their swimming abilities, and their distribution in the reservoir behind the dam, together with equally specific information on seasonal changes in conditions within the reservoir and water flow, and key elements of dam design and operation, such as the location of the turbines and spillway.

There is also growing attention being given to the possibilities of reducing the mortality caused by fish passage through turbines. Studies have shown that survival through conventional (existing) turbines ranges from virtually zero in adult eels of *Anguilla* spp. (Montén, 1985) to very high levels of >95% (Eicher Associates Inc, 1987). This depends on numerous biological variables (fish species, size, and life stage) and physical variables (type of turbine, head, number of blades, and rotation speed). In general, survival is highest through horizontal, adjustable (bulb) turbines, followed by vertical axis, adjustable (Kaplan) turbines, then vertical axis, fixed (Francis) turbines, and finally impulse turbines (Pelton). Of the two most commonly-used turbines, survival is higher through Kaplan turbines than through Francis turbines because Francis turbines utilise higher head, more blades,

'Newly designed fish-friendly turbines are being tested in the USA. At the present moment, however, these are only at the experimental stage'

and rotate at higher speeds than Kaplan turbines, increasing the risk of mortality from blade strike, pressures, and hydraulic shear. However these studies have only been done on a limited number of species (usually salmonid fishes) and dams.

To address this problem, newly designed fish-friendly turbines are being tested in the USA. At the present moment, however, these are only at the experimental stage and none has been tested at full operational scale. There are therefore substantial uncertainties about their viability and benefits, including very limited information on their impact on different species and life stages, and on the indirect mortality they cause.

Questions Addressed by the Group

1. What is the importance of fish migration in the Mekong?
2. What is a barrier to fish migration?
3. Would a barrier to migration have the same affect on all fish species?
4. Can fish ladders be used to provide upstream passage for migrating fishes?
5. Can other types of fish passes (such as fish locks and fish elevators) be used to enable fish to pass high-level dams?
6. Should fish passes be built if the upstream habitat has been altered?
7. Can fish survive downstream migration over spillways and through hydroelectric turbines?
8. Do fish friendly turbines produce less electricity than traditional turbines?
9. Are there mechanisms for guiding fish away from entrainment in turbines, and through an alternative route for downstream migration?
10. How do survivals of fish passing hydroelectric dams via different routes (turbine, screening and bypass, spill, trap-and-transport) compare?
11. What measures can be undertaken to maximise the yield from fisheries created in reservoirs used for hydropower production?
12. What measures can be undertaken to maintain fisheries production in rivers downstream of dams?
13. How does the yield from fisheries created in impoundments after dam construction compare with the yield lost from the former riverine fishery?
14. What general conclusions can be made, based on experience, about the effects of dams on fisheries resources in tropical rivers?

What can be done to compensate for losses in fisheries yield caused by dams?

Dams create reservoirs and these provide potential for fish production (Bernacsek,1997). However, the ecological conditions in these reservoirs differ greatly from those in the undammed river and the fisheries production that can be achieved there is dependent on a wide range of factors including location, depth, surface area and management regime. Because fish production is generally higher in large rivers and on lowland floodplains, it will normally be more difficult to compensate for losses in production caused by dam construction in these areas than when dams are constructed on tributaries and further upstream.
In large African reservoirs with moderate to heavy fishing effort, yields range from 27-65 kg/ha/year. In medium-sized reservoirs, this figure rises to 80 kg/ha/year. Highest yields in Africa are recorded in small reservoirs, and this is also true of shallow reservoirs in Lao PDR where yields are about 90 kg/ha/year. However, these production figures compare unfavourably with estimated yields of 50-500 kg/ha/year from natural Mekong floodplains (Hortle, 2007). Most mainstream dams proposed for the Mekong will create deep reservoirs confined to the river channel so fisheries production there is likely to be most directly comparable to the relatively low production recorded in large African reservoirs. Estimates of production from dams in South and Southeast Asia indicate that productivity levels are low and higher yields can be obtained only by fisheries enhancements such as stocking and fish cages, which necessitate significant additional cost in terms of both initial capital investment and recurrent annual costs. On the basis of this evidence, the Panel concluded that compensation for loss in yield from river fisheries is impossible to achieve through development of reservoir fisheries. Fisheries enhancements through stocking and some forms of aquaculture may be possible, but they will only be able to compensate for a small part of the production that is lost from the river fishery. They will also be costly, will not benefit the same people who

'On the basis of this evidence,compensation for loss in yield from river fisheries is impossible to achieve through development of reservoir fisheries'

currently benefit from the fishery, and can create substantial environmental problems.

What general lessons can be learned from mitigation efforts for dams in other regions?
The experience from river systems, dams and their fisheries in other regions is that each river fishery and every dam is unique. As a result, specific management measures need to be designed for each migrating species and each dam. In doing so, solutions for new dams cannot simply be copied from existing designs but can be developed from existing concepts. The approach to developing fish-passage devices designed to allow fish to migrate upstream or downstream past dams needs to be tailored to each species concerned and the location, design, and operation of the dam. Substantial biological knowledge for each fish species is required to design these measures. Where the number of species is high and the biological information is low, it is important to focus mitigation efforts on key target species, or design and apply multiple strategies for fish passage. For example, for downstream passage of multiple species of different sizes, high-flow volumes could be used in bypassing the turbines and/or multiple routes provided through and past the dams. This is likely to mean a reduction in the flow passing through the turbines and therefore a reduction in revenue generated.

'It takes many years of experimentation, and many hundreds of millions of dollars, to develop and apply effective mitigation measures'

An important lesson from the Columbia River is that successes in designing and operating fish passes have been realised because dams are managed for fish passage as first priority and power generation as second priority during the migration seasons. The chance of success with these approaches will be greatest where mitigation and flexibility are integrated into dam design at the start, rather than retrofitting which can be extremely expensive. Finally, the experience from other regions is that it takes many years of experimentation, and many hundreds of millions of dollars, to develop and apply effective mitigation measures. These costs and the time required to pursue effective mitigation need to be built into the planning and design of hydropower dams.

Conclusions

Bringing together the information presented in Vientiane, the group recognised that the Mekong's fisheries are of critical economic and social importance for the countries and people of the basin. It concluded that a large part of the benefit is dependent on mainstream fish migration and that mainstream dams will effectively stop much of this migration leading to reduced production, substantial economic cost and social deprivation. After reviewing the available evidence from dams in all other regions the group went on to conclude that on the basis of current knowledge:

- existing mitigation technology cannot handle the scale of fish migration on the Mekong mainstream;
- dams in the middle and lower LMB will have the largest impacts on fisheries and the largest economic and social costs;
- dams higher in the basin and on tributaries will have relatively less impact on fisheries production;
- if dams are built upstream and on tributaries, specific mitigation measures should be designed from the start and integrated into dam engineering and operation;
- in considering the design of mitigation measures existing off-the-shelf designs cannot be used, but the basic concepts used in developing these can be drawn upon.

The meeting also recognised that the ability to provide the partial mitigation measures seen in North America and Europe has been dependent on substantive research and development over several decades and on teams of highly qualified biologists and fish passage engineers. Similar investments will be needed in the Mekong before any level of certainty on their effectiveness can be determined.

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References

Ahmed, M., Hap Navy, Ly Vuthy and M. Tiongco (1998). Socioeconomic assessment of freshwater capture fisheries in Cambodia: report on a household survey. Mekong River Commission, Phnom Penh, Cambodia. 186 pp.

Baran, E., Jantunen, T. and C.K. Chong (2007). Values of inland fisheries in the Mekong River Basin. WorldFish Center, Phnom Penh, Cambodia. 76 pp.

Baran, E. and Jutagate, T (In press). What is the importance and nature of fish migration in the Mekong? In: MRC (ed.) Dams as barriers to fish migration in the Mekong, and possibilities for mitigation. MRC Technical Paper, Mekong River Commission, Vientiane.

Baran, E., Starr, P. and Y. Kura (2007). Influence of built structures on Tonle Sap fisheries. Cambodia National Mekong Committee and WorldFish Center, Phnom Penh, Cambodia. 44 pp.

Bernacsek, G. (1997), Large dam fisheries of the Lower Mekong countries: review and assessment. Project on Management of Fisheries Reservoirs in the Mekong Basin, Mekong River Commission, Phnom Penh, Cambodia. Vol. I and II, August 1997.

Eicher Associates Inc. (1987). Turbine-related fish mortality: review and evaluation of studies. Report EPRI-AP-5480 to Electric Power Research Institute, Palo Alto, California.

Hortle, K. (2007). Consumption and yield of fish and other aquatic animals from the Lower Mekong Basin. MRC Technical Paper No. 16. Mekong River Commission, Vientiane, Lao PDR. 87 pp.

Hortle, K.G., Troeung, R. and S. Lieng (2008). Yield and value of the wild fishery of rice fields in Battambang Province, near the Tonle Sap Lake, Cambodia. MRC Technical Paper No. 18. Mekong River Commission, Vientiane, Lao PDR. 62 pp.

Lévêque, C. and D. Paugy (eds.) (1999). Les poissons des eaux continentales africaines : diversité, écologie, utilisation par l'homme. IRD éditions, Paris. 521 pp.

Lymer, E. D., Funge-Smith, S. and J. Clausen (In press). Status and potential of fisheries and aquaculture in Asia and the Pacific 2008. FAO Regional Office for Asia and the Pacific. RAP Publication 2008. 102 pages.

Nho Pham Van and H. Guttman (1999). Aquatic resources use assessment in Tay Ninh Province, Vietnam (results from 1997 survey). AIT Aqua Outreach Working paper No. SV-51. Asian Institute of Technomogy, Bangkok, Thailand.

Mekong River Commission (2005). Annual Report of the MRC Programme for Fisheries Management and Development Cooperation, April 2004 - March 2005. Mekong River Commission, Vientiane, Lao PDR.

Montén, E. (1985). Fish and turbines; fish injuries during passage through power station turbines. Vattenfall AB, Stockholm, Sweden.

Oldani, N.O. and C.R.M. Baigin (2002). Performance of a fishway system in a major South American Dam on the Parana River (Argentina-Paraguay). River Research and Applications 18: 171-183.

Poulsen, A.F. , Ouch Poeu, Sintavong Viravong, Ubolratana Suntornratana and Nguyen Thanh Tung (2002). Fish migrations of the Lower Mekong River Basin: implications for development, planning and environmental management. MRC Technical Paper No. 8, Mekong River Commission, Phnom Penh. Cambodia. 62 pp.

Rab, M.A., N. Hap and M. Ahmed (2004). Socioeconomics and values of aquatic resources in Cambodia: results from a sample survey of Great Lake and Mekong Bassac Rivers. Presentation at the 7th Asian Fisheries Forum, 30 Nov.-4 Dec. 2004, Penang, Malaysia.

Sjorslev, J.G. (ed.) (2001). An Giang fisheries survey. Report for the Component Assessment of Mekong Fisheries; AMFC/RIA2. Mekong River Commission, Phnom Penh, Cambodia.

Van Zalinge, N., Degen, P., Chumnarn, P., Sam, N., Jensen, J., Nguyen, V.H. and X. Choulamany (2004). The Mekong River system. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries, Vol. 1. R.L. Welcomme and T. Petr, eds. FAO, Bangkok. pp. 333-355.

Welcomme, R. (1985). River Fisheries. FAO Fisheries Technical Paper No. 262. 330 pp.

Welcomme, R. (2001). Inland Fisheries Ecology and Management. Fishing News Books, Blackwell Science, Oxford. 358 pp.

Yim, C. and B. McKenney (2003). Domestic fish trade: case study of fish marketing from the Great Lake to Phnom Penh. Working Paper No. 29. Cambodia Development Resource Institute, Phnom Penh, Cambodia. 24 pp.

How much of the Mekong fish catch is at risk from mainstream dam development?

By Chris Barlow, Eric Baran, Ashley S. Halls and Mrigesh Kshatriya*

In the absence of reliable data on the species composition of the catch in the Lower Mekong Basin, the authors look at three approaches to estimate the size of the region's migratory fish resources.

There are currently 11 proposals for dams to be built on the mainstream of the Mekong River in countries downstream from China (see map on page 3 and table on pages 6-7). Planning agencies need to be able to evaluate the positive and negative impacts of these proposals. The major negative impact is the potential loss of fisheries as a consequence of dams blocking fish migration routes and altering aquatic habitats both upstream and downstream of the dams. In this regard, an estimate of the catch—and ultimately the value—of fish threatened by mainstream dam development in the Lower Mekong Basin (LMB) is fundamental for effective basin development planning and balanced decision-making.

Many reviews have highlighted the exceptional importance, by global standards, of fish resources in the Lower Mekong Basin (e.g., Lagler, 1976; Jensen, 2000; Van Zalinge *et al*., 2004; Baran *et al*., 2007; Hortle, 2007). However, no comprehensive field-based assessment and monitoring of fish resources basinwide has ever been undertaken. Logistically, generating such information is extremely difficult, because of the geographic spread of the fisheries, their seasonality, the abundance of species targeted by a wide range of gear, and the range of fishing practices from the family subsistence to commercial levels. Existing national statistics are not based on field studies (Coates, 2002) and are not disaggregated at the species level. This striking knowledge gap does not allow quantitative estimation of the importance of migratory fishes in the LMB: only approximations are possible.

Not all species of fish caught in the basin are at risk from mainstream dams. Some with only limited migrations over short ranges may not be impaired by dam structures. Others are highly adaptable to habitat modification including impoundment. Species most likely to be affected will be those that undertake significant passive and active migrations along the mainstream between critical spawning, feeding, and refuge habitats as part of their life histories.

In this report, we provide three different approaches to estimating the size of the migratory fish resource in the LMB. The first uses an expert panel approach, drawing on the knowledge of experienced fisheries professionals in the region. The second is based on analyses of published literature. The third categorises different species of fish into guilds based on their biology and then uses a fisher catch survey to determine the proportion of the catch that is highly threatened by dam construction.

Method 1: Surveying experts

In the first half of 2007, the MRC Fisheries Programme co-opted an expert panel to provide an estimate of the size and value of the migratory fish resource in the LMB. The expert panel consisted of 13 fisheries scientists from Lao PDR, Cambodia and international organisations operating in the LMB. The survey was conducted by email. Participants were not identified to each other to avoid peer or group pressure when answering the questions.

To estimate the size of the migratory fish resource, all participants were asked to answer and comment on the question: *What percentage of the total yield from the capture fishery in the LMB is 'white fish' (that is, those that are highly migratory)?* Responses (both estimates and comments) were compiled and sent to the respondents, giving them an opportunity to revise

their estimates based on the group's initial comments. After the second round of responses, the individual estimates were averaged to provide the overall estimate from the expert panel.

The estimate for the value of the resource in terms of first-sale price was determined using the same approach, although the question was limited to white fishes which migrate upstream and downstream of the Lao-Cambodian border. While this estimate is not strictly representative of the value of white fishes throughout the entire LMB, it is adequate for providing an indicative estimate of the value of the migratory fish resource in the LMB.

The combined results from the group indicated that migratory fish resources comprise 71% of the fisheries yield in the LMB. The first sale value of migratory fishes at the time of the survey (2007) was estimated to be US$1.89/kg.

'First-sale value of migratory fishes was estimated to be US$1.89/kg'

Hortle (2007) estimated that in 2000 the yield of freshwater fish in the basin, minus the aquaculture component, was approximately 1,860,000 tonnes. Combining this figure with the expert panel's estimate of size and first sale price of the migratory fish resource, the following estimates can be derived:

Size of migratory fish resource in LMB = (1,860,000 x 71%) = 1,320,000 tonnes

First sale value of migratory fish resource in LMB = (1,320,000 x 1000 x 1.89) = US$2,500 million

Method 2: Reviewing literature

Three major migration systems have been distinguished in the Lower Mekong Basin (Poulsen *et al.*, 2002):
(i) the Lower Mekong Migration System, characterised by its extensive floodplains and extending from the sea to the Khone Falls in southern Lao PDR;
(ii) the Middle Mekong Migration System, from Khone Falls to Vientiane, characterised by big tributaries and local wetlands; and
(iii) the Upper Mekong Migration System, from Vientiane to China.

We propose below an estimate of what is at stake in each migration system if fish migrations are disrupted in the LMB. While these systems are treated independently in this analysis, it is important to appreciate that there is considerable movement of fish between the systems, particularly between the lower and middle migration systems.

In fact, the lower and middle migrations systems are not distinguished based on geography (the Khone Falls actually demarcate them, but many species migrate through the Khone Falls). Rather, the two systems are distinguished functionally. In the lower migration system, the dry season habitat is upstream of the flood plains. In the middle system, the dry season habitat is downstream of the flood plains. Consequently, at the onset of the flood season, fish migrate downstream in the lower migration system, but upstream in the middle migration system (see Poulsen *et al*. (2002) for a full explanation).

1. The Lower Mekong Migration System includes the whole of Cambodia and all the Vietnamese Mekong Basin. Fish resources in this system thus correspond to 100% of the Mekong yield in Cambodia and in Viet Nam. What is the yield in these areas? One estimate (Van Zalinge *et al.*, 2004) based on fisheries catch studies amounts to 682,000 tonnes in Cambodia and 845,000 tonnes in Viet Nam. A second estimate, based on household consumption studies (Hortle, 2007), amounts to 481,000 tonnes in Cambodia and 692,000 tonnes in Viet Nam.These estimates thus give a range for the fish production in the Lower Mekong Migration System:

- Estimate 1: (Cambodia: 682,000 tonnes x 100%) + (Viet Nam: 845,000 tonnes x 100%) = 1.53 million tonnes
- Estimate 2: (Cambodia: 481,000 tonnes x 100%) + (Viet Nam: 692,000 tonnes x 100%) = 1.17 million tonnes

Thus, the lower system produces between 1.2 and 1.5 million tonnes of fish annually, that is, 6 to 7 times more than the whole fishery sector (marine and freshwater) in Australia. Using the figure of 63% of Tonle Sap fish

being migratory white fish (van Zalinge *et al*., 2000), the yield of migratory fish at risk if major barriers are built across the migration route amounts to 1.2 – 1.5 million x 63% = 750,000 – 950,000 tonnes. This represents more than the total fish production of France or New Zealand (around 600,000 tonnes each).

2. The Middle Mekong Migration System includes northeastern Thailand and the most productive part of the Mekong Basin in Lao PDR. Fish resources in this system correspond to 100% of the yield in the Thai Mekong basin[1], and by our estimates 80% of the yield in Lao Mekong. According to Van Zalinge *et al.* (2004) (Estimate 1), the Mekong Basin produces yearly 932,000 tonnes in Thailand and 183,000 tonnes in Lao PDR; according to Hortle (2007) (Estimate 2), Thailand produces 720,000 tonnes a year and Lao PDR 168,000 tonnes. This leads to the following estimates of fish production for the middle system:

- Estimate 1: (Thailand: 932,000 tonnes x 100%) + (Lao PDR: 183,000 x 80%) = 1.08 million tonnes
- Estimate 2: (Thailand: 720,000 tonnes x 100%) + (Lao PDR: 168,000 x 80%) = 850,000 tonnes

Thus, the middle system produces between 850,000 to 1 million tonnes annually. Assuming a similar ratio of migratory fishes as in the lower system (around 60%), that would correspond to 500,000 – 600,000 tonnes of fish resources at risk in case of dam development. In this system, the environmental impact of dams will be spread between many more tributaries than in the lower system. However, mainstream dams that disconnect floodplains from the mainstream remain a major concern for all fisheries resources in this area.

3. The Upper Mekong Migration System corresponds to the whole Chinese Lancang-Mekong area and the least productive part of the Mekong Basin in Lao PDR. Fish resources in this system correspond to 100% of the yield in the Chinese-Langcang Mekong (25,000 tonnes according to Xie and Li, 2003) and 20% of the yield in the Lao section of the Mekong basin. Hence the estimates of fish production for the Upper Mekong Migration System are:

- Estimate 1: (China: 25,000 tonnes x 100%) + (Lao PDR: 183,000 x 20%) = 62,000 tonnes
- Estimate 2: (China: 25,000 tonnes x 100%) + (Lao PDR: 168,000 x 20%) = 58,000 tonnes

The upper system thus produces around 60,000 tonnes of fish a year, which makes it the zone where there is the least to lose from hydropower development. Using again the estimate of 60% of the resource being migratory fish, we estimate the migratory stock in the upper system to be 36,000 tonnes. If we remove the Chinese portion (which is not within the LMB although it is certainly connected via migration), we have an estimate for the Lao portion of the upper system of 20,000 tonnes.

In summary, our calculations provide estimates of the migratory fish resource in the three migration systems of the LMB of:

- Lower Mekong Migration System (Viet Nam to Khone Falls) = 750,000 – 950,000 tonnes
- Middle Mekong Migration System (Khone Falls to Vientiane) = 500,000 – 600,000 tonnes
- Upper Mekong Migration System (Vientiane to China) = 20,000 tonnes (36,000 tonnes if Chinese fisheries are included).
- Entire LMB excluding China = 1,270,000 – 1,570,000 tonnes

Method 3: Combining information on fish migrations with catch survey data

As part of a recent modelling exercise to explore the barrier effects of dams on migratory fish populations in the LMB, Kshatriya and Halls (in prep.) determined which groups of fishes are likely to be susceptible based on their biology. Ten 'migratory guilds' or groups of species sharing similar migratory behaviour were identified based upon the degree to which the mainstream acts as a conduit or migration corridor for their movement (as eggs, larvae, juveniles and adults) between habitats. These represent variants or aggregations of the environmental guilds proposed by Welcomme *et al*. (2006).

[1] While there is some fish production in the Thai section of the Upper Mekong Migration System, for this analysis it is considered negligible compared with production from the Songkhram and Mun-Chi systems in the Middle Mekong Migration System

The migrations, and therefore the viability, of populations of species belonging to four guilds ('main channel resident', 'main channel spawner', 'semi-anadromous' and 'catadromous') were identified as being most threatened by mainstream dam development. One guild (floodplain spawner) may be partially impacted, while the other five guilds are unlikely to be affected by mainstream dams (Table 1).

Species of fish caught in the LMB were assigned to each guild on the basis of their presence or absence as adults and larvae/juveniles within the main habitats of the basin (rithron[2], main channel and tributaries, deep pools, floodplains and estuary) as recorded in MRC monitoring programmes and *ad hoc* surveys, as well as on the basis of information contained in the Mekong Fish Database (MFD) and wider literature.

A survey conducted by the MRC Fisheries Programme in 2003-04 identified 233 species of fish belonging to 55 families as present in the main channel, floodplains and estuary. The whitefish or highly migratory fishes comprised 150 species belonging to guilds 1-5, 8 and 9.

Fifty-eight species were assigned to the highly vulnerable guilds (2, 3, 8 and 9). They include 5 of the 11 Mekong fish species threatened by extinction according to the IUCN 'Red List' (http://www.redlist.org) including the Mekong giant catfish (*Pangasianodon gigas*), the Mekong stingray (*Dasyatis laosensis*) and Jullien's barb (*Probarbus jullieni*). A further 26 species belonging to the 'floodplain spawner' guild were identified as being at medium risk of impact.

The 58 very species belonging to the highly vulnerable guilds (2, 3, 8 and 9) contributed to 38.5 % of the total weight of all 233 species recorded in the fisher catch survey in 2003/04 (Kshatriya and Halls, in prep.).

We can combine this estimate of the proportion of the highly vulnerable fish groups in the LMB catch with the figure provided by Hortle (2007) for the total fish yield of 1,860,000 tonnes in the LMB to estimate the overall size of the highly vulnerable migratory fish groups in the LMB. That is, (1,860,000 x 38.5%) = 744,000 tonnes.

Method 3 was primarily undertaken to identify species of fish whose migrations are likely to be impacted by mainstream dam development as part of a recent modelling exercise undertaken by the MRC and the WorldFish Center. Whilst the fisher catch survey data provide some objective basis for determining the relative importance of the threatened species in the basin, the

Table 1. Species in the main channel, floodplains and estuary

Numbers of species assigned to each guild and their contribution to total catch recorded by MRC fisher-catch survey (Nov 2003-Dec 2004)

	Guild Name	Mainstream Dam Threat Level	Number of Species	Catch (kg)	Catch (%)
1	Rithron resident	Low or no threat	6	190	0.16
2	Main channel resident	Very high	38	18,694	15.37
3	Main channel spawner	Very high	14	26,160	21.51
4	Floodplain spawner	Medium	26	17,945	14.76
5	Generalist	Low or no threat	56	43,203	35.53
6	Floodplain resident ('black fish')	Low or no threat	22	6,251	5.14
7	Estuarine resident	Low or no threat	42	5,773	4.75
8	Semi-anadromous	Very high	3	80	0.06
9	Catadromous	Very high	3	1,865	1.53
10	Marine	Low or no threat	19	1,290	1.06
	Unknown	-	4	155	0.13
	Grand Total:		**233**	**121,607**	**100**

Source: Kshatriya and Halls, in prep.

[2] Residing in the riffle and pool zone in headwaters

estimates may be biased given that the majority of the reported landings contained in the database were for gillnet fishers targeting mainstream habitat.
It does not, for example, include landings from industrial-scale or specialised fisheries such as the Cambodian bagnet fishery in the Tonle Sap river that targets migratory species seeking refuge habitat (believed to be located near the border with Lao PDR) during the falling water period.

Nor does it include the *ly* trap fisheries of Khone Falls in southern Lao PDR that target the upstream spawning migrations of fish. Including such fisheries would likely raise the estimate of the proportion of the basin's catch threatened by dam development. However, at the same time, the fisher catch survey is unlikely to have representatively sampled landings of floodplain-resident species or generalists from floodplain systems such as the Songkhram system in Thailand which would have the converse effect on the estimates.

'The migratory fish resource at risk is 0.7-1.6 million tonnes per year'

A more accurate assessment of how much of the catch from the LMB is threatened by mainstream dam development will require unbiased estimates of the relative contribution of the threatened species to the entire landings within the basin. This will require a carefully designed basin-wide and species-wise household or fisher-based catch assessment survey with appropriate stratification to account for temporal, spatial and habitat-dependent variation in fish catches.

It should also be borne in mind that the estimate of the proportion of the basin's catch that is a risk from mainstream dam development derived using the fisher catch survey data above relates only to the barrier effects of dams on fish migrations. It does not include the potential additional effects of changes to water quality, flow and sediment transport on fish abundance and landings arising from dam construction. It is therefore likely to be a conservative estimate of potential loss.

Conclusions

The results from the three methods indicate that the migratory fish resource at risk from mainstream dam development in the Mekong is in the range 0.7 – 1.6 million tonnes per year (Table 2). In more familiar terms, that amount of fish is equivalent to 1.6-3.5 times the entire beef production of Cambodia, Lao PDR, Thailand, and Viet Nam; or 0.9-1.8 times the entire pork production of Cambodia, Lao PDR, and Thailand (FAO statistics, http://faostat.fao.org).

The size of the migratory fish resources in the Lower and Middle Migrations Systems (between the delta and Vientiane) is far larger than the resource in the Upper Migration System (northern Lao PDR) (Table 2). Therefore, dams built in the Lower and Middle Migration Systems are likely to have a greater impact on fisheries production in the LMB than dams built in the Upper Migration System. However, the calculation of local

Table 2. Estimates of migratory fish resources in the Lower Mekong Basin

Method	Estimate Derived	Annual Yield (tonnes)	Annual Value (US$ million)
1	Highly migratory fish resource in the LMB	1,320,000	2,500*
2	Highly migratory fish resource in the LMB		
	(i) Lower Mekong Migration System (Viet Nam to Khone Falls)	750,000 – 950,000	1,400 – 1,800*
	(ii) Middle Mekong Migration System (Khone Falls to Vientiane)	500,000 – 600,000	950 – 1,100*
	(iii) Upper Mekong Migration System (Vientiane to China border)	20,000	37*
	LMB	1,270,000 – 1,570,000	2,400 – 3,000*
3	Highly vulnerable migratory fish groups in the LMB	744,000	1,400*

* the values for first-sale price are derived using the unit value for fish ($1.89/kg) estimated in Method 1

yields at risk does not include far-reaching impacts, such as sediment retention in upstream dams and its impact on overall fish and river productivity. Furthermore, the Mekong River in northern Lao PDR is very specific in terms of aquatic biodiversity, with a number of local species characteristic of headwaters, rapids and high streams.

The analysis also indicates a first sale value for the resource of US$1,400-3,000 million per year. This is actually a conservative estimate, because it does not take into account the economic benefits that flow from the trade and processing of fish products. Nor does it include the very considerable indirect values of the Mekong fisheries, such as their contribution to the nutrition, employment and well-being of millions of rural people in the LMB, who generally have few other livelihood options.

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References

Baran, E., Jantunen, T. and C.K. Chong (2007). Values of inland fisheries in the Mekong River Basin. WorldFish Center, Phnom Penh, Cambodia. 76 pages.

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 pp.

Hortle, K.G. (2007). Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin. MRC Technical Paper No. 16, Mekong River Commission, Vientiane. Lao PDR. 87 pp.

Jensen, J. (2000). Can this really be true? Rice, yes, and fish please! Catch and Culture 5(3): 1-3.

Kshatriya, M. and A.S. Halls (in prep.). Modeling the effects of mainstream dams on migratory fish populations in the lower Mekong basin. Draft report to the Mekong River Commission Secretariat.

Lagler, K.F. (1976). Fisheries and integrated Mekong river basin development. The University of Michigan, School of natural resources 363 pp.

Poulsen, A.F., Poeu, O., Viravong, S., Suntornratana, U. and N.T. Tung (2002). Fish migrations of the Lower Mekong Basin: implications for development, planning and environmental management. MRC Technical Paper No. 8. Mekong River Commission, Phnom Penh. 62 pp.

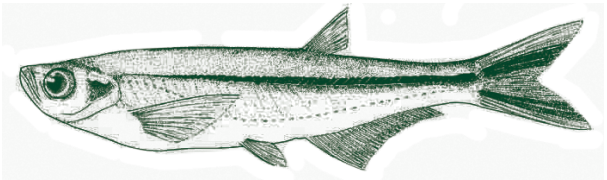
Poulsen, A.F., Hortle, K.G., Valbo-Jorgensen, J., Chan, S., Chhuoun, C.K., Viravong, S., Bouakhamvongsa, K., Suntornratana, U., Yoorang, N., Nguyen, T.T. and B.Q. Tran (2004). Distribution and ecology of some important riverine fish species of the Mekong River basin. MRC Technical Paper No.10, Mekong River Commission, Phnom Penh. 116 pp.

Van Zalinge, N., Nao Thuok, Touch Seang Tana and Deap Loeung (2000). Where there is water, there is fish? Cambodian fisheries issues in a Mekong River Basin perspective. p. 37-48. In M. Ahmed and P. Hirsch (eds.) Common property in the Mekong: issues of sustainability and subsistence. ICLARM Studies and Reviews 26, 67 pp.

Van Zalinge, N., Degen, P., Pongsri, C., Sam Nuov, Jensen, J., Nguyen, V.H. and X. Choulamany (2004). The Mekong River system. Pp 333-355. In R.L. Welcomme and T. Petr (eds.) "Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries, Vol. 1". FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. 356 pp.

Xie, S.Q. and Z.J. Li (2003). Inland fisheries statistics in China. Pp 20-26. In "New approaches for the improvement of inland capture fishery statistics in the Mekong Basin". Ad-hoc expert consultation, Udon Thani, Thailand, 2-5 September 2002. FAO RAP publication 2003/01. FAO, Bangkok, Thailand. 145 pp.

Welcomme, R.O., Winemiller, K.O. and I.G. Cowx (2006). Fish environmental guilds as a tool for assessment of ecological condition of rivers. River Res. Applic. 22: 377-396.



Wild population of Mekong **giant catfish** faces **new challenge**

By Roger Mollot*

Mainstream dams in the Lower Mekong Basin could lead to the extinction of a flagship species from the river

The Mekong giant catfish, *Pangasianodon gigas*, is endemic to the Mekong Basin and an exceptional example of its unique biodiversity. Growing up to three meters in length and over 300 kg in weight, this largely herbivorous giant has a historical range from the Mekong Delta in Viet Nam all the way upstream into Yunnan province of China. This long-distance migration is believed to be part of the life cycle requirements to find suitable feeding, spawning and nursing habitats.

As part of these long-distant migrations the Mekong giant catfish utilises a range of habitat types, including deep pools and rapids. The reliance on a number of different habitats, combined with the unique characteristics of its immense size and cultural significance, leads many to regard the fish as a flagship species for the Mekong River Basin.

While there is limited understanding of the ecology and migration behaviour, it is understood that the wild population of the Mekong giant catfish has declined drastically due to excessive fishing pressure. Its current range is believed to have been reduced as wild stocks have declined, and many of the historical fishing grounds are no longer utilised by fishers in search of this mythological creature (see Hartmann, 2008).

Today there is increased awareness and interest on the part of the fisheries agencies of the region to

A Mekong giant catfish captured in Chiang Khong district in northern Thailand by the Mekong Giant Catfish Fshermen's Association of Chiang Khong
Photo: Suthep Kritsanavarin

collaborate on the management and protection of the wild stocks in the Mekong River. Monitoring of the by-catch of the Mekong giant catfish in the stationary bag-net fishery of Cambodia has been implemented for several years (Hogan *et al.*, 2004); a Mekong giant catfish tracking project has been implemented in Thailand with collaboration between Japanese and Thai researchers (Mitamura *et al.*, 2008); and a quantitative assessment model to estimate spawner abundance has been developed (Lorenzen *et al.*, 2006). Furthermore, in 2008 government and community representatives from the provinces of Chiang Rai, Thailand, and Bokeo, Lao PDR, discussed a transboundary approach to protect the species. The outcome of this historical transboundary dialogue is the first time that two countries of the Mekong Basin have agreed to set limits on fishing pressure in order to protect the wild stocks.

'dams have potential to cut off the long-distance migration route of the Mekong giant catfish'

But even as the technical capacity to protect the wild stocks increases, the species faces larger threats from an unfamiliar source. Regional energy forecasts have led to a boom in the hydropower industry and the resurgence of mainstream hydropower development plans throughout the Mekong Basin. In addition to the existing mainstream dams in China, up to nine mainstream dams are in the planning or feasibility stage for Lao PDR (www.poweringprogress.org) and two for Cambodia (see pages 6-7).

What are flagship species?

A flagship species is one that is representative of a specific habitat, development issue or environmental cause. Chosen for their vulnerability to specific threats, they often represent an environmental or social cause and serve to attract support for the issue from the general public and policy makers. Successful management and conservation of a flagship species also serves to benefit the status of many other species which share similar habitats or are threatened by similar issues

Any one of these planned dams has potential to cut off the long-distance migration route of the Mekong giant catfish, impact critical habitats like spawning areas, and divide the existing wild population into separate groups above and below each dam. A series of dams would further isolate populations. These impacts are distinct realities that would threaten annual recruitment and the very survival of the species in the Mekong River. While it is impossible to be definitive regarding the ultimate result, most fisheries biologists familiar with the species believe the dams on the mainstream would be the final straw leading to the eventual extinction of the Mekong giant catfish in the Mekong River.

Recruitment

In fisheries the term "Annual Recruitment" refers to the addition of new individuals to the overall population or fish stock. It may also refer to new additions to sub-components, e.g., 'recruitment to the fishery' refers to fish entering the actual fishery, and this is determined by the size and age at which they are first caught.

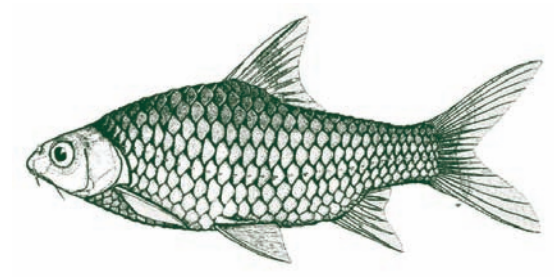
Source: FAO FishBase (www.fishbase.org)

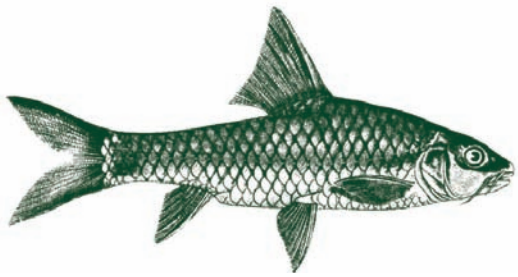
All six countries of the Mekong Basin are parties to the Convention on Biological Diversity, and as such have stated their commitment to the protection of biodiversity and local ecological knowledge through implementation of national biodiversity strategy and action plans. Subsequent legislation in the forms of environment law and fishery law would assist each country in the protection of national biodiversity through legal frameworks.

In Cambodia, the Mekong giant catfish is one of 59 species of threatened fish and aquatic animals that are being considered for full protection under the Fisheries Law. In Lao PDR, it is listed as a Category I Restricted Species in the Aquatic Animals and Wildlife Law. Such a listing demonstrates the government's intention to protect the species from becoming extinct in the wild. Category I species are subject to regulations regarding their harvest in order to ensure adequate protection within Lao PDR. Complementary to this, the Department of Livestock and Fisheries is now finalising a draft fisheries law which will further support the management and development of the fisheries sector

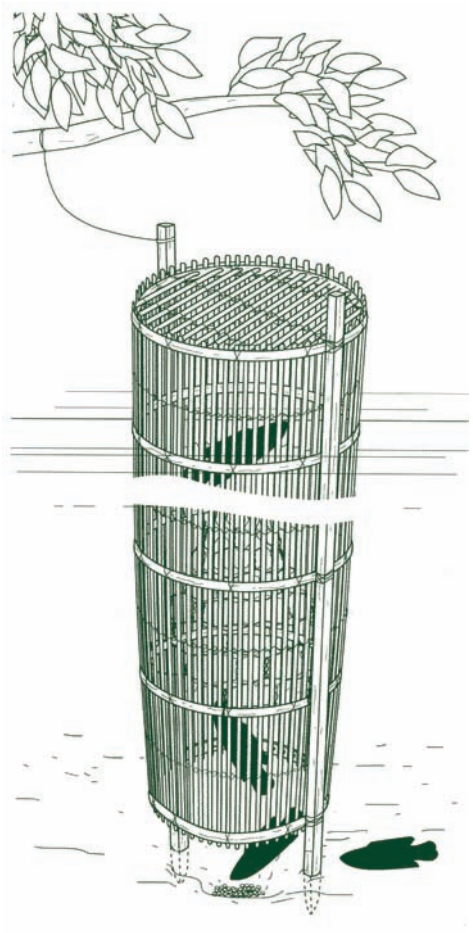
and the protection of aquatic biodiversity in Lao PDR.

With a developing legal framework to manage and protect fisheries and aquatic biodiversity, there is growing concern over the potential conflict arising between hydropower development plans and the obligation of Mekong states to protect the living aquatic resources for the benefit of the people as defined in various legislation. As a flagship species of the Mekong River, the threats facing the Mekong giant catfish from hydropower represent real threats to hundreds of other migratory fish species important to local economy and food security.





Plans for dams on the Mekong mainstream are now being considered in terms of their economic benefits and social and environmental consequences for the people and states of the Lower Mekong Basin. One outcome of the consideration may be whether the Mekong giant catfish will live on for future generations of Mekong communities, or whether this Mekong giant will become a fabled story of the past.



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References

Hartmann, W. (2008). Historic Lao fishery for Mekong giant catfish sheds light on traditional management. Catch and Culture (Mekong River Commission Newsletter), 14(1): 13-19.

Hogan, Z., Moyle, P.B., May, B., Vander Zanden, M.J. and I.G. Baird (2004). The imperiled giants of the Mekong River. Am. Sci. 92: 228–237.

Lorenzen, K., Sukumasavin, N. and Z. Hogan (2006). Development of a conservation strategy for the critically endangered Mekong giant catfish: quantitative assessment report. Mekong Giant Catfish Working Group Report 3.

Mitamura, H., Mitsunaga, Y., Arai, N. and T. Viputhanumas (2008). Movements of immature hatchery-reared Mekong giant catfish *Pangasianodon gigas* released in the Mekong River, measured using acoustic telemetry. Fish Sci. 74: 1034-1039.

Floods and the Mekong River system (Part 3)

By Tim Burnhill and Peter Adamson*

In this final article in our three-part series, we examine the magnitude of flooding in the Lower Mekong Basin and whether extreme floods are becoming more common

In the second article in this series (*Catch and Culture* 14(1)) we described how hydrologists measure the size of the annual flood according to its volume (annual flood volume) and its height (annual flood peak). Using the historical record of these two criteria, they are able to categorise the size of floods into normal, significant and extreme, by reference to the average annual flood volume and the average annual flood peak.[1] In addition to these measures, hydrologists also use the 'long-term mean annual discharge'[2] to define the onset and end of the wet season. Put simply, the wet season begins when the flow of the river exceeds the long-term mean annual discharge, and ends when the flow drops below this value.

These four measurements—annual flood volume, annual flood peak, onset of the wet season, and end of the wet season—can be calculated using records from hydro-meteorological monitoring stations along the Mekong from Chiang Saen in northern Thailand to Tan Chao on the Mekong Delta of Viet Nam (see Figure 1). The records from many of the stations extend back decades (for example, those from the station at Vientiane go back to 1913) and together they provide a unique data set with which to evaluate variations in the onset of the seasons and the magnitude of the flood, both across the basin and through time.

Figure 1. Hydro-meteorological stations

Location of stations on the mainstream of the Mekong with good and lengthy historical records

The onset of the seasons

For most of the people living in the Lower Mekong Basin (LMB), early to mid November is a special time; the monsoon has withdrawn, the harvest is in, and fresh new rice is on the table. It is a month of festivals—*Bone Omtouk* in Cambodia, *That Luang* in Lao PDR, in *Loy Kha Tong* in Thailand.

[1] A significant flood year is defined as a year when either the annual flood volume or the annual flood peak is greater than one standard deviation greater or less than the average value. In an extreme flood year these values exceed two standard deviations greater or less than the average mean. Of course, it is possible to have significant wet and significant dry flood years, and extreme wet and extreme dry flood years.

[2] The mean annual discharge is the average discharge (flow) of the river over a whole calendar year. The long-term mean annual discharge is the average of this value over the period of record.

Table 1. Wet seasons

Start and end of the wet season at Vientiane and Kratie

	Week of occurrence			
	Vientiane		Kratie	
	Average Week No. (date)	Standard Deviation (weeks)	Average Week No. (date)	Standard Deviation (weeks)
Start wet season	25 (23rd June)	2.2	25 (23rd June)	1.9
End wet season	45 (11th November)	2.1	44 (7th November)	1.7

The dates of these festivals are set to coincide with the first full moon in November, and therefore the actual calendar dates vary slightly from year to year. The fact that the dates of these festivals (and others that celebrate the changing seasons) can be determined with such confidence is due to the surprising reliability of the annual hydrograph of the Mekong river system. Table 1 above gives the average week and date of the start and end of the flood season at Vientiane and Kratie, based on records extending back to 1913 and 1924 respectively. Two features stand out. Firstly, these average dates are almost identical at both locations. Secondly, the date when the flood season starts and ends is very predictable—the standard deviation of each event is only about two weeks.

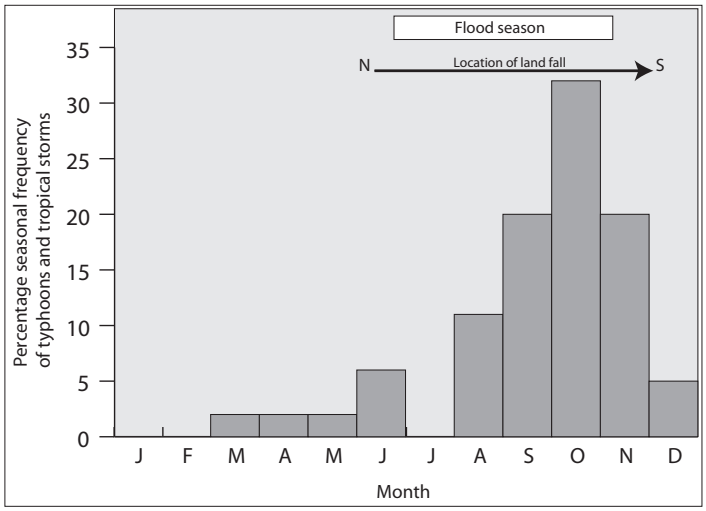
The similarity of the timing of the onset of the seasons at Vientiane and Kratie is surprising as the contribution to the overall flow of the Mekong from Upper Mekong Basin in China (the Yunnan component) is far greater at Vientiane than Kratie.[3] Furthermore, the flow at Kratie is strongly influenced by the contribution from the so-called 'left bank tributaries', such as the Se Kong, Se San, and Sre Pok. These tributaries drain catchments that receive large amounts of rainfall from typhoons and tropical storms that develop over the South China Sea, and track across the southern part of the LMB during the latter part of the monsoon season (Figure 2).

Given these factors, it might be expected that the flood season would begin earlier in Vientiane and end later in Kratie. That this is not the case, illustrates the dominant imprint of the SW Monsoon on the overall climatic pattern of the region and the hydrology of the Lower Mekong Basin.

The regularity of the dates on which the flood season starts and ends is one of the most striking features of the hydrology of the basin. They are far more predictable than are either the volume of the annual flood or the height of the annual flood peak. This predictability is very important for the animals and plants that have evolved to take advantage of the benefits that come with the cycle of flood and recession. The life cycles of many are adapted to be in step with the pace of changing of the seasons. Therefore, its is likely that modifications to the timing of the flood caused by humans on a global

Figure 2. Typhoons and storms

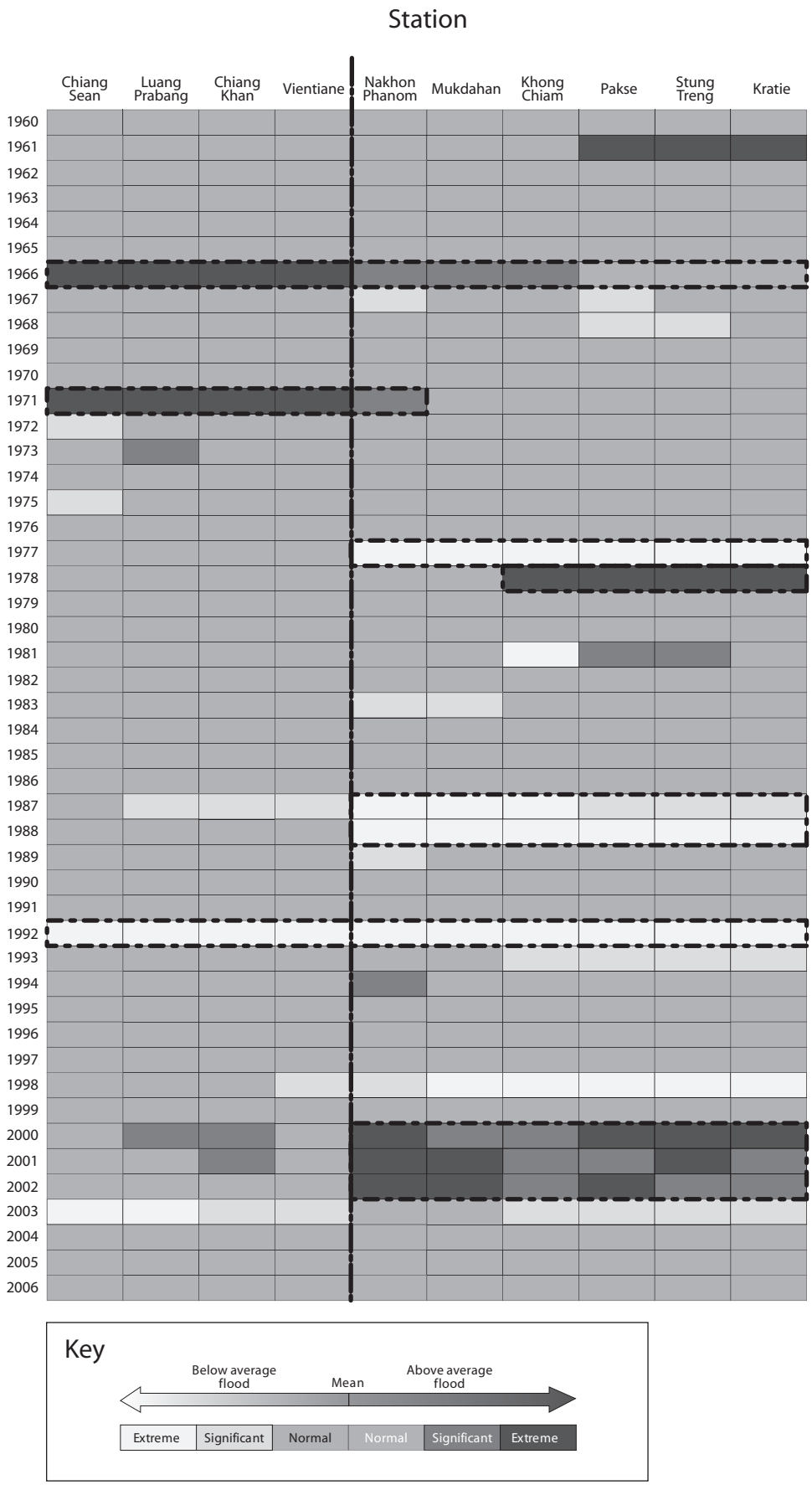
Frequency of typhoons and tropical storms in the Lower Mekong Basin. The arrow indicates that the landfall of typhoons and storms coming from the South China Sea move from north to south Viet Nam as the wet season progress.



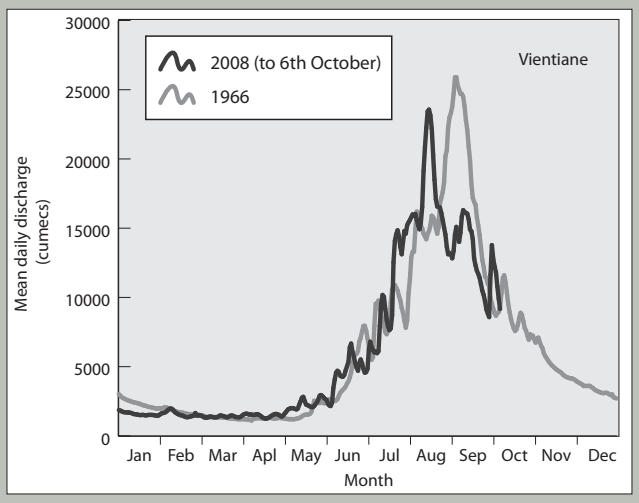
[3] In the wet season, contribution of the Yunnan component to the flow of the Mekong is about 40% at Vientiane and less than 15% at Kratie (MRC, 2005). In the dry season this contribution increases to about 60% and 30% respectively.

Figure 3. Significant and extreme flood years

Historic and geographic distribution of significant and extreme flood years in the Lower Mekong Basin

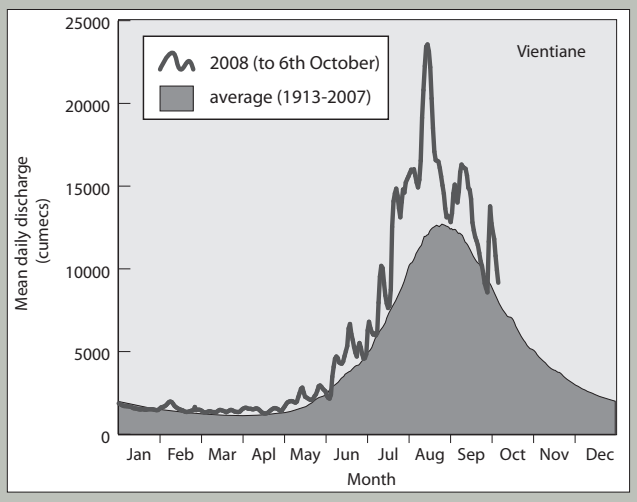


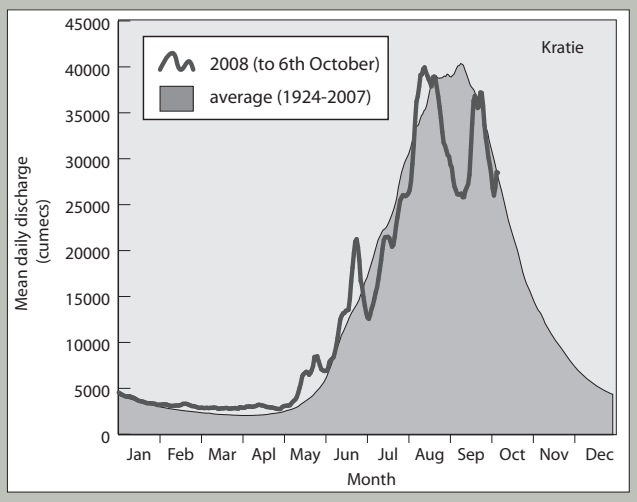
The flood in 2008



The flood in 2008 was extraordinary—but only locally so. As the chart on the left shows, the Mekong upstream of Vientiane suffered the most extreme floods since the record flood of 1996. At the city, the level of the Mekong was higher than in 1966, but flood protection bunds put in place by the American Corps of Engineers in the late 1960s and the efforts of the citizens of Vientiane (who filled and put in place over one million sandbags), prevented major inundation. Villages outside Vientiane, however, were flooded and there was considerable damage to crops and people's livelihoods.

Further downstream the impact of the flood was much reduced. The charts below compare the 2008 flood with the average of the floods on record at Vientiane (below left) and Kratie (below right). Although, at the time of writing, the flood season is not quite over, it is already clear that 2008 will be an extreme flood year at Vientiane, while at Kratie 2008 will be a normal flood year.





(climate change) or a regional (development of water resources) scale, will effect the animal and plant life of the Lower Mekong Basin on which many of the people of the basin depend for their livelihoods.

The magnitude of the flood

While the timing of the start and end of the flood is remarkably consistent, the magnitude of the flood, particularly the annual flood volume, has varied at different localities in the basin. This means that one part of the basin can suffer a significant, or even an extreme, flood year while at the same time other parts have a normal flood year. This year, 2008, provides a good example of this geographical disparity (see box above).

Figure 3 illustrates the historical record of the flood of ten hydro-meteorological monitoring stations on the mainstream of the Mekong, classified according to the magnitude of the annual flood volume (see Figure 1 for location). The plot of these records, both geographically and through time, gives an excellent visual image of the variability of the flood.

One striking observation is the discontinuity between the stations upstream and downstream of Vientiane. In 1966, for example, the extreme flooding suffered by the stations upstream diminished rapidly downstream, such that Pakse recorded a normal flood year. The flood in 1971 followed a similar pattern. In contrast, the significant and extreme floods from 2000 through

to 2002 were confined to the downstream stations. During the same period, the stations upstream of Vientiane recorded normal flood years. Years when the flood was significantly below normal are largely restricted to downstream stations. So, while the floods in 1977, 1987, and 1988, were extremely low downstream of Vientiane, they were normal upstream of the city.

'Typhoons and tropical storms are largely responsible for the extremes'

This geographical discontinuity in the flood records reflects an important characteristic of the climate of the Lower Mekong Basin and the hydrology of its river system. It appears that while the SW Monsoon is the dominant weather system defining the overall character of the wet season (such as its duration), it is typhoons and tropical storms that are largely responsible for the extremes. Unlike the monsoon, which brings moist air from the Indian Ocean to the west, these originate in the east over the Pacific Ocean, and make landfall along the coasts of southern China and Viet Nam.

In most years, the landfall of these storms moves southwards as the typhoon season progresses (MRC, 2008). As a result, the early typhoons shed most of their rain in catchments outside the Lower Mekong Basin, such as the Red River Basin in northern Viet Nam. However, occasionally, intense storms early in the season, such as typhoon Phyllis in 1966 and tropical storm Kammuri this year (2008), have the strength to track over northern Lao PDR, causing extreme flooding upstream of Vientiane.

Later in the typhoon season, the storms make landfall on the narrow costal plain of central and southern Viet Nam before tracking across the highlands that form the border with Lao PDR (see Figure 2 on page 27). Rain that falls on these mountains feeds the catchments of the large left bank tributaries of the Mekong, which enter the river downstream of Vientiane. In the wet season these catchments contribute well over 50% of the discharge of the Mekong, and exert great influence on the volume of water entering the highly productive floodplains of the Great Lake-Tonle Sap system and the Mekong Delta.

Only rarely have extreme flood years (either high or low) been recorded basin-wide. In the case of low years, these tend to be those wet seasons, such as in 1992 and 2003, when the monsoon is weak, or fails, and the flood throughout the basin is well below normal.

Are extreme floods becoming more common?

In extreme years it is natural enough to look for external causal factors, such as climate change or perhaps dams on the mainstream, rather than accepting these years as falling within the envelope the Mekong's natural flow. However, looking at the distribution of these extreme flood years within the natural envelope may be more informative. Do they form clusters? Are they becoming more common? A cursory look shows little pattern to records of the sites upstream of Vientiane. On the other hand, the records of the downstream locations do show some pattern—e.g. dry years in 1987 – 88, wet years in 2000 – 03. Furthermore, extreme flood years seem to have been more common after 1986. (For example, 9 of the 13 significant or extreme flood years recorded at Kratie occurred in the 20 years since 1987, while only 4 were recorded in the previous 27 years).

It is too early yet to know if these patterns are the response to human activity or are features of other natural phenomena. Hydrologists define the 'natural envelope' using only the hydrological records that are available to them. While these may go back a few decades, they represent only a small window in the overall history and prehistory of the Mekong. It is more than likely that the flow of Mekong is cyclical at a number of time scales, ranging from decades, through millennia, to millions of years, and that these cycles are responses to a variety of earth orbital and solar factors that drive climate change.[4] Therefore, caution is required before attributing these apparently recent changes to modern anthropogenic causes.

[4] Comprehensive accounts of the variety of external factors that affect the evolution and variability of the monsoon can be found in Kale *et al*. (2003) and Wang *et al*. (2005). These factors include plate tectonic activity (millions of years), earth orbital dynamics—including glaciations (100,000 to 10,000 year cycles), solar activity (1,000 to 10 year cycles), and El Niño and La Niña oscillations (8-3 year cycles).

Lao monks surveying flood damage at a Vientiane temple in August, 2008
PHOTO: STANISLAS FRADELIZI

Nevertheless, the influence of human induced climate change and the impacts of resource developments cannot be denied. The glaciers on the high Himalaya are retreating (WWF, 2005), sea levels will rise, and the water resources of the Mekong will be exploited. These factors will inevitably modify the flow of the river and its seasonable variability, and will have both predictable and unforeseen consequences on the river flow, its ecosystems, and for the people whose livelihoods and lives depend on them.

Understanding the floods of the Mekong in their both recent and their historic and prehistoric contexts, may just provide a guide to the nature of extreme floods in the future.

**Dr Burnhill is a science writer with the MRC and Dr Adamson is a hydrologist providing services to the MRC.*

References

Kale, V.S., Gupta, A. and A.K. Singhvi (2003). Late Pleistocene – Holocene palaeohydrology of monsoon Asia. Palaeohydrology: Understanding global change. Eds K.J. Gregory and G. Benito. John Willey & Sons. Ltd. London. pp 213 – 232.

MRC (2005) An overview of the hydrology of the Mekong Basin. Mekong River Commission, Vientiane, Lao PDR.

MRC (2008) Flood situation report, August 2008. MRC Technical Paper No 21. Mekong River Commission, Vientiane, Lao PDR.

Wang, P. *et al*. (2005) Evolution and variability of the Asian monsoon system: state of the art and outstanding issues. Quaternary Science Reviews. 24(2005). pp 595-629.

WWF (2005) An overview of glaciers, glacier retreat, and subsequent impacts in Nepal, India and China. World Wildlife Foundation, Nepal.

Tonle Sap Basin **Authority** takes shape

By Peter Starr*

In response to growing political recognition of the Tonle Sap's importance, a new Cambodian government agency has taken charge of coordinating the management, conservation and development of the river basins that form Southeast Asia's biggest lake

The large floodplain around the Tonle Sap Lake is a crucial nursery habitat for the fisheries of the Lower Mekong Basin. A single hectare can produce as much as 230 kg of fish a year, making it the world's most productive inland fishery. Moreover, Tonle Sap fisheries account for about two thirds of Cambodia's total inland fisheries production which is conservatively estimated at 400,000 tonnes a year — the highest freshwater fish yield in the world after China, India and Bangladesh. What drives this exceptional productivity is the huge amount of water that flows into the lake every year, pushing water levels from as low as 1.4 metres above sea level in the dry season to more than 10 metres above sea level in the wet season. As a result, the surface area of the lake can expand from as little as 2,500 km² to as much as 15,000 km² while the volume of water can swell from less than 2 km³ in the dry season to 75 km³ in the wet season. According to a recent study by the Cambodia National Mekong Committee (CNMC) and the WorldFish Center, 52 percent of this water comes directly from the Mekong River in an average year. Another 30 percent comes from various rivers that flow into the lake from hills and mountains in the surrounding provinces. About 13 percent comes from rainfall over the lake itself with the remaining 5 percent coming from rising Mekong floodwaters flowing across the floodplain. In an average year, 60 percent of the lake's water comes from Cambodia and almost 20 percent from Lao PDR.

Dr Tao Seng Hour, Senior Minister and Chairman of the Tonle Sap Basin Authority
PHOTO: LEM CHAMNAP

China and Thailand account for about 10 percent each. Such vast quantities of water give fish access to enormous amounts of food, especially in flooded forest areas around the lake. Many species spawn before or during the flood, widely dispersing eggs across the floodplain.

Population and development pressures are the major threats to the lake's ecosystem. Despite the lake's inherent richness of natural resources and numerous development projects have been mobilised for the Tonle Sap, most indicators of poverty in the Tonle Sap area are more negative than other rural areas of Cambodia.

'The Tonle Sap Basin is the heart of our culture and heritage which is why we must conserve, manage and develop it properly'

Until recently, most development assistance for the Tonle Sap has largely focused on the five provinces surrounding the lake—Kompong Chhnang, Pursat, Battambang, Siem Reap and Kompong Thom. However, a new body established by the Cambodian government is now taking a broader basinwide approach that includes five more provinces as well as the municipality of Phnom Penh. The five additional provinces— Banteay Meanchey, Oudor Meanchey, Preah Vihear, Kompong Cham and Kandal— extend the jurisdiction of the Tonle Sap Basin Authority (TSBA) to the entire catchment area of 11 different river basins. Together with Phnom Penh, these basins make up 42 percent of Cambodia's territory and are home to 4.4 million people, about a third of the country's population. "The Tonle Sap Basin is the heart of our culture and heritage which is why we must conserve, manage and develop it properly," says Senior Minister Dr Tao Seng Hour, the former minister of agriculture, forestry and fisheries who chairs the new authority in his capacity as deputy chairman of the Council for Agricultural and Rural Development and chairman of the National Committee for Population and Development. Despite millions of dollars in aid to Tonle Sap projects in recent years, the chairman notes that there has been little to show in terms of concrete results. "Since there are so many projects being implemented, I've asked my colleagues to compile a project list in order for us to coordinate and monitor these investments," he says. "A lot of money has been spent but we have not seen satisfactory results so far. Coordination must be improved. We are responsible for coordinating and evaluating these projects and reporting directly to the prime minister."

According to the Ministry of Interior, loans and grant for Tonle Sap projects exceeded $50 million between 2002 and 2006. Most of this money has come from the Asian Development Bank (ADB) including a loan of almost $11 million for the Tonle Sap Environmental Management Project which has been executed by the Ministry of Agriculture, Forestry and Fisheries (see *Catch and Culture*, Vol 11, No 3). Responsibility for implementing and monitoring this project, has, however, been scattered among several agencies such as the Ministry of Environment, the United Nations Development Programme and the CNMC. The project has also been geographically limited to the Tonle Sap Biosphere Reserve, a protected area established by royal decree in 2001. Project activities have therefore focussed on areas within the reserve's boundary, which is formed by two national highways, and not areas further inland. The reserve itself covers about 20 percent of the basin area and accounts for about a third of its population. The ADB has meanwhile approved grants of almost US$20 million for a Tonle Sap "sustainable livelihoods" project under the Ministry of Interior and US$18 million for a Tonle Sap rural water supply and sanitation project under the Ministry of Rural Development. "We've had so many projects and programmes. But the people's living conditions around the Tonle Sap are not yet well improved," says Hou Taing Eng, the former secretary-general of the CNMC who is secretary-general of the new authority. "The ADB recognised this was caused by a misunderstanding of cooperation among the people operating there. What we are trying to do is to coordinate the economic, social and natural resources of the Tonle Sap Basin to have a direct impact on people's livelihoods." For the time being, the activities of the authority's 40 staff are constrained by an annual budget of 300 million riel (US$75,000). In the future, however, it is expected that development assistance to Tonle Sap projects will fall under the coordination umbrella of the basin authority.

'A lot of money has been spent but we have not seen satisfactory results so far. Coordination must be improved'

The move to set up the TSBA followed a national forum on the Tonle Sap Initiative, a collection of ADB programmes and projects aiming to reduce poverty while managing natural resources and the environment in a sustainable manner. In his opening address to the forum held in Phnom Penh in March last year, Prime Minister Hun Sen warned that Cambodia could face a "serious environmental disaster" from excessive exploitation of the Tonle Sap, notably from the clearing of flooded forest for large-scale rice farming. To develop the area around the lake, Samdech Hun Sen called for an "integrated basinwide approach" extending beyond Cambodia's borders. He also urged the forum to consider a new agency for the Tonle Sap to mobilise and galvanise support from all ministries and a wide range of development partners (see *Catch and Culture,* Vol 13, No 1).

Legal instruments

Six months after the national forum, King Norodom Sihamoni promulgated a royal decree to establish the new authority. The decree specifically refers to the Law on Fisheries passed in 2006 (see *Catch and Culture* Vol 12, No 3) and other recent legislation related to natural resource management and the environment. The authority's primary role is "coordinating the management, conservation and development of the Tonle Sap Basin." It reports to the Council of Ministers and has the right to send representatives to cabinet meetings. The decree provides for the authority to be chaired by the vice chairman of the Council for Agricultural and Rural Development, another body under the Council of Ministers. The other members are secretaries of state from 16 ministries, senior officials from seven other agencies and 11 provincial and municipal governors. The ministries represented in the authority include nine of the ten ministries that are also members of the CNMC plus seven others including the Ministry of Economy and Finance, which is responsible for relations with development partners such as the ADB and the World Bank. The authority's responsibilities include preparing policies, strategic plans, programmes and projects in collaboration with institutions, local authorities and development partners. The TSBA is also responsible for coordinating "all ongoing and planned activities in the Tonle Sap Basin" as well as monitoring and evaluating projects to ensure that they consistently follow government strategies and plans. The royal decree provides for coordination to be extended to both national and international organisations, non-governmental organisations and other members of civil society.

Towards the end of last year, the king promulgated a second royal decree appointing nine advisors to the authority including Fisheries Administration Director General Nao Thuok. Other advisors include Ly Thuch — the former chairman of the National Assembly Commission on the Economy, Planning, Investment, Agriculture, Rural Development, Environment and Water Resources — and Hang Chuon Naron, the secretary general of the Ministry of Economy and Finance. The decree also named Mr Hou Taing Eng as secretary-general of the authority with the rank of secretary of state along with seven deputies responsible for day to day operations with the rank of under-secretary of state. The deputies include Long Cheang, one of four deputy directors at the Fisheries Administration. The other deputies have expertise in various areas ranging from planning and coordination, water resources and agronomy to health and education.

Prime Minister Hun Sen later confirmed Dr Tao Seng Huor as chairman and appointed six vice chairmen including Ministry of Agriculture, Forestry and Fisheries Secretary of State Teng Lao. Others include Ministry of Environment Secretary of State Yin Kim Sean, Ministry of Water Resources and Meteorology Secretary of State Phang Sareth and Professor Sin Mengsrun, a forestry expert who is also an advisor to the Office of the Council of Ministers. The 29 other senior officials appointed as members include Ministry of Economy and Finance Secretary of State Ouk Rabun, CNMC Secretary-General Pich Dun and Council for Agricultural and Rural Development Secretary-General Rath Virak.

Under a government sub-decree signed by the prime minister in May this year, the general secretariat of the authority has five departments. These are responsible for administration and finance, planning and cooperation, economic project coordination, social

project coordination, and research and information dissemination. The duties of the latter include analysing information and making predictions on the state of the basin and changing trends as a basis for policies, strategies, development plans and overall decision making. The sub-decree also provides for "focal teams" at the provincial and municipal level. These are headed by 11 deputy governors with technical officers from various provincial or municipal departments serving as assistants. In accordance with the first royal decree promulgated in September last year, a 15-member executive committee oversees the operations of the authority and reports directly Deputy Prime Minister Sok An, the minister in charge of the Office of the Council of Ministers. The executive committee meets every month and comprises Dr Tao Seng Huor and the six deputy chairmen along with Mr Hou Taing Eng and the seven deputy secretaries general at the secretariat.

The structure of the authority is considerably simpler than the Tonle Sap Basin Management Organization envisaged by the ADB. It also has a broader membership and carries significantly more political weight. After two rounds of technical assistance totalling close to $0.5 million between 2003 and 2005, ADB consultants recommended the establishment of an organisation comprising a coordination committee with two secretariats—one for the Tonle Sap Biosphere Reserve and the other for basinwide planning for water and related resources. These two secretariats would have been located within the CNMC and overseen by a new deputy secretary general with sole responsibility for the Tonle Sap. Under the ADB proposal, the coordination committee would have been complemented by sub-committees for catchment areas that straddle two or more provinces such as the Mongkol Borei, Boribo, Chinit and Seng river basins. These would have been further supplemented by provincial committees and district task forces with secretariats attached to the provincial departments and district offices of water resources and meteorology. Membership of the organization would have been restricted to 10 ministries and only eight provinces.

** Mr Starr is the editor of Catch and Culture. In 2006 and 2007, he also worked as media consultant for an environmental education and awareness campaign that was part of the Tonle Sap Environmental Management Project.*

Further reading

Baran, E., Starr, P. and Y. Kura (2007). Influence of built structures on Tonle Sap fisheries, Cambodian National Mekong Committee and the World Fish Center, Phnom Penh, 44 pp.

Kingdom of Cambodia (2007). Royal Decree of the Establishment of the Tonle Sap Authority, September 8, Phnom Penh, 4 pp.

Kingdom of Cambodia (2007). Royal Decree, November 19, Phnom Penh, 2 pp.

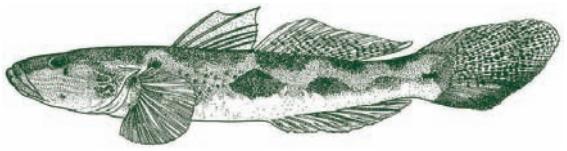
Kingdom of Cambodia (2007). Decision on the Nomination of Composition of Royal of the Tonle Sap Basin Authority, November 29, Phnom Penh, 3 pp.

Kingdom of Cambodia (2008). Sub-Decree in the Organization and Functioning of the General Secretariat of the Tonle Sap Basin Authority, May 9, Phnom Penh, 7 pp.

Milner, H., Carson, S. Tes, S. and U. Sokco (2005). Cambodia: Establishment of the Tonle Sap Management Organization II (Final Report). Asian Development Bank and Cambodian National Mekong Committee.

Milner, H., Carson, S. Tes, S. and U. Sokco (2005). Cambodia: Establishment of the Tonle Sap Management Organization II (Final Report Appendices). Asian Development Bank and Cambodian National Mekong Committee.

MRC (2003). State of the Basin Report: 2003,.Mekong River Commission, Phnom Penh, Camodia. 300 pp.



Promoting **gender issues** at the **Fisheries** Department in **Thailand**

By Napaporn Sriputinibondh*

Thailand's Department of Fisheries has been awarded as an outstanding government agency in gender equity promotion. Director-General Dr Somying Piumsombun received the award at a ceremony presided over by Prime Minister Samak Sundaravej at the Royal Thai Navy Conference Room in Bangkok in March. The following article looks at government efforts to promote gender issues in Thailand over the past decade.

Gender is prominently featured in the Thai Constitution of 1997, also known as the "People's Charter." Articles 30 and 80 clearly describe the equal status of men and women, and the roles to be played by government agencies in promoting gender issues. In implementing the constitutional provisions, the Office of Women's Affairs and Family Development under the Ministry of Social Development and Human Security submitted a proposal endorsed by the cabinet in 2001. The Civil Service Commission subsequently translated the constitutional provision into a programme involving all civil service agencies in promoting gender issues. As a result, government departments appointed chief and deputy chief gender equality officers. At the same time, departmental bureaux and divisions appointed gender focal points to coordinate gender issues and formulate a Master Plan on Gender Equality Promotion.

To comply with government policy, the Thai Department of Fisheries has integrated gender issues into its mission, targeting the promotion of such

Director-General Dr Somying Piumsombun (front left, holding award) with the author (front right, with flowers)

issues to service beneficiaries through work plans and projects as well as administrative and service activities. While a core strategy aims to promote gender issues among target beneficiaries, a subsidiary strategy targets officials within the department where such issues are integrated into the way they work.

'In fisheries in Thailand, women work alongside men, notably in preserving and marketing fish'

In fisheries in Thailand, women work alongside men, notably in preserving and marketing fish. They also sometimes accompany men fishing. Among mechanisms developed and opportunities created for female economic participation, a Fisheries Extension Project has adopted an initiative of HRH Princess Mahachakri Sirindhorn to support school lunches with animal protein from fish from school ponds. An "organic aquaculture" project has also been promoted as part of a major government policy to shift farming away from the heavy dependence on chemicals and fertilizers to organic inputs that are locally available. The project promotes the application of local wisdom and the Sufficiency Economy, a development philosophy graciously crafted by His Majesty the King.

Rehabilitation of small-scale fisheries has been undertaken in the tsunami-affected areas in six southern provinces with assistance in aquaculture, replacing gear and repairing piers and processing plants. The participation of women in these activities was highly visible, especially in areas such as processing and farm accounting. In a separate project with the European Union, the government introduced co-management practices to fisheries and coastal communities. The Coastal Habitats and Resources Management Project featured active participation of all stakeholders, especially women and youths. Under the co-management mechanisms, all stakeholders could bring with them their skills and talents to contribute to planning, implementing, monitoring, and learning from the joint activities with a keen sense of participation. The leadership provided by women was highly visible in many project areas.

Gender activities with MRC

With the Fisheries Programme of the MRC, the Department of Fisheries has also coordinated the implementation of fisheries activities highlighting the participation of women. The projects under this programme have included activities under the programme's Fisheries Ecology, Valuation and Mitigation Component such as surveying deep pools, recording fish catches and studying fish markets. Activities under the Fisheries Management and Governance Component have ranged from establishing conservation areas and training schoolchildren to studying the efficiency of fishing gear. Under the programme's Aquaculture of Indigenous Mekong Fish Species Component, activities have included breeding and propagation, economic and biological research, aquaculture extension and capacity building for fish farmers.

Sex of fish farmers and others registered with Department of Fisheries

Activity	Female (%)	Male (%)	No record (%)
1. Hatchery and Nursing	26	73	1
2. Fish Farming	31	66	3
3. Supplementary Aquatic Food Factories	12	31	57
4. Fish Product Factor Traders	35	57	8
5. Middlemen	36	57	7
6. Primary Fish Processing (owners)	40	40	23
7. Cold Storage Facilities (owners)	16	32	52
8.Traditional Fish Processing (owners)	56	39	5
9. Fish Processing Factories	10	26	64
10. Importers and Exporter	16	44	39
11. Ornamental Fish	35	54	11

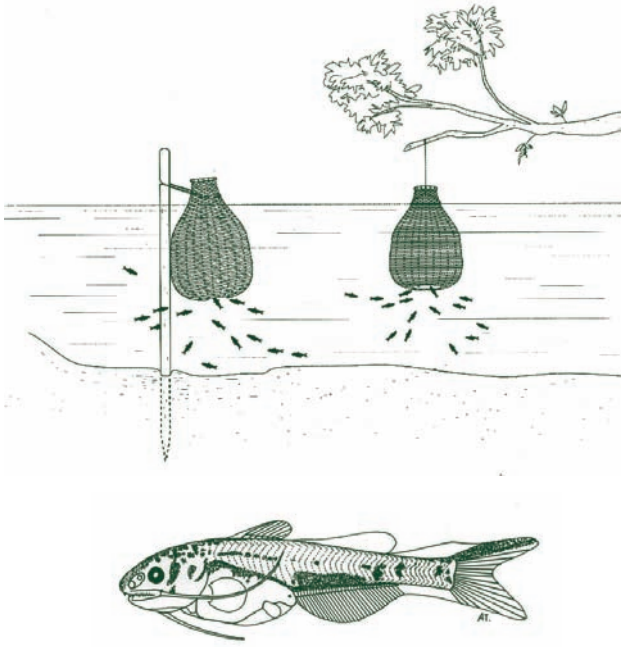
Training, Study Tours and Seminars in 2007

	Female Officers		Male Officers		Total
Activities	Number	%	Number	%	Number
Inside Department	981	44	1,243	56	2,224
Outside Department	75	57	57	43	132
Total	1,056	45	1,300	55	2,356

Many fisheries development projects being implemented in the lower Songkhram River Basin in northeastern Thailand have offered great opportunities for research on gender issues. Like elsewhere in Thailand, women here are active in participating in all livelihood activities. However, with the large number of projects being implemented, research can be easier. To implement its gender equality promotion program, the department has established a gender database where information on officials and beneficiaries is generated, catalogued, and maintained. Activities formulated have included capacity building among officials, awareness and recognition of gender's role and harmonious working conditions where men and women share responsibilities. The department has also established a gender committee to oversee equity in employment and deployment of officials in work assignments. The necessary budget for implementing these activities has been earmarked.

Outstanding government agency

Monitoring and evaluation of gender-related projects revealed that information on gender is needed to prepare project work plans to satisfy the needs of the whole community. Monitoring and evaluation has also shown that the number of women participating in training and implementation of aquaculture and aquatic resource conservation projects has been increasing and that a satisfactory gender balance has been achieved.



** Ms Napaporn Sriputinibondh is Thailand's National Coordinator in the Network for Promoting Gender in Fisheries Development in the Lower Mekong Basin. Between 2003 and 2004, she served as the network's regional coordinator*

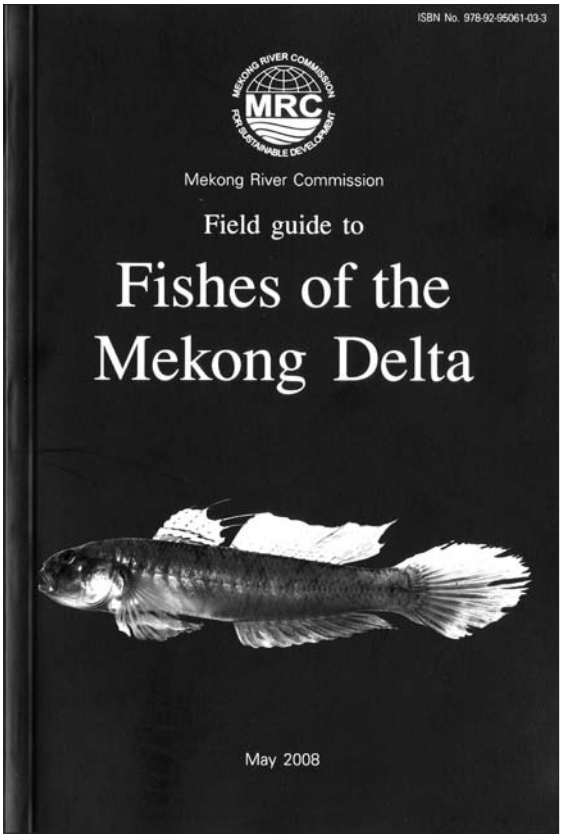
New **field guide** for the delta

A valuable new book indexes 363 species in all four riparian languages

The Mekong Delta extends from Kampong Cham in Cambodia, through Viet Nam to the mouth of the river where the Mekong discharges into the South China Sea. It is an area of high biodiversity with some of the richest fauna and flora in the Lower Mekong Basin. Between 1961 and 1993, reports by Japanese, Vietnamese and Swiss authors provided lists of fish fauna in the Mekong Delta. In his comprehensive account of fish in Cambodia jointly published by the MRC, FAO and Danida in 1996, Walter Rainboth of the University of Wisconsin recorded more than 350 species in the Cambodian stretch of the Mekong including many from the delta. And in 2004, the MRC published a Mekong Fish Database CD that includes more than 400 species from the delta.

Working with Chavalit Vidthayanon of WWF Thailand, the MRC has now produced a 288-page field guide to 363 of the most common species found in the delta, most of which have significant economic and ecological value. The *Field Guide to the Fishes of the Mekong Delta* includes a checklist of 460 species known to date. They are ranked according to family (of which there are 66) and bio-geographical status (endemic and indigenous fish as well as visitors from marine waters). Carps, barbs and minnows (cyprinids) and gobies (gobiids) predominate, accounting for about 30 percent of all delta species. Twenty-eight species are endemic to the Mekong of which four are restricted to the delta. Of the species known in the delta, 346 have a broad geographical range and many occur throughout the Southeast Asia region. Seventy-five species are regular visitors from the South China Sea. More than 250 are economically important as food fish and 25 are common in aquarium trade.

The 363 species covered in detail by the field guide have been selected on the basis of their abundance, commercial importance and significance in terms of conservation. For each of these species, the book includes the scientific name and the common names in English as well as Khmer, Lao, Thai and Vietnamese.



It also provides colour photographs of adult fish and, where appropriate, photos or drawings of juveniles. The entry for each fish includes a species diagnosis and a review of its biology, distribution and range. Two indexes list the 363 species according to both their scientific and common names including names in all four riparian languages.

Dr Chavalit has been active in the field of fish taxonomy since the early 1990s and is now recognised as a leading expert on Mekong fishes. Although the book's main purpose is to serve as a practical guide to technicians, students and other researchers, it will also be a welcome addition to libraries and personal collections as an authority on the species of this area.

Available for US$15 through mrcs@mrcmekong.org

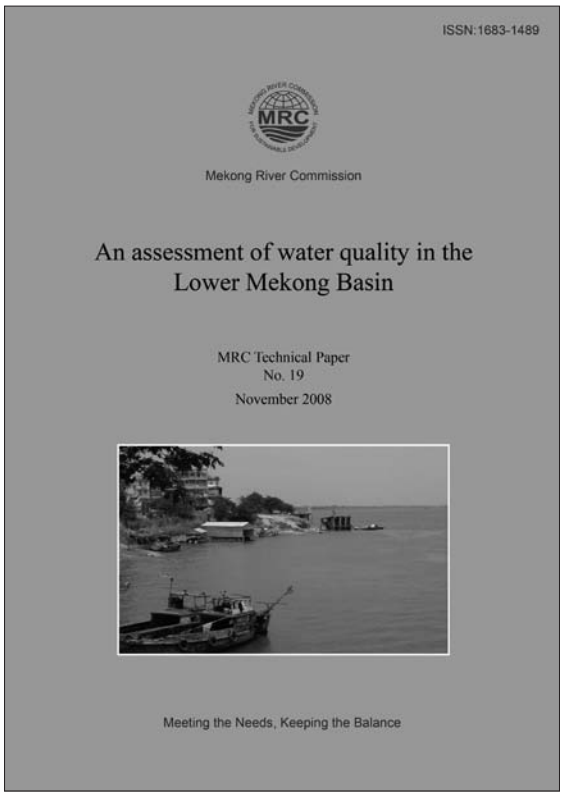
Text based on excerpts from the introduction and the foreword by Jeremy Bird, Chief Executive Officer of the MRCS

Assessing **water quality**

A new technical paper assesses the water quality of the Mekong, its tributaries and the Delta.

Water quality is one of the key factors affecting the environmental health of the Mekong River system. In 1985, the Interim Mekong Committee established the Water Quality Monitoring Network (WQMN) to provide an ongoing record of the water quality of the river, its major tributaries and the Mekong Delta. Ninety stations were sampled during 2005. Of these, 55 are designated 'primary stations' as they have basin wide, or transboundary, significance. The remaining 35 are designated 'secondary stations'. Twenty-three of the primary stations are located on the mainstream, (17 on the Mekong, and 6 on the Bassac), 23 on tributaries, and 9 on the delta.

MRC Technical Paper No. 19, *An assessment of water quality in the Lower Mekong Basin*, documents data recorded from 1985 to 2005 or, in some cases, the sub-set of data recorded from 2000 to 2005. Three main categories of water-quality indexes (WQI) are used for the protection of aquatic life, human impact and agricultural use. Each category is subdivided into classes according to the number of chemical parameters (DO, pH, etc.) that meet guideline thresholds. The classes are high, good, moderate and poor quality for aquatic life; not impacted, slightly impacted, impacted and severely impacted for human impact; and no restrictions, some restrictions, and severe restrictions for agricultural use. In the mainstream and tributaries, the WQI for aquatic life is mostly high quality. However, in the delta only one station is classed as high quality and two others are good quality. Of the remainder, four are moderate quality and one is poor quality. Signs of significant human impact on water quality are observed at stations in the uppermost part of the LMB and downstream of Phnom Penh. The lower index values at the downstream stations reflect higher population densities, particularly in the highly-populated and intensively-farmed delta. At all but one of delta stations, the index for human impact is classed as severely impacted. In the mainstream and tributaries, the index for agricultural use is consistently at the



level of no restrictions. However, at some stations on the Cau Mau peninsula of the delta, the index for agricultural use is classed as severe restrictions.

The paper evaluates three major sources of pollution: urban areas, industrial wastewater and agriculture. While there is no strong evidence for transboundary pollution within the basin, it finds there is some evidence for transboundary transmission of pollutants from the Upper Mekong Basin into the LMB. The paper also finds no sign of any significant basin-wide trends for any parameter. With the continuing development of both agriculture (increased use of fertilisers) and urbanisation, there is reason to expect changes in water quality in some tributaries. It is possible that reforestation of areas in the Khorat Plateau will lead to water-quality improvement. The paper identifies salinity, acidification and eutrophication as the three principal water quality issues in the lower basin.

Available as a free download or in hard copy format for US$5 through mrcs@mekong.org.

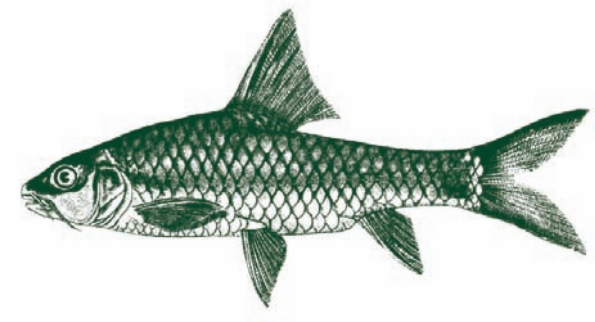
Text based on excerpts from the summary

Mekong **Fisheries Index**

Seafood industry tangled in nets of global turmoil

Thanh Nien News, December 8, 2008

The global economic crunch has bitten deep into the local seafood industry. Many processors and exporters have lowered production and cut jobs while many farmers have quit breeding fish. Doan Toi, general director of Nam Viet Corporation in the Mekong Delta province of An Giang, says the company has slashed 5,000 jobs, or nearly half of its workforce, over the past several months. Nam Viet, the country's largest exporter of pangasius (*tra* and *basa* catfish), has earned more than US$200 million in export turnover this year. Tran Thien Hai, chairman of the Viet Nam Association of Seafood Exporters and Producers, says with demand low in Viet Nam's major shrimp export markets such as US and Japan, many companies have had to cut production and are trying to penetrate into other markets like Russia, the Republic of Korea and Australia. Duong Ngoc Minh, general director of the seafood processing firm Hung Vuong Corporation in the Mekong Delta province of Tien Giang, says due to the global financial crisis, many catfish importers have failed to obtain a bank guarantee, hurting their business operations badly. Minh also says that demand from EU importers and consumers has dropped with the euro falling against the US dollar. He expects the catfish processing and exporting sector's labour force to reduce by 20-30 percent in early 2009. While *tra* and *basa* exports are expected to generate $1.4 billion in turnover this year, Minh says it would be difficult to reach even $1 billion next year if the government does not help the industry out. Minh says many fish farmers have abandoned their vocation over the past four months after suffering big losses, and as a result, supply of the fish would drop sharply next year. *Tra* and *basa* fish are currently priced at VND12,000-VND14,000 ($0.70-0.80) per kilogram while input costs are around VND16,500 ($1) per kilogram. "The country's seafood industry will continue to face difficulties, driven by the global financial crisis, until the end of 2010," the Thoi bao Kinh te Saigon Online (Saigon Economic Times) quoted Deputy Minister of Agriculture and Rural Development Luong Le Phuong as saying at a recent seminar. The seminar covered the development of Viet Nam's seafood industry after the country joined the World Trade Organization (WTO) nearly two years ago. The Deputy Minister says that though the seafood industry has achieved a great deal of success and gained a lot of experience after the WTO integration, it remains a vulnerable industry. He said the ministry had asked the government to grant import licenses for unprocessed seafood products to local businesses which would process it for exports, as a measure to boost export growth. Viet Nam is also encouraging international investors to upgrade post-processing technology, he added. Viet Nam, the world's eighth largest seafood exporter, earned $4.27 billion from exports in the first 11 months of this year.



Eco-systems key to sustainable catfish farming

Viet Nam News, 6 December 2008

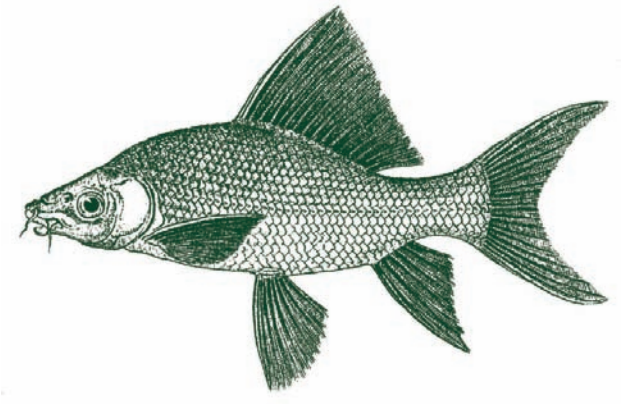
More than 150 representatives from 18 nations gathered in the Cuu Long (Mekong) Delta city of Can Tho in early December for an international symposium to share experience in all aspects of basa farming. The event, called "Pangasius aquaculture in Asia: Present status and challenges for sustainable development" discussed reproduction, nutrition, technology, diseases, environmental and social impacts as well as marketing. Pangasius aquaculture in the Cuu Long (Mekong) Delta is one of the fastest of its kind in the world, achieving a production level of 1.2 million tonnes in less than a decade, but recently, food safety and environmental integrity have been highlighted by customers. Speakers said that an inter-governmental organisation to help achieve sustainability is necessary and the the Vietnamese government should play a role in post-production market and value-chain issues to cope with emerging problems in aquaculture. All adaptive measures needed also to involve farmers.

It was also suggested that certifications be provided to farmers who follow standards for environmental protection, such as sector-wide performance monitoring which involves, among other things, better zoning practices. The idea is to avoid areas of high biodiversity and to have better water management to maintain water quality for river bodies.

Fish-to-Fuel in Viet Nam?

Greentechmedia.com, 2 December 2008

A research consortium led by Finland-based VTT Technical Research Centre will spend US$6.3 million to build a biodiesel plant fed by Vietnamese fish processing waste. The ENERFISH project, expected to be complete by 2011, will use as feedstock the 120,000 kg of fish waste turned out daily by the Hiep Thanh Seafood JSC fish processing plant in Viet Nam's Mekong River delta region. Right now that processing facility sells its fish waste to animal feed makers. In Viet Nam, other fish processors have tried out waste-to-biodiesel projects, with varying degrees of success. In 2006, processors Minh Tu Ltd. and Agifish started projects to make biodiesel from catfish fat, only to find that, at times, they could get a better price selling that fat to exporters than processing it into fuel. Still, with the Mekong Delta region using about 20 million litres of diesel every day, fish processors could see a growing demand for their biodiesel if Viet Nam's government helps by clearing regulatory hurdles to using the fuel.



Southern province suffers major loss in shrimp aquaculture

Thanh Nien News, 2 December 2008

Bac Lieu Province in the Mekong Delta has lost up to 197 hectares of shrimp farms in late November, the deputy head of provincial Agriculture and Rural Development Department Ta Minh Phu said Monday. The new figure adds up to 21,550 hectares of aquaculture shrimp destroyed since the beginning of the year, with the most affected localities being Bac Lieu Town and Hoa Binh, Dong Hai and Gia Rai districts.The cost of raising shrimp has increased by 20-40 percent due to surging input prices, while the market price of the crustacean has dropped by nearly a third compared to the same period last year. It is estimated that a shrimp farmer will lose VND10-40 million (US$590-2,362) per hectare on average.

WWF, Coca-Cola Helps Restore Mekong Delta Habitats

Bernama.com, Malaysia, 19 November 2008

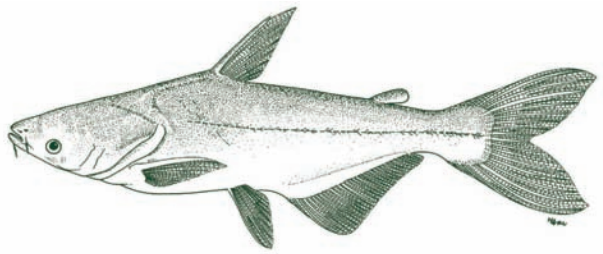
A collaborative project between the WorldWide Fund for Nature (WWF) and soft drink maker Coca-Cola has restored almost 2,000 hectares of grasslands in the Mekong Delta, boosting fresh water conservation efforts. The recovery of the natural environment in Tram Chim National Park in Dong Thap province serves as a key factor to improve water quality, restore underground water and regulate floods and drought. The project has enhanced the park's high biodiversity value which supports 130 native plant species, 232 species of birds, of which 16 are on the International Union for Conservation of Nature's Red List and Viet Nam Red Data Book. It is home to approximately 150 types of freshwater fish, making up 33 percent of the total freshwater fish species found in the Mekong Delta. Launched in April 2008, the three-year project targets the recovery of natural wetlands of the Plain of Reeds (Dong Thap Muoi) at the Tram Chim National Park.

Seafood sales slide on global market turmoil

ThanhNien News/Bloomberg, 14 November, 2008

Seafood sales to Viet Nam's largest overseas markets have slumped as the global credit crunch forces employers to cut payrolls. The International Monetary Fund has forecast that the US, Japan and European economies will all contract next year in their first simultaneous recession since World War II. Importers are having credit problems, so many have cut orders. At the same time, local fisheries processors are facing higher production costs and a cash shortage because of higher interest rates. Seafood is Viet Nam's third-largest export by value after petroleum products and textiles, according to the Hanoi-based General Statistics Office. The country has exported US$3.8

billion worth up to the end of October. Viet Nam exports catfish to nearly 80 countries and territories. However, the biggest markets are Russia, Ukraine, the United States and the EU. And this year things are looking ominous, orders from Russia and Ukraine have slowed considerably. Russia last year imported US$155.6 million worth of catfish and Ukraine imported US$104.7 million. The rising value of the US dollar is also creating difficulties as catfish becomes more expensive in Europe. The Ministry of Agriculture predicts the last three months of this year will be most important, as the target of $1.5 billion in catfish export turnover seems unreachable in the current economic climate. In addition, heavy rains and floods at the end of last month and early this month destroyed more than 27,000 hectares of fish farms in the northern and central regions, according to the Ministry of Agriculture and Rural Development.



Viet Nam plans to develop *tra* catfish industry in Mekong Delta

Vietnam News Agency, 11 November, 2008

The Ministry of Agriculture and Rural Development (MARD) has passed a plan on development of production and sales of *tra* catfish in the Mekong Delta until 2010, with further orientations towards 2020.The breeding of *tra* fish will be developed in favorable water areas such as the Tien and Hau rivers. Water and land areas will be also zoned off for the production of fries and for fish processing factories in Can Tho city and An Giang, Dong Thap, Vinh Long, Hau Giang, Soc Trang, Tien Giang, Ben Tre and Tra Vinh provinces. The plan aims at increasing the *tra* catfish farming acreage in the Mekong Delta to 8,600 hectares by 2010, and 13,000 ha by 2020 for an annual output of 1.25 million tonnes and 1.85 million tonnes, respectively. The region's exports of *tra* catfish are estimated to increase by an average of 5.9 percent per year, fetching about $ 1.5 billion by 2010 and $ 2.3 billion by 2020.This increase in fish production and processing will also generate more jobs for local workers, with the number of workers involved in this sector estimated to increase from 200,000 in 2010 to 250,000 in 2020.

Fish expert's determination breeds success

Bangkok Post, 1 November 2008

In a bid to boost the catfish population in the Mekong, the Department of Fisheries' resources management expert Saneh Pholprasit embarked on a bold mission to breed them in captivity in 1983. The attempt succeeded 18 years later. In 2001, Mr Saneh's team managed to spawn over 400,000 catfish hatchlings through artificial insemination, of which, about 70,000 survived. They were distributed to fishery centres in four regions of the country for further breeding attempts and also for release in natural waterways and for sale to fish farmers wanting to set up their own breeding farms. Mr Somwang said a hybrid fish species of *pla buek* has been bred with the smaller sister of the family, *pla sawai* (striped catfish), by several fish farmers in recent years. The new species of *pla sawai* is called "big *wai*". The breeders also sell big wai offspring to other farmers. Apart from conserving *pla buek* via artificial breeding, local groups of fishermen also try to limit fishing by conserving areas known to be catfish habitats in the Mekong River. Among such groups is Chiang Khong Conservation. Group leader Somkiat Khueanchiangsa said his group had tried to shorten the pla buek fishing season in the Mekong. There are six major catfish habitats in the river, which also serves as a natural borderline among Mekong countries. Apart from protecting those habitats, his group is also calling for the conservation of the river's ecology by the other Mekong countries.

Overfishing hurting dolphins

Phnom Penh Post, Monday, 13 October 2008

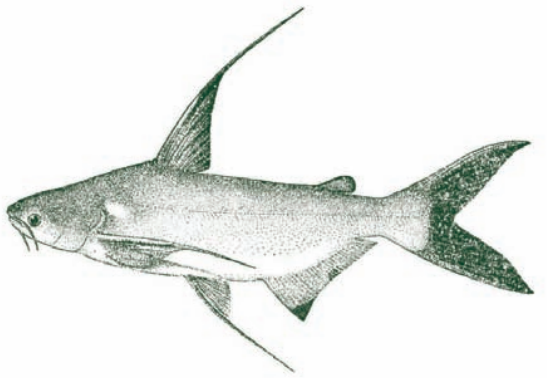
Overfishing on the Mekong River in Stung Treng province is depleting the food stocks of freshwater dolphins living there and could force the rare animals to leave the area in what officials say would be a catastrophe for the local tourism industry. Officials say the lack of fish this season has been caused by fishermen who fish in Cambodian waters and then export between two and three tonnes of fish a day to Lao PDR. This is an illegal activity but perpetrators are rarely caught or punished. However, the ministry's Fisheries Department in Stung Treng said it was hard for the department to stop overfishing and illegal exports, due to lack of staff. September to February is the dolphin's breeding season, and if they do not have enough to eat during this time they will have a very tough time. There are currently about 150 dolphins in

the river, but locals say the number of dolphins close to the shore has decreased this season. Dolphins only eat half of the body of the fish and leave the other half floating in the river and there weren't very many half-eaten fish bodies floating in the river this season.

Inflation puts strain on nation's fishermen

Phnom Penh Post, 8 October 2008

Rising food and fuel prices are eating away at the profit margins of Cambodia's fishermen, prompting fishing communities to address the issue. More than 200 fishing communities along the Mekong River, the Tonle Sap and coastal areas were represented at a two-day workshop, organised by the nongovernmental organisation Fisheries Action Coalition Team (FACT). Participants said catches had declined to about 5kg or less per day, which was not enough to support a family, and the price of goods had risen sharply but the prices fishermen are getting for their hauls were not increasing commensurately. High petrol prices were making it harder for fishermen to earn a living. Ly Vuthy, chief of the community fishery development office at the Fishery Administration, acknowledged the concerns of the nation's fishing communities. "It is a problem to be addressed," he said, adding the government is looking into the case and will act soon.



Two catfish exporters register for lifting of US anti-dumping tariffs

VietNamNet Bridge, 7 October 2008

The Saigon-Mekong Fish Company (SAMEFICO) and Cadovimex II have asked the US Department of Commerce to reconsider the anti-dumping policy imposed on their products. In their submissions to the US's top watchdog, the two enterprises clearly explained that their frozen Tra trademark catfish fillets were not exported to the US market during the period under inspection, namely from August 1, 2007 to July 31, 2008.The documents also proved that the two enterprises have never entered into a joint-venture with any other partners to export their products to the US during the afore-mentioned period. The two exporters have submitted documentary proof, establishing both the timeframe and the volume of the first shipments of frozen catfish fillets to enter the US market, as well as the dates their products were checked in or out of storehouses before reaching customers. The DOC said they will make their preliminary results public 180 days from the start of inspections. The final decision will be announced 90 days after the publication of the preliminary results.

Low space limits fisheries growth

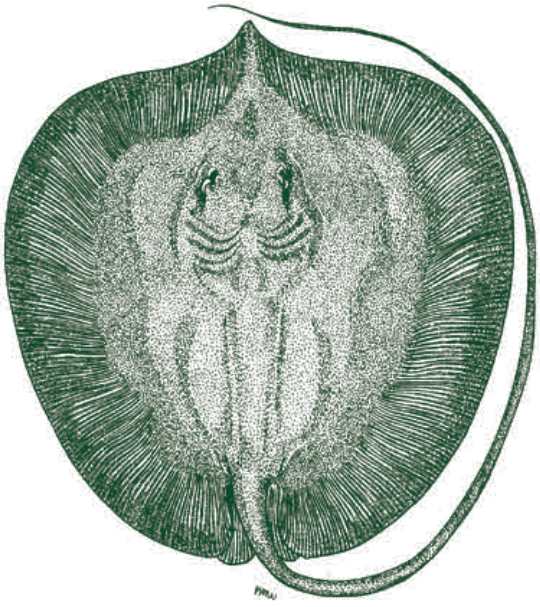
VietNam News, 6 October 2008

Limited cold storage space is hindering the development of the fisheries industry, especially in the *tra* and *basa* catfish sector, particularly considering the volatility in the global market. Due to a shortage of space, domestic seafood exporters cannot wait for prices to rise, and have to export stock even if prices are low. Most freezers in the area have a capacity of only 2,000 to 3,000 tonnes, with only a handful of larger 5,000 tonne freezers available. In the past decade, the *tra* and *basa* catfish processing industry has expanded rapidly, and now has an annual output capacity of around 1 million tonnes. The seafood export industry expected to earn more than US$1 billion this year, according to the Ministry of Fisheries. However, due to limited capital, processors have not invested in cold storage capacity. Industry insiders estimated capital of roughly $1.5 to 2 million was needed to set up a 10,000 tonne cold storage facility and government incentives were needed to justify such a large expense.

Fisheries gets bio-tech boost

Viet Nam News, 4 October 2008

The Vietnamese Government has approved a US$51.6 million bio-technology plan aimed at getting the fisheries sector up to ASEAN standards according to the Ministry of Agriculture and Rural Development and foreign enterprises were being encouraged to join the move. The ministry would co-ordinate with relevant sectors to build a legal corridor and study international laws to protect domestic bio-tech products. With more than 40 projects, the bio-tech plan is expected to meet 30 per cent of demand for disease-resistant fisheries breeds including prawn, *tra* catfish, green-clawed prawn, African carp, crab and red snappers by 2010; 70 per cent by 2015; and 100 per cent by 2020. Research institutes are being urged to send talented scientists on 6-12 month study-trips to countries with well-developed fisheries bio-technology. The fisheries sector has already completed studies in areas including technology on developing breeds, preserving species, boosting quality and managing the environment, the problem was that the application of bio-technologies had been carried out at laboratories which lacked modern equipment. Fishermen often bred stocks using traditional techniques, but this often led to weak resistance against disease. Each seafood research institute had one laboratory which



carried out many different projects at the same time but these were hindered by a lack of staff. In the Cuu Long (Mekong) Delta, there are about 1.1 million ha dedicated to aqua-products, accounting for 55 per cent of the country's breeding area. Nearly all of these aqua-products are exported. Local farmers face a number of problems, such as good crops but cheap prices, good prices but poor crops, lack of successful breeds and outbreaks of disease. Provinces in Tay Nguyen (Central Highland) had potential to breed aqua-products, but the current amount of breeds met only about 40 per cent of demand, the remainder were bought from northern provinces and the Cuu Long region.

New catfishes found in Viet Nam

Practical Fishkeeping, November 2008

Two new species of hillstream catfish have been described from central Vietnam. Heok Hee Ng and Jörg Freyhof name the two new species *Glyptothorax filicatus* and *Glyptothorax strabonis* in a recent issue of the journal Zootaxa. *Glyptothorax filicatus* from the Mekong River drainage in central Viet Nam, is distinguished from congeners by the pattern of grooves in its thoracic adhesive apparatus (a patch of skin folds on the chest of the fish) and a combination of proportional measurements of the head and body. This species is named after the frond-like pattern on its adhesive apparatus (the name is the Latin for "adorned with ferns"). *Glyptothorax strabonis* from the Giang River drainage in central Viet Nam, is distinguished from congeners by its small eye, as well as the shape of its thoracic adhesive apparatus and proportional measurements of the head and body. The species is named after its small eyes (from the Latin meaning "one who squints"). For more information, see the paper: Ng, HH and J Freyhof (2008) Two new species of *Glyptothorax* (Teleostei: Sisoridae) from central Vietnam. Zootaxa 1873, pp. 11–25.

Save your liver, don't eat raw fish

Vientiane Times, 9 September 2008

In Lao PDR many people prefer to put the fish into their mouths live or to add them, swimming, to a bowl of chili sauce; they say they taste much better raw. However, doctors warn this popular menu item puts people at high risk of a parasitic infection known as opisthorchiasis. In humans, opisthorchiasis may affect the liver, pancreas, and gall bladder. If not treated in the early stages, the disease may cause cirrhosis of the liver and increased risk of liver cancer. According to the Centre for Malariology, Parasitology and Entomology, last year 1,128 people were affected with opisthorchiasis in Savannakhet province (a survey was conducted in Songkhone, Xayphouthong and

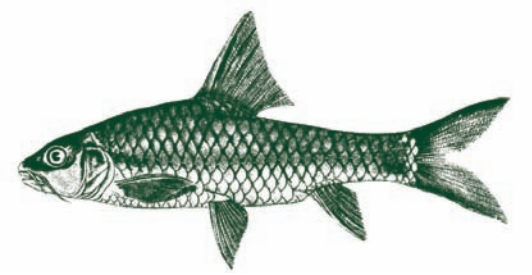
Kaysone Phomvihane districts). A further 240 people contracted the disease in Viengkham, Pakxaeng, Phonxay and Pak-ou districts in Luang Prabang province, 707 people were affected in Pakxan and Khamkeuth districts in Borikhamxay province, 526 people in Xaysettha and Sanamxay districts in Attapeu province, 4,893 people in Khong and Mounlapamok districts in Champassak province, and three people in La and Nga districts in Oudomxay province. Scaled fish species were most likely to cause infection with opisthorchiasis. An estimated 70 out of 100 people tested positive for the disease during check-ups, most of whom were men. Provincial health officials are using radio promotional spots to reduce this common health risk. Health officials are also trying to raise awareness of the risk and are explaining the disease and its prevention when they work in local communities. But it is difficult to change people's behaviour. Raw fish is a popular snack all over the country, especially

in the form of fermented fish sauce such as *padaek, pakhem, pasom* and *pachao* . If people always cooked fish before they ate it, the infection could be avoided. People tended not to worry about this disease because they know it will not kill them immediately. However, many people in Lao PDR have already died from this disease. Fish in ponds and marshes are more likely to cause an infection because small, isolated bodies of water harbour more pathogens than the Mekong River. Public Health Department staff and the Education Department are teaching children in primary schools about the dangers of opisthorchiasis and its prevention, hoping they will learn how to fight the disease in the years to come.

Danish Grant keeps Mekong River Commission Fisheries Programme Afloat

Ministry of Foreign Affairs of Denmark. September 4, 2008.

A new Danish grant of US$3.6 million to the MRC Fisheries Programme in 2009-2010 will enable the MRC to continue to facilitate sustainable development of fisheries in the Mekong River Basin and to analyse the effects to fisheries of major hydropower investments in the Basin. The new Danish grants follows up a grant of US$6 million for the period 2005-2008 and ensures that the MRC Fisheries Programme can continue its activities which has become ever more important in light of the ongoing and planned major hydropower and dam investments in the Mekong River basin. The implementation of the many planned major hydropower and dam projects in the Mekong Basin may have a major impact on the Mekong River fisheries. The MRC Fisheries Programme will increase research and analysis of the effects on fisheries of these investments in order to enable decision makers to take informed decisions in regard to hydropower and dam projects. The overall objective of the MRC Fisheries Programme is to contribute to a coordinated and sustainable development, utilisation and protection of the fisheries resources of the Mekong River at local, national and regional levels, which is of key importance to the livelihoods of the poor population in the entire Mekong Region. The programme has helped strengthen information systems and awareness of the biological and socio-economic factors of importance for a sustainable utilisation and protection of the fisheries resources in the Mekong River, and works to build capacity and introduce sustainable fisheries management methods.

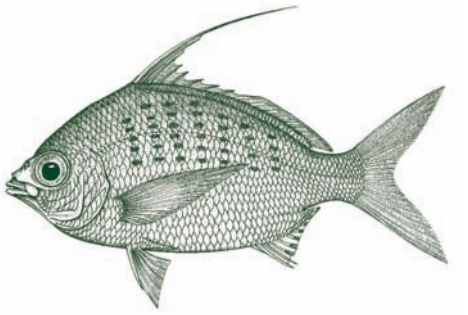


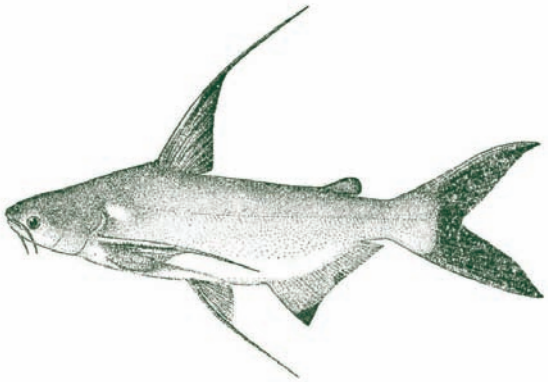
Cambodia, "environmentally sustainable" tourism to save Mekong dolphin

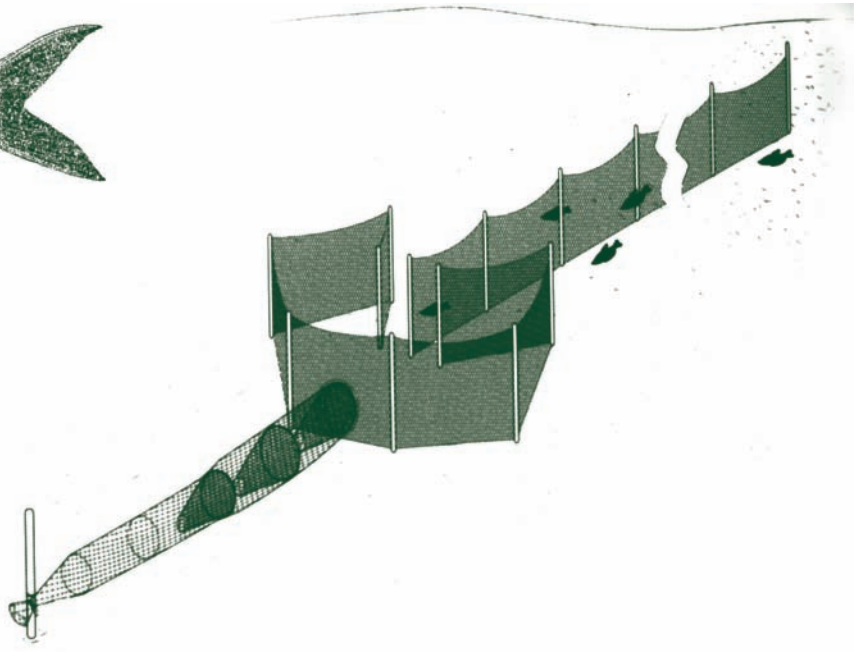
Phnom Penh (AsiaNews/Agencies)

Saving the few dozen freshwater dolphins still remaining in the Mekong River, and helping the local population by guaranteeing them a source of livelihood is the aim of the "ecotourism" project begun in the border area between Lao PDR and Cambodia by the Cambodia Rural Development Team (CRDT), which has the twofold objective of protecting wildlife and providing an alternative source of income for the inhabitants of the villages. The village of Sambor, in the north of Cambodia, is one of the places

selected by the CRDT as a model of environmentally sustainable development. Tourists are given the opportunity to live in contact with the local population, to help the inhabitants protect the natural habitat of the dolphins, and to teach a little English to the children. The most frequently requested activities include well digging, sewer construction, and work in the fields. The experiment promoted by the activists is intended to save the dolphins from extinction by radically changing the habits of the inhabitants of the village, who for decades have used aggressive fishing methods like explosives and high-capacity nets. Now the freshwater dolphins are seen as a resource to be “exploited” in order to attract foreign capital and tourism; the visitors pay US$60 for three days in contact with nature, and the money is used to support the local population. But recent studies have demonstrated that if the benefit for individuals is beyond question, the same cannot be said for the dolphins: in spite of a small increase in their numbers in the initial phase of the project, it is not yet clear whether this is truly effective for preserving the species. Scientists affirm that a new and not yet identified disease is spreading rapidly, killing the offspring. Researchers fear that the new virus - caused by pollution in the water, infested with chemical agents and the runoff from gold mining projects - could soon lead to the total extinction of the dolphins.







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