Catch and Culture

Fisheries Research and Development in the Mekong Region

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INSIDE

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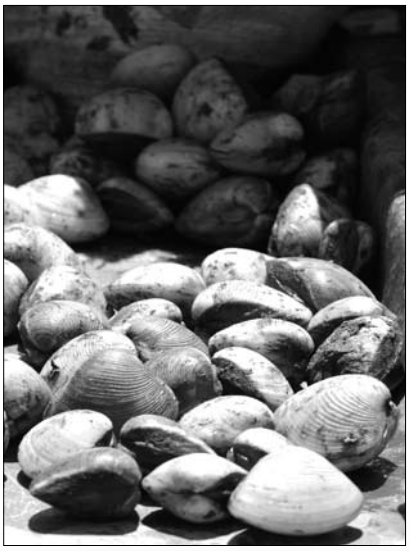
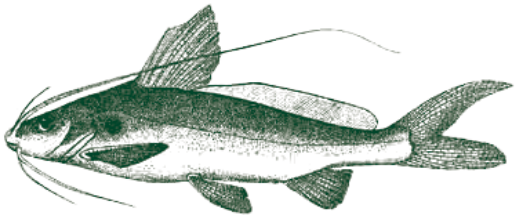


Editorial



In this edition, we feature two articles on a couple of issues that are both highly topical and extremely complex—hydropower development and climate change.

The first article examines what has happened to wild fish stocks in two river basins on the Pacific seaboard of North America. The two rivers have very different histories. One has dams on tributaries but not on its mainstream while the other has dams on both. In discussing the implications for salmon in the two rivers, we look at what we might learn from the different development approaches in managing water resource development in the Lower Mekong Basin.

The second article looks at a regional climate change initiative recently launched by the Mekong River Commission in cooperation with international and regional partners. If the Lower Mekong Basin becomes warmer and receives more rain in the wet season, what are the implications for fisheries, especially in countries like Viet Nam and Cambodia, whose fisheries may be particularly vulnerable to climate change?

Also featured in this issue are the latest efforts to develop certification standards for farmed catfish and the launch of an MRC survey of fish larvae aimed at identifying significant fish spawning grounds along the Mekong mainstream. We also feature a clam fishery in the Mekong Delta, which hopes to become the second fishery in Asia to be certified as sustainable and well managed, and look at the important contribution of fisheries to Cambodia's economy. And as part of an occasional new series, we look back at the foundations of regional fisheries cooperation in the early 1990s.

Our special insert in this edition is devoted to freshwater aquariums in Thailand, notably the Bueng Chawak Exhibition Centre for Aquatic Animals in Suphan Buri province which attracts tens of thousands of visitors each month. If properly managed, it seems that freshwater aquariums can not only raise public awareness of fisheries but also make money at the same time.

Hydropower in the **Fraser** and **Columbia** Rivers: a **contrast** in approaches to **fisheries protection**

By John W. Ferguson and Michael Healey *

The previous edition of* Catch and Culture *(Vol 14, No 3) carried two articles that described the possible impact on fisheries of proposed hydropower dams on the mainstream of the Mekong. As further background on dams and their impacts on fisheries, in this paper we examine what has happened to wild fish stocks in two river basins on the Pacific seaboard of North America that have had contrasting development histories. The Fraser River has dams on its tributaries but not on the mainstream, while the Columbia River has dams on both tributaries and the mainstream. We discuss the implications this has had for stocks of salmon in the two rivers, and what we might learn from the different development approaches in managing water resource development in the Mekong.

Fraser River Basin

The Fraser River is the largest river that drains the Pacific seaboard of Canada, and the fifth largest in the country. The catchment has an area of 234,00 km^2, covering about one-quarter of the area of the province of British Columbia. The mean annual discharge is 3,600 m^3/sec. However, the discharge is seasonal, being dominated by the annual snowmelt in the summer months. As a result the peak discharge, which occurs in May/June (~ 8,000 m^3/sec), can be ten times larger than the flow in the winter months of February and March (~ 800 m^3/sec).

The basin is the home to almost three million people (about two-thirds of the population of British Columbia) including more than 100 indigenous tribes (Native Americans (US) and First Nations (Canada)). It is the 'economic engine' of the province, producing about 80% of British Columbia's GDP. Much of this is derived from natural resources. Fisheries, both commercial and recreational, make an important contribution to the economy of the basin.

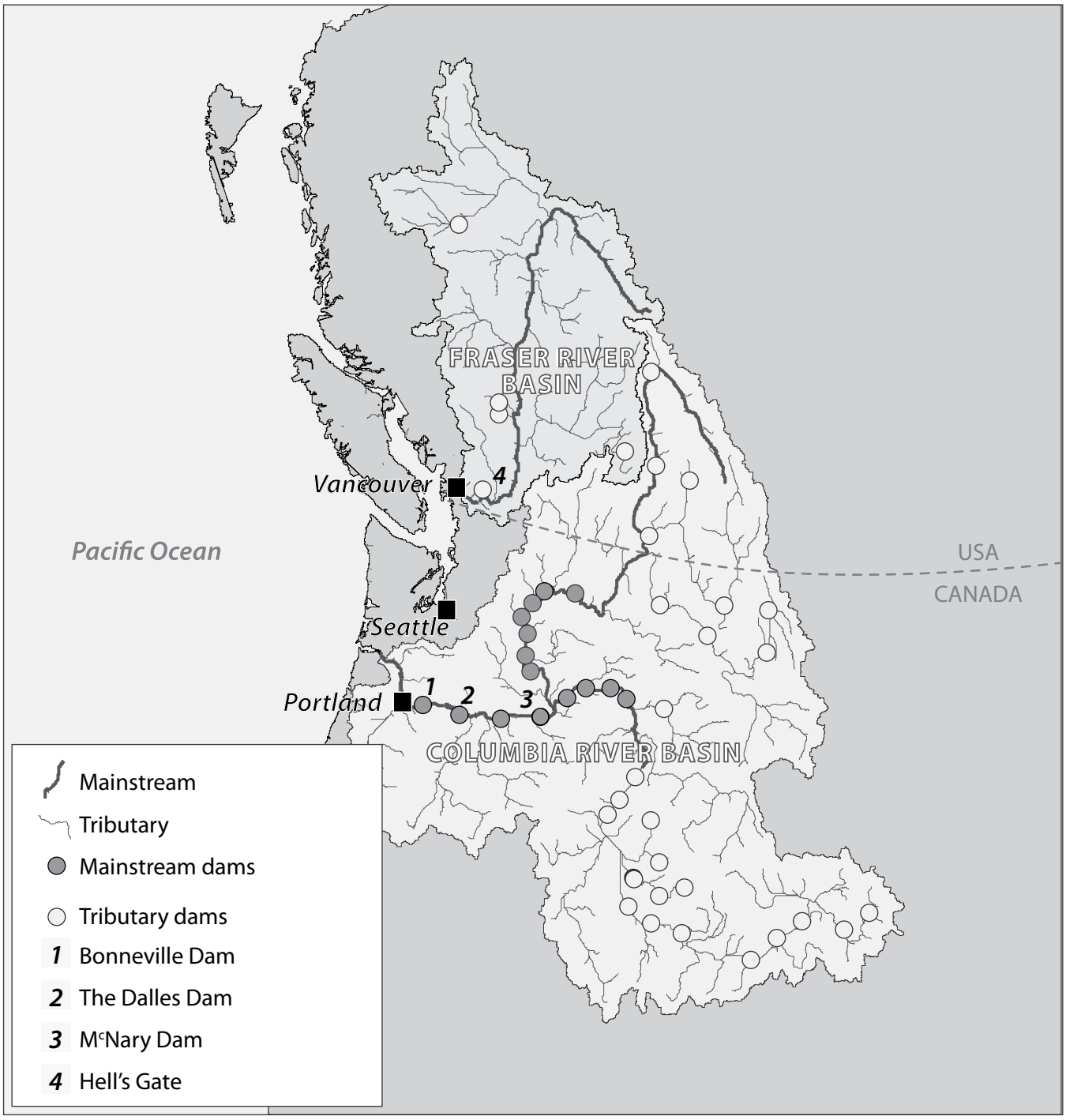
According to Northcote and Larkin (1989), the Fraser River is the greatest salmonid producing system in the world. It contains seven species of salmon (genus *Oncorhynchus*), which form the core of the lucrative commercial and recreational fisheries of British Columbia and are critically important to the cultures of First Nation societies in the basin. Harvesting salmon contributes more than US$1 billion annually to the economies of British Columbia and the adjacent state of Washington in the USA.

There are five commercially important species of Pacific salmon, namely sockeye salmon *(O. nerka)*, pink salmon *(O. gorbuscha)*, chum salmon *(O. keta)* coho salmon *(O. kisutch)* and Chinook salmon *(O. tschawytscha)*. These species are anadromous, spawning in freshwater but migrating to the sea as juveniles where they grow to adulthood. They are harvested mainly in the ocean but also to some extent in freshwater. The two remaining species, rainbow/steelhead trout *(O. mykiss)* and cutthroat trout *(O. clarkii)*, also have anadromous populations but most complete their lifecycles in freshwater. They are harvested mainly in recreational fisheries (the five Pacific salmon species are also harvested in recreational fisheries).

Columbia River Basin

The Columbia River has a catchment of 567,000 km^2 and a mean annual discharge of 7,800 m^3/sec. It is the largest river in the Pacific Northwest. The

Fraser and Columbia basins



Graphic: Tim Burnhill

headwaters of the river are in the Canadian province of British Columbia, but 85% of its drainage basin is in the USA. Here the basin covers nearly all of Idaho, large portions of Oregon, and Washington and small portions of Montana, Wyoming, Utah, and Nevada. The natural flow rates of the Columbia River are also highly seasonal, peaking at 13,592 m^3/sec in the summer months and 3,898 m^3/sec in the winter months (see box on page 7). However, discharge is regulated by many large water storage reservoirs located in the upper watershed, and flows are released for multiple purposes, including flood control, hydropower production, and irrigation.

Based on recent run sizes and harvest levels, salmon and steelhead production in the Columbia River Basin

contributed $142 million in personal income annually to communities on the West Coast in 2005 (IEAB, 2005).

Like the Fraser River, the fish community is comprised primarily of anadromous species including the seven salmonid species living in the Canadian river. Other important species include the native Pacific lamprey *(Lampetra tridentate)* and the introduced American shad *(Alosa sapidissima)*.

Early Development

Salmon have been an important source of food for the Native American peoples living in the Pacific Northwest for at least 10,000 years (Butler and O'Connor, 2004). Before the intervention of European settlers, an estimated 8-10 million adult salmon returned each year to the Columbia River (National Research Council, 1996). The extent of their harvest is unkown, but Schalk (1986) estimates that in the early 1800s Native Americans caught 19,000 tonnes of salmon from the river annually.

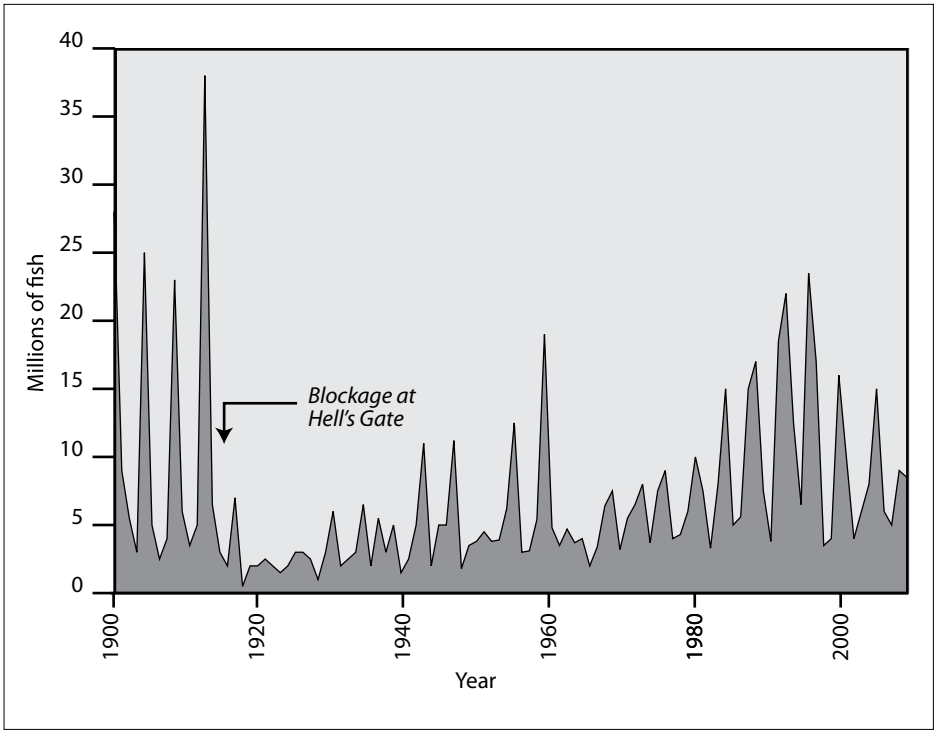
European colonists first arrived in the region in the late 1700s. By the mid 1800s, the settlers had begun to exploit the natural resources of both basins with dramatic effect on the habitat and stocks of wild salmonids.

In 1858, gold was discovered in the Fraser River and placer mining caused significant degradation of salmon spawning and nursery areas. Exploiting the timber resources of the basin added further stress to the wild population as a forestry practice at the time involved the construction of temporary 'splash dams' behind which logs were stored. These blocked salmon migrations and release of the impounded water scoured riverbed gravels, destroying eggs and young fish.

Perhaps the gravest damage to wild stocks in the Fraser Basin was caused during the construction of the Canadian Northern Railway in 1914 when blasting in the Fraser Canyon caused a rockslide in the narrow channel at Hell's Gate. This constriction was already a difficult passage for salmon during their spawning migration and the slide further narrowed the river, increasing water velocity and altering flow patterns. Stocks of sockeye and pink salmon, in particular, were hit by this catastrophe, and pressure on these species, which was exacerbated by heavy fishing, caused populations to plummet. Prior to 1916, the catch of Fraser River sockeye averaged 8.5 million fish; from 1917 to 1932 the catch averaged only 1.7 million fish (see chart at below).

The declines in sockeye and pink salmon ultimately led to the creation of a joint Canada/US management agency in 1937, the International Pacific Salmon Fisheries Commission (IPSFC). This agency played a central role in managing and rebuilding sockeye and pink salmon runs in the Fraser River. With the backing of the IPSFC, fishways were built around the blockage at Hell's Gate and fisheries were managed to ensure adequate migrations. Gradually, Fraser sockeye and pink salmon began to increase in abundance and reached historic levels in the 1990s. Despite a slight recent decline in some species (sockeye and coho salmon), today the Fraser River salmonid fishery is one of the most productive fisheries in the world.

Fraser sockeye salmon runs (1901-2006)



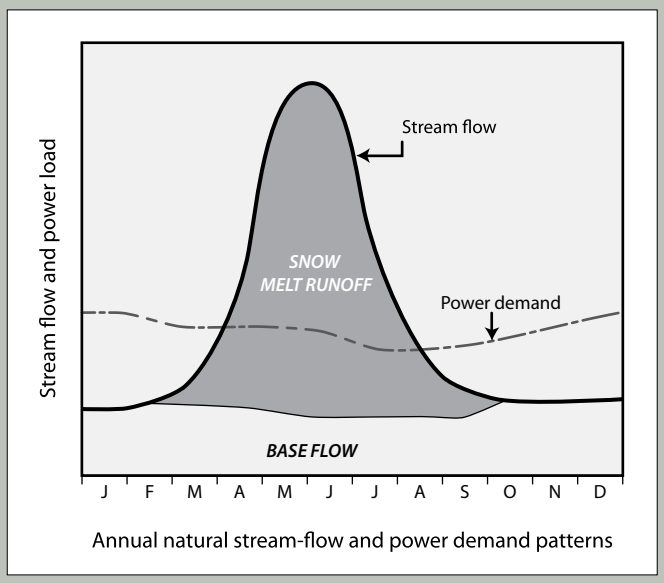
In the Columbia Basin, early

Dramatic change in Columbia River flows

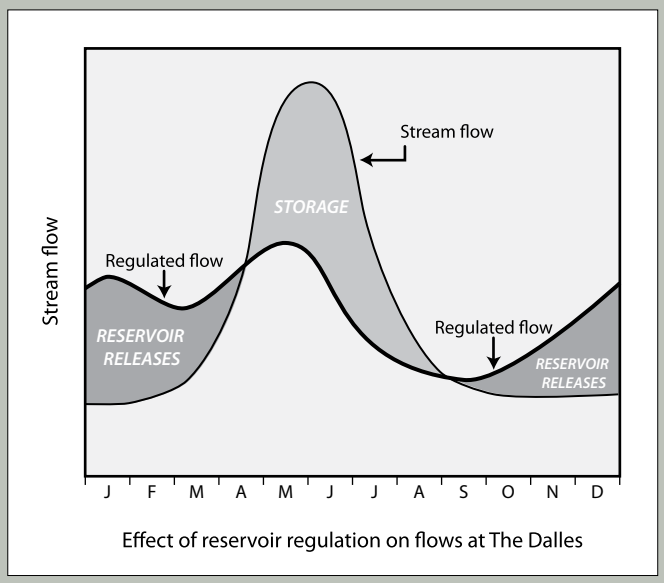
By Tim Burnhill *

While it may not be one of the world's major drainage basins, the catchment of the Columbia River surely ranks as one of the most developed river systems on the planet. Today, 14 mainstream and nearly 400 tributary dams impound over 55 million acre-feet of water and have generating capacity of 33,000 MGw. In addition to hydropower, the network of dams is used for flood control, navigation, stream-flow regulation, and the storage and delivery of stored waters.

The development of the basin began in earnest in 1931 following the publication of a Corps of Engineers report on the hydropower potential of the Columbia River that was commissioned by the US Congress. The report, which called for the construction of 10 dams on the Columbia River, set the framework for the development of the basin for the next 40 years. Construction on the famous Bonneville and Grand Coulee dams begin in 1933, and the dams became operational in 1939 and 1941 respectively. Both dams were important elements of America's war effort during the Second World War.



Annual natural stream-flow and power demand patterns



Effect of reservoir regulation on flows at The Dalles

The development of the basin and the construction of dams have dramatically altered the natural flow of the river-system and its annual hydrograph. Before regulation the system had strong seasonable variability, with 75% of the flow occurring in the months from April to September (the largest contribution coming from summer snowmelt rather than precipitation, which is heaviest during the winter months.) By 1980, flow regulation due to impoundments and releases significantly adjusted this seasonal pattern, and now the flow is more evenly distributed between the winter and summer months.

** Dr Burnhill is a science writer with the Mekong River Commission Secretariat*

Sources

Muckleson, K.W. (2003) International management in the Columbia River system. IHP-VI Technical Documents in Hydrology PC-CP series No. 12. UNESCO/IHP/WWAP

National Research Council (U.S.) (2004) Managing the Columbia River: Instream flows, Water Withdrawal, and Salmon Survival. National Academies Press. Washington. 246 pp.

colonial settlers and fur trappers traded salmon from Native Americans. However, the volume of salmon traded was small because the fish spoiled quickly if left untreated. This changed in the 1860s when procedures for canning salmon were developed and extensive harvesting began following the installation of the first cannery in 1866 (see chart below). Further development of the basin through hydropower, flood control, transport of commerce, and irrigation began in the early 1900s. The sharp decline in the abundance of salmon from historic levels can be attributed to the overfishing, habitat degradation, and impaired access to spawning grounds resulting from these developments (Lichatowich, 1999).

Hydropower Development

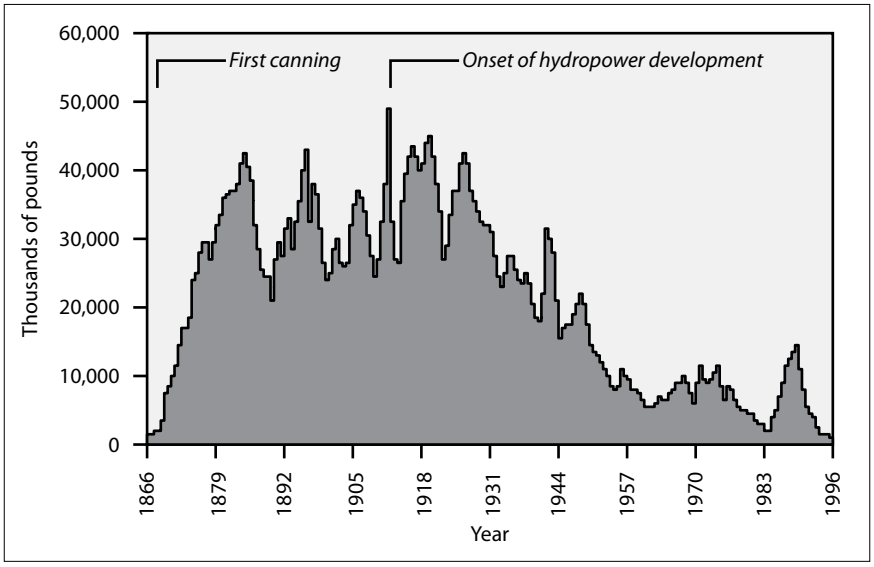
Development of the hydropower potential of both basins began in the early 1900s but has taken very differing routes from then to the present day. Hydropower projects in the Fraser Basin are limited to the tributary system and the mainstream remains undeveloped. In contrast, both the mainstream and the tributary network of the Columbia River have been heavily developed. As a result, in the Columbia River salmon must pass from one to nine dams on their migrations to spawning and nursery grounds.

There were plans for dams on the mainstream of the Fraser River, but none of these were approved. The most ambitious proposed scheme, at Moran Canyon, involved a 261 m high dam and a 260 km long reservoir with a power generation capacity equal to the combined output of the Grand Coulee and two Hoover dams.

If this dam had been constructed, it may well have been the first of many dams on the mainstream and could have lead to the development of the full hydropower potential of the basin. Why this did not occur is not entirely clear. Certainly public opinion was divided over the Moran dam, but the proposal had influential supporters and the government of British Columbia was promoting power development in the province. However, a variety of factors seem to have contributed to keeping the Fraser River free flowing:

- The salmon runs were important to the economies of both British Columbia and Washington, and were administered under an international agreement. This would have made it difficult for British Columbia to initiate the project unilaterally;
- Careful review and analysis of the impacts of the dams revealed the inadequacy of possible mitigation schemes, such as fish ladders and artificial propagation;
- Opposition to the dam was well organised whereas the proponents were fragmented and competitive;
- There were numerous alternative sites available for hydropower development in the province other than the Fraser River, and also in the Columbia River basin;
- In Canada, the responsibility for fisheries management lies with the federal government. The federal government opposed the dam because of its likely impact the salmon stocks and the importance of these to the First Nations people;
- The free flowing Fraser River remains very productive and, although some salmon runs are enhanced through artificial propagation and stocking, the majority of salmon production from the river is from wild stock. Had the mainstream been dammed, it is very likely that many sockeye and Chinook salmon populations would have been lost.

Columbia River commercial salmon harvests (1866-2006)



In stark contrast, the hydropower potential of the Columbia River has been developed vigorously since the early 1900s. Fish passage at the lowest mainstream dam, at Bonneville, has been monitored since the dam was constructed in 1938. The records show that the overall abundance of adult salmon entering the river is now relatively stable, albeit at lower levels than before European colonisation. The average salmon count over the last decade was just over 1 million fish, whereas the population of returning adults in pre-colonial times is estimated at around 8 – 10 million fish.

However, these levels have been achieved through stocking of hatchery-reared juvenile fish, while the abundance and diversity of wild salmonid populations have decreased significantly since the late 1800s. The first hatchery in the Columbia Basin began production in 1877—well before the first hydropower development. The product from these hatcheries was used to supplement losses from harvest and habitat degradation, and since 1888 there has not been a year in which production in the Columbia Basin was entirely natural.

In 2008, 147 million juvenile salmon arrived that the river's estuary prior to entering the Pacific Ocean. The proportion of this population that are from wild stock varies greatly with species, but, as an example, 75% of the yearling juvenile Chinook salmon arriving at McNary Dam were estimated to have been of hatchery stock. Gustafson *et al*. (2007) estimated that 30% of the historic salmon populations have been lost, and that many of the remaining wild stocks have been significantly reduced due to the impacts of dams and a period of poor ocean productivity. As a result, 13 of the 16 'population units' used to define structure of salmon populations in the basin are now classed as 'threatened' or 'endangered'.

It is clear that artificial propagation on its own does not preserve the natural salmon fisheries of the Columbia Basin. Additional measures, primarily fish ladders, to help the upstream migration of adult salmon have been installed at each of the 13 hydropower dams on the mainstream. While these passages have performed quite well, mortality of fish migrating upstream through the hydropower system remained a significant problem during the 1960s and early 1970s. This was due in part due to high levels of gas supersaturation in the tailrace at the base of the dams. Furthermore, few mainstream dams were designed to take account of the downstream migration of juvenile salmon.

These issues came to a head during the extreme low flow years of 1973 and 1977 when survival rates of juvenile salmon migrating downstream through the hydropower systems dropped to less than 5% (Raymond, 1988). It was then clear that additional protection measures were needed to sustain salmon stocks and provided the impetus for the long process of improving passage conditions for juvenile salmon that continues today. Major milestones were:

- Installation of systems to guide fish away from turbine intakes and bypass fish around dams (1975);
- Collection of migrating juvenile salmon at upstream dams and transporting them in barges to below downstream dams (1980);
- Storage of water in flood control reservoirs during the winter to provide increased flows through mainstream dams during the following spring and summer to assist downstream migration (1982);
- Spill water at dams to provide non-turbine passage routes (1982);
- Abatement of total dissolved gas and management of gas supersaturation (1996):
- Development of surface-orientated routes of passage at many dam sites (1990s):
- Development of new turbine designs that improve survival of fish passing through turbines (1990s).

The message for the Mekong

The contrasting approaches to hydroelectric development in the Fraser and Columbia basins provides some clear messages regarding the potential impact mainstream dams may have on the fisheries resources of the Mekong.

Firstly, the location of dams in reaches of large rivers can have profound impacts on fish populations and fisheries. The absence of dams on the mainstream of the Fraser River has helped to preserve this world-class fishery. In contrast, dams on the mainstream of the Columbia River contributed to the severe depletion of wild fish stocks.

Key findings:

- The Fraser River has no dams on the mainstream; the Columbia River has many. Largely as a result of this different approach to location of dams, the Fraser River now has healthier wild salmon fisheries than does the Columbia River.
- Stocks of salmon in the Columbia River have been impacted by numerous human activities, including dams, and extensive mitigation efforts have been directed toward conserving those stocks most imperiled. This has involved technologies for fish passing both upstream and downstream of dams, stock enhancement through hatchery production of target species, and management of water releases at key times to facilitate fish migration. The result has been that no fish stocks currently being protected and receiving the focus of these mitigation efforts have become extinct. However, the abundance of wild fish has generally decreased and has been replaced with adult salmon produced in hatcheries and stocked as juveniles.
- Development of mitigation techniques in the Columbia River has taken more than 40 years and is on-going. The total expenditure has been more than US$7,000 million (not readjusted for today's values); current expenditure is approaching US$1,000 million per year.
- Managing migratory fish stocks of the Fraser-Columbia systems is straightforward compared with the suite of fishes in the Mekong. The Mekong system has at least 58 highly migratory species threatened by mainstream dam development, while the Columbia and Fraser have 9 and 8 migratory species respectively. Mekong fishes are not powerful upstream swimmers like salmon are. Downstream movement in the Mekong takes place over much of the year and involves eggs, juvenile and adult fish, unlike salmon which, generally speaking, migrate downstream as smolts during a predictable and narrow time period. The biology of Mekong species with respect to fish passage requirements is effectively unknown, as are the engineering criteria necessary for developing successful fish passage structures to enable fish to safely pass dams.

Secondly, overcoming the impacts of large dams on migratory fishes in the Fraser and Columbia has required the integration of a number of mitigation measures. Most prominent are fish passages (fish ladders) for upstream migration and a range of methods for getting juvenile fish downstream past the barriers. At the same time, water flows need to be managed to provide favourable conditions for fish passage (which is often contrary to hydropower generation requirements). Stocking of hatchery produced juvenile fish, while contributing to the numbers of fish in the system, does not assist in preserving wild fish stocks.

Finally, mitigation solutions are very costly and take time to develop and implement. In the Columbia River, over the last 30 years over US$ 7 billion has been spent on mitigating the effects of dams on salmon (Williams, 2008). In fact, these costs are currently approaching US$1 billion a year. However, these technological fixes do not fully restore migratory conditions to levels under which salmon evolved prior to dams being installed. Thus, they may keep salmon stocks from going extinct, but are not likely to provide complete mitigation for freshwater ecosystems that have been altered by water resource development (Williams, 2008).

Beyond these general lessons, the mitigation methods developed in the Columbia Basin raises more specific issues that are pertinent to the Mekong. Perhaps the most important is that the measures in the Columbia River target a small number of species (five) of the same salmonid group. Populations of other commercially and culturally important fish, such as the Pacific lamprey and sturgeon, remain under severe stress. In addition, introduced species, such as the American shad, have been quick to adapt to the changing riverine ecosystems, possibly adding additional stress to the populations native fish.

The Mekong has a much greater fish biodiversity than the Columbia or Fraser Rivers (approximately 900 compared with 30-40 species). The Mekong has at least 58 highly migratory species threatened by mainstream dam development (Halls and Kshatriya, in press), while the Columbia and Fraser Rivers have 9 and 8 migratory species respectively. Therefore, devising solutions to mitigate the impact of mainstream dams on the Mekong's fisheries appears far more challenging than the task that faced the efforts to preserve the salmonids of the Pacific Northwest.

** Dr Ferguson is Director of the Fish Ecology Division of the Northwest Fisheries Science Center in Seattle and Dr Healey is Professor Emeritus at the Institute for Resources, Environment and Sustainability at the University of British Columbia in Vancouver*

References

Butler, V. and J. O'Connor. 2004. *9,000 years of salmon fishing on the Columbia River, North America.* Quaternary Research 62: 1-8.

Gustafson, R., R. Waples, J. Myers, L. Weitkamp, G. Bryant, O. Johnson and J. Hard. 2007. *Pacific salmon extinctions: quantifying lost and remaining diversity.* Conservation Biology 21(4): 1009-1020.

Halls, A. and Kshatriya, M. in press. *Modelling the cumulative effects of mainstream hydropower dams on migratory fish populations in the lower Mekong basin.* MRC Technical Paper No. 25. Mekong River Commission, Vientiane.

Independent Economic Advisory Board (IEAB). 2005. *Economic effects from Columbia River Basin anadromous salmonid fish production: IEAB Report 2005-1.* Report to Northwest Power Planning Council, Portland Oregon. 46 p. plus Appendices.

Lichatowich, J. 1999. *Salmon without rivers, a history of the Pacific Salmon crisis.* Island Press, Washington D.C.

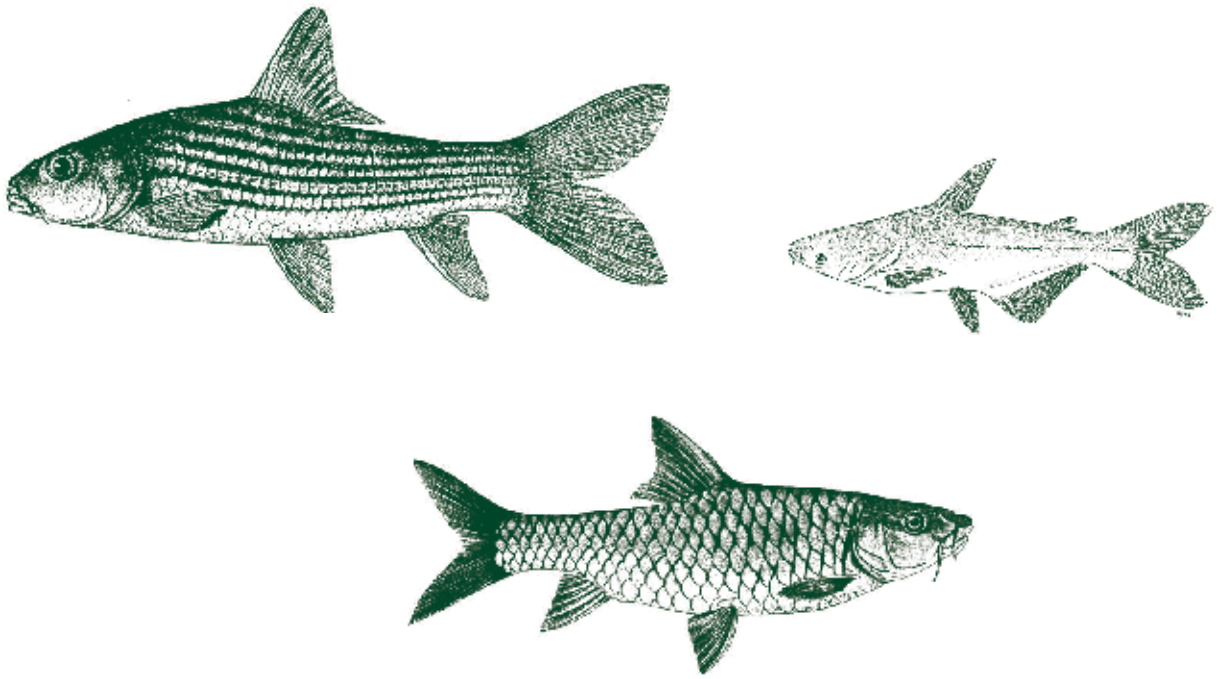
National Research Council (NRC). 1996. *Upstream: Salmon and society in the Pacific Northwest.* National Academy Press, Washington D.C

Northcote, T., and P. Larkin. 1989. *The Fraser River: A major salmonine productive system.* Pp. 174-204 in D. Dodge, (ed.) Proceedings of the International Large River Symposium. Canadian Special Publications Fisheries Aquatic Science 106.

Raymond, H. 1988. *Effects of hydroelectric development and fisheries enhancement on spring and summer Chinook salmon and steelhead in the Columbia River Basin.* North American Journal of Fisheries Management 8: 1-24.

Schalk, R. 1986. *Estimating salmon and steelhead usage in the Columbia Basin before 1850: The anthropological perspective.* Northwest Environmental Journal 2(2): 1–29.

Williams, J.G. 2008. *Mitigating the effects of high-head dams on the Columbia River, USA: experience from the trenches.* Hydrobiologia 609: 241–251.



Addressing **fisheries** in the **Climate Change** and **Adaptation Initiative**

By Ashley S. Halls *

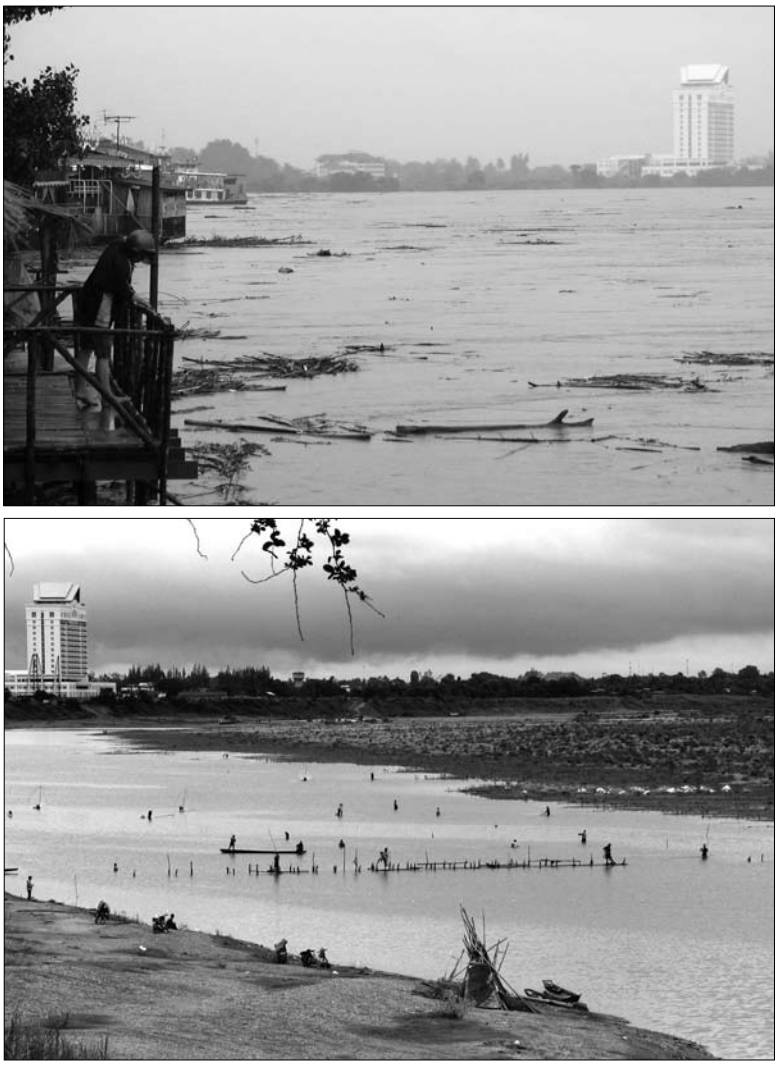
The Lower Mekong Basin is getting warmer and more rain is falling in the wet season. In the delta, the sea level has already risen by as much as 3 cm and further increases are expected, possibly by as much as 1 m by the end of this century. More uncertain are future patterns of precipitation and water availability in the dry season. Reducing this uncertainty will be an important first step of a new regional initiative which coincides with a study showing that fisheries in Viet Nam and Cambodia are among the most vulnerable to climate change.

The Mekong River Commission held a regional forum in Bangkok on February 2-3 to formulate a Climate Change and Adaptation Initiative (CCAI) for the basin. The CCAI is being led by the MRC Environment Programme with technical support from the International Water Management Institute (IWMI), Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Southeast Asia Global Change System for Analysis Research and Training (SEA START).

Attended by nearly 200 regional stakeholders and international experts, the forum provided an opportunity to gain feedback from key stakeholders on the planned approach and framework, review existing knowledge, and identify stakeholder needs from the initiative. The forum also sought to promote dialogue on climate change and adaption in the Lower Mekong basin (LMB) among regional development partners and organisations.

Fisheries and climate change

The CCAI forum coincided with the publication of a climate change study by a team of scientists from the WorldFish Center, the MRC, and the Universities of East Anglia, UK, and Simon Fraser, Canada. The study, funded by Britain's Department for International Development and published in the journal *Fish and Fisheries*, examined the vulnerability of national economies to the impacts of climate change on their fisheries. Using indices of exposure, sensitivity and adaptive capacity, the team mapped and ranked the vulnerability of 132 national economies to climate change (see Allison *et al*. 2009).



How will the wet and dry season views of the Mekong change as climate change impacts the Mekong region?

Significantly, the study ranked Viet Nam and Cambodia as two of the most vulnerable countries in tropical Asia (ranking 27 and 30 respectively), along with Bangladesh, Pakistan and the Yemen. Their vulnerabilities arise from the combined effect of predicted warming, economic and dietary importance of fisheries and comparatively limited capacity. Lao PDR was also found to be vulnerable but its ranking at 37 may underestimate its true relative vulnerability because its fisheries are likely to be grossly underestimated in the statistics employed for the study. Thailand ranked 82 in the study because despite the significance of its fisheries, it is better able to cope with climate change impacts having a higher gross domestic product, a more diversified economy, and lower rates of poverty (Allison pers comm.).

Climate change in the Mekong region?

Riparian experts at the CCIA forum presented what appeared to amount to unequivocal evidence that the climate of the LMB has already changed in recent decades. In Viet Nam, for example, annual average temperature was reported to have increased by approximately 0.71°C and sea level by 2.5 to 3 cm during the last fifty years.

Predictions from down-scaled Global Circulation Models (GCM) of future climate change in the region under different scenarios of human development and emissions are broadly consistent, indicating warming throughout the region in the range of 0.6 – 0.7°C with increasing and more variable precipitation in the wet season. Less consistent are the predictions for the dry season. Depending upon the choice of model, precipitation during the dry season may increase or decrease, but greater variability can be expected in both cases.

Uncertainty surrounding the direction of climate change during the dry season will be reflected in predictions of the likely impacts on fisheries (and other sectors) and raise obstacles to the formulation of appropriate and effective adaptive coping strategies. Efforts to reduce this uncertainty as part of the CCAI would therefore appear to be a priority.

What might be the impacts of climate change on fish resources and dependent livelihoods in the LMB and what strategies might exist to cope with these impacts? Of course, these and other sector-relevant questions will form the focus of the CCAI during the coming years. But what can we say now?

Warming in the basin could affect fisheries yields both positively or negatively depending on how dissolved oxygen concentrations and aquatic productivity (food availability) respond. Changes to the distribution of species are likely. Salinity changes in the delta may also drive changes in species distribution but the net effects on fisheries yields are unlikely to be significant. Expansion of existing aquaculture systems based upon valuable euryhaline species may form attractive adaptive strategies for farmers inhabiting the delta.

Higher flows during the wet season are predicted to bring benefits to fisheries but very high flows or rapid changes in water level may diminish reproductive success in some species.

Increased precipitation during the dry season is expected to increase fishery yields providing that elevated water levels do not diminish the system's primary productivity and habitat diversity. Drier conditions will impact on fishery yields.

Empirical studies are being undertaken by the MRC Fisheries Programme to predict the net effect of the expected changes to the basin's climate. Faced with complex interactions among competing sectors at the land-water interface, the integrated water resources management (IWRM) approach to basin planning adopted by the MRC-led Climate Change and Adaptation Initiative will help to formulate and implement effective national adaptation plans and guide local autonomous coping strategies.

The recently published study by Allison *et al*. (2009) emphasises the difficulty in attempting to predict what are likely to be profound impacts on fish populations, stemming largely from a lack of knowledge and understanding of the response of ecosystems to the anticipated physical changes in the environment.

Potential effects of climate change

These impacts are likely to arise through complex behavioural and physiological responses of fish which may be exacerbated by additional changes to the

environment arising from adaptive coping strategies pursued by other sectors, particularly those that compete for water.

Higher temperatures reduce oxygen solubility in water but can raise the oxygen and food intake demand of fish as their metabolic rates are raised. Associated rises in gill ventilation rates can lead to increased uptake of aquatic pollutants, potentially rendering the flesh unfit for human consumption. Higher water temperatures can also favour the survival of parasites and bacteria. All these responses combine to potentially reduce fish survival, growth (in food limited environments) and reproductive success both in wild populations and aquaculture systems. Studies have also shown that the reproductive success of tropical species can be directly affected by elevated temperatures. Species with relatively narrow thermal tolerances may therefore be displaced to regions where water temperatures more closely match their thermal optima, to be replaced by more temperature tolerant species (Ficke *et al*. 2007).

The combination of reductions in river flow and sea level rise is anticipated to change salinity profiles in the Mekong Delta in Viet Nam and lead to greater upstream salinity intrusion. These changes may displace stenohaline (narrow salinity tolerance) species further upstream and increase the upstream range and biomass of euryhaline (wide salinity tolerance) species inhabiting the basin, including those that depend upon brackish water environments to complete their life-cycles such as the giant river prawn *Macrobrachium rosenbergii*. The net effect on wild fish production and fishing opportunities remain uncertain but anticipated to be small (Barlow & Burnhill undated). The expansion of existing aquaculture systems based upon species such as *M. rosenbergii* may become an important adaptive strategy option for farmers inhabiting the delta.

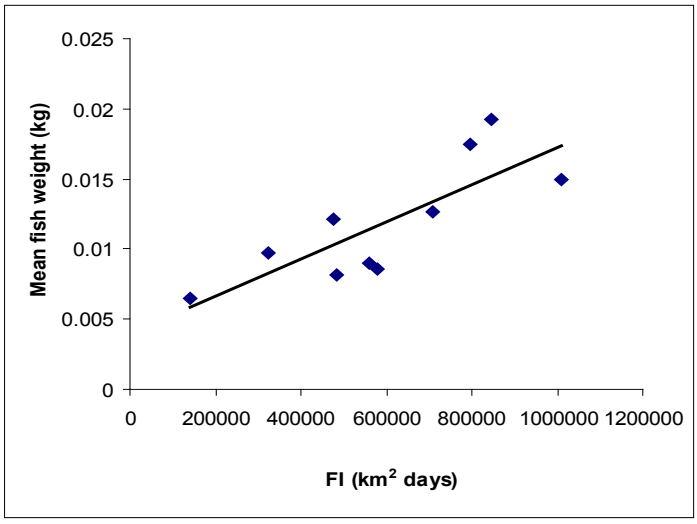
Changes to river flow in response to changing spatial and temporal patterns of precipitation in the basin are likely to have the most profound impact on the basin's fisheries resources. Increasing flows during the flood season will translate to more extensive and prolonged floodplain inundation potentially increasing overall system productivity including the fish component (Junk *et al*. 1989; Welcomme 1985). Recent research (Halls *et al*. 2008) has shown that the growth of fish in the LMB is strongly linked to flood extent and duration (see chart below). Longer more extensive floods are likely to provide greater and more prolonged feeding opportunities for fish. Improved growth can favour survival and reproductive potential (fecundity).

However, not all species may benefit. Increasing river flows may hamper upstream spawning migrations, erode spawning beds or sweep eggs and juveniles past downstream nursery and feeding habitat. Overly-rapid changes in water level can also lead to diminished reproductive success of channel margin spawning phytophil and nest-building species. Changes to the timing of flows also have the potential to disrupt spawning behaviour (Welcomme & Halls 2001).

The dry season is a period of great stress to many river fish species arising from diminished feeding opportunities and water quality, and elevated risk of predation or capture. Fish survival during this period is therefore likely to be density-dependent (Welcomme & Hagborg 1977). Increased precipitation and water availability during this period might favour fish survival and ultimately exploitable biomass, whilst drier conditions would have the converse effect (Halls & Welcomme 2004). Increasing dry season water levels also have the potential to diminish primary production and habitat diversity within the system by permanently inundating fringing forests and vegetation, leading to

Figure 1. Fish and floods

Mean body weight of fish caught by the Cambodian bagnet fishery plotted as a function of a flood index. (FI)



Source: Halls *et al.* (2008).

permanent die-back and by effectively reducing the size of the flood margin or aquatic terrestrial transition zone (ATTZ) for nutrient recycling (Junk *et al.* 1989).

Can we predict impacts on Mekong fisheries?
Considering all of these potential impact pathways and their interactions in the context of existing stressors (e.g. exploitation, habitat modification, pollution and infrastructure development for power generation, flood control and irrigation), predicting the overall net effects of climate change on exploitable fish biomass and its variability through space and time is a major challenge.

Empirical studies may prove effective in addressing this challenge. For example, the historical response of fish populations to variations in the basin's hydrology should provide some indication of how they are likely to respond to future changes in flow arising from climate change and basin development activities. The Fisheries Ecology, Valuation and Mitigation Component of the MRC Fisheries Programme is pursuing this empirical modelling approach, building on the results illustrated in Figure 1 above to include the response of fish survival, recruitment and capture vulnerability to flow (flood) variability. This model will greatly assist in predicting future trends in fish biomass and yield under different climate change and basin development flow-change scenarios.

Given the small-scale, largely unmechanised nature of the fisheries of the LMB, the scope for mitigating climate change by the fisheries sector by reducing CO_2 emissions to slow or reverse global warming appears very limited. However, formulating and implementing national adaptation programmes of action in the context of integrated water resources management (IWRM) are likely to be key functions of the CCAI. These may include options such as (re) building the resilience of overexploited or vulnerable populations to shocks and perturbations by reducing the rates at which they are exploited, and by adopting ecosystem and precautionary approaches to co-management partnerships (FAO 2008; Brander 2007).

Careful consideration will have to be given to both planned and autonomous adaptive coping strategies pursued by the agricultural sector. Less predictable flooding patterns and reductions in dry season flows may force small-scale farmers to build makeshift levees to protect their crops from flood damage and to increasingly rely upon surface water bodies to meet their irrigation needs. Planned adaptation may favour the construction of large-scale storage reservoirs, flood control embankments and irrigation schemes. As already experienced by millions of fishers in Bangladesh, these types of adaptations typically impact negatively on the fisheries sector by obstructing fish migrations and diminishing dry season habitat availability and quality (Halls et al. 1998; 1999). As alternatives, crop diversification, sustainable groundwater management systems and other soft-engineering solutions may yield win-win outcomes for both sectors (Shanker *et al.* 2005).

The IWRM approach to basin planning adopted by the MRC should prove effective in addressing these types of interactions in the context of existing stressors and thereby help to formulate and implement effective national adaptation plans and guide local autonomous coping strategies.

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References

Allison, E.H., Perry, A.L., Badjeck, M.C., Adger, W.N., Brown, K., Conway, C., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. & Dulvy, K.N. (2009). *Vulnerability of national economies to the impacts of climate change on fisheries.* Fish and Fisheries 10: 173-196

.

Barlow, C. & Burnhill, T. (undated). *The consequences of climate change on the fisheries of the Mekong River system.* Contribution to Intergovernmental Panel on Climate Change.

Brander, K.M. (2007). *Global fish production and climate change.* PNAS 104:19709-19714.

Ficke, A.D., Myrick, C.A., & Hansen, L.J. (2007). *Potential impacts of global climate change on freshwater fisheries.* Reviews in Fish Biology and Fisheries 17: 581-613.

Halls, A.S., Hoggarth, D.D. & Debnath, D. (1998) *Impact of flood control schemes on river fish migrations and species assemblages in Bangladesh*. Journal of Fish Biology 53 (Suppl. A), 358-380.

Halls, A.S., Hoggarth, D.D. & Debnath, K. (1999). *Impacts of hydraulic engineering on the dynamics and production potential of floodplain fish populations in Bangladesh.* Fisheries Management and Ecology 6: 261-285.

Halls, A.S. & Welcomme, R.L. (2004). *Dynamics of river fish populations in response to hydrological conditions: a simulation study.* River Research and Applications 20: 985-1000.

Halls, A.S. Lieng, S., Ngor, P. & Tun, P. (2008). *New research reveals ecological insights into the dai fishery.* Catch & Culture 14: 8-12.

FAO (2008). *FAO expert workshop on climate change implications for fisheries and aquaculture.* FAO Fisheries Report 870: 32pp.

Junk, W.J., Bayley, P.B., Sparks, R.E.(1989). *The flood pulse concept in river-floodplain systems*. In Proceedings of the International Large Rivers Symposium, Vol 106, Edited by Dodge, D.P. pp 110-127.

Shankar, B., Halls, A.S., & Barr, J. (2005). *The Effects of Surface Water Abstraction for Rice Irrigation on Floodplain Fish Production in Bangladesh.* International Journal of Water 3: 61-68.

Welcomme, R.L. & Hagborg, D. (1977). *Towards a model of a floodplain fish population and its fishery.* Environmental Biology of Fishes 2: 7-24.

Welcomme, R.L (1985). *River Fisheries.* FAO Fisheries Technical Paper 262: 330pp.

Welcomme, R.L., & Halls, A.S. (2001). *Some considerations of the effects of differences in flood patterns on fish populations*. Ecohydrology and Hydrobiology 1: 313-321.

Views of the Mekong in Vientiane, Lao PDR. High flow photo was taken on 9 August 2005, and the low flow photo on 4 November 2006.

Catfish aquaculture **standards** near completion

International standards for farmed shark catfish are moving closer to being finalised following a third dialogue meeting in Viet Nam

Over the past decade, the World Wildlife Fund (WWF) has initiated eight aquaculture dialogues to develop global standards for farming shrimp, salmon, molluscs, tilapia, pangasius, abalone, trout and seriola/cobia. The dialogues represent species that have the greatest impact on the environment, the highest market value or the heaviest trading in the global market. With more than 2,000 farmers, conservationists, government officials and others taking part, the dialogues are seen as the world's most inclusive and transparent process for creating measurable, performance-based standards for aquaculture. Draft standards for tilapia were posted for public comment in September last year and final standards are expected to be completed this year, almost four years and five meetings after the dialogue was launched in 2005. The Pangasius Aquaculture Dialogue for shark catfish is expected to be shorter. Launched in Ho Chi Minh City in late 2007 (see *Catch and Culture*, Vol 14, No 1), the draft standards are expected to be posted for public comment during the first half of this year following a third meeting in Can Tho in December 2008. By early 2010, WWF hopes that all eight dialogues will have completed draft standards.

The draft standards discussed at the the recent Can Tho meeting are largely based on Viet Nam's experience as the world's largest producer, although they also reflect experiences in other producer countries which include China. The meeting, attended by more than 80 people, heard that standards will apply to all producing countries and every production system regardless of scale (in the Mekong Delta, the three production systems comprise ponds, pens and cages). Given that the standards are designed to be met by the top 20% in terms of industry performance based on current practices, others will have to modify their production systems in order to comply, which is expected to encourage innovation towards better performance. The standards are expected to be completed by the end of this year. David Graham of Birds Eye/Iglo, a British frozen foods distributor, told the meeting that they would promote profitable and sustainable growth and "protect the industry from catastrophic failure" while meeting demand for sustainable products and improving consumer confidence. Although they may later be expanded to more species, he said the standards would initially apply to the two main export species, Bocourt's catfish (*Pangasius bocourti*) and the Sutchi river catfish (*Pangasianodon hypophthalmus*) which was previously misidentified as *Pangasius hypophthalmus*. To add to the taxonomic confusion, both species are frequently marketed abroad as "pangasius" or sometimes even "basa", the Vietnamese name for the first species.

Water pollution, animal health and chemicals

The draft standards are designed to uphold eight principles including minimising the negative impact of pangasius farming on water resources by focussing on water quality, sludge, discharge, nutrient efficiency and water budgets (see Table 1 on page 17). The indicators proposed to address water pollution and waste management include total ammonia, dissolved oxygen and total phosphorus, which are three of six parameters used in a recent MRC assessment of water quality for aquatic life in the Lower Mekong Basin (see MRC Technical Paper No. 19).

In the area of health management, the standards are designed to implement measures to maintain healthy fish stocks and profitable activities by focussing on management efficiency and fish survival. It was felt by some stakeholders that "fish welfare" should be included in the standards. At the time of the December meeting, however, indicators were limited to survival rates and food conversion ratios during the grow-out period when the fish weigh more than 50g. The standards proposed for this period are a survival rate of more than 70% and an annual average of less than 2 for the economic feed conversion average, which is the volume of feed used divided by net fish production (biomass at harvest minus biomass stocked).

Table 1. Water pollution and waste management indicators

Indicator	Proposed standard
Total Ammonia (TAN)	< 10 ppm
Dissolved Oxygen (DO)	4 mg/L or more
Biological Oxygen Demand (BOD_5)[1]	10 mg/L or less
Total Phosphorus (TP)	< 5 mg/L
Quality of discharge water (parameter values)	No more than 110 % of water received
Direct discharge of sludge in public water bodies	Prohibited
Nutrient efficiency	64kg of nitrogen per tonne of fish[2]
Turbidity of total discharge	?
Amount of water used per tonne of fish	?

[1]dissolved oxygen consumed in five days

[2]with nitrogen accounting for 4% of diet and a food conversion ratio of 1.6

Standards for antibiotics and chemicals are designed to uphold the principle of ensuring food safety and product quality while reducing the impact on the ecosystem and human health. With a focus on antibiotic and chemical use as well as residues in both fish and the environment, the dialogue had proposed four standards as of December (see Table 2 below). Participants agreed on the need for a fifth standard comprising a list of banned antibiotics and chemicals that takes into account international regulations and antibiotics for human use only. The meeting also agreed on the need to identify competent authorities such as fish health specialists to make veterinary prescriptions.

Ban on selective breeding seen as impractical

To address the issues of genetics and biodiversity, the proposed standards also include the principle of minimising the impact of pangasius farming on natural populations, local biodiversity and natural habitats. The proposed indicators are based on non-indigenous species and genetic diversity as well as biosecurity and escapees. To address the latter, measures proposed included appropriate bund height above high water or flood levels and traps on water outlets. However, some of the proposed standards were seen as problematic or impractical. One would prohibit pangasius farming in areas that do not already have an established population unless a “proper” risk assessment has been carried out. Another would require seed to be sourced from stocks drawn from pangasius populations already established in the “river system” used by the farms and yet another would prohibit the use of seed from genetically-modified organisms or hybrids. The most controversial proposal would require selective breeding, which has been

Table 2. Antibiotic and chemical indicators

Indicator	Proposed standard
Local regulations	Farmers must be able to prove that all antibiotics and chemicals are registered by local authorities to be used in aquaculture
Veterinary prescriptions	Antibiotics must be prescribed by either a licensed or identified animal health specialist for a diagnosed disease
Withdrawal after treatment	After any antibiotic or antiparasitic treatment, withdrawal periods must be respected according to product specificity. In the case of undocumented chemicals, the rule of 500 "degree days" must be applied (20 days at a water temperature of 25°C)
Documented control plan	Farmers must carry out a "documented analysis control plan" on fish before harvest and the environment (possible parameters include heavy metals, chlorinated pesticides, malachite green and antibiotics)

‘Enhanced fisheries’ retained in wild capture programme

Marine Stewardship Council draws a line in the sand

In January, the World Wildlife Fund (WWF) announced plans to fund the development of a new Aquaculture Stewardship Council (ASC) to ensure that farms comply with global certification standards. In a statement, WWF said it was “fully funding the business development phase for the ASC and the business strategy for this new venture, which is expected to be in operation within two years.” The new body is expected to be similar to the London-headquartered MSC, established a decade ago by WWF and Dutch household products giant Unilever. The announcement followed a decision by the MSC board of trustees in late 2006 not to expand the scope of its certification programme to include aquaculture. The MSC has, however, since clarified its position on “enhanced fisheries” involving different forms and degrees of human intervention. The clarification, announced in March, opens the way for many forms of enhanced fisheries to be assessed under its wild capture fisheries certification programme. In a statement, the council noted that its board confirmed last year that the MSC would not be expanding the programme to include farms. But it also recognised that a “wide variety” of enhanced fisheries existed between wild capture fisheries and aquaculture—and that the MSC had been increasingly asked in recent years to clarify the scope of its programme. Since late 2007, the MSC executive and governance bodies had discussed the issue at three separate meetings. At the latest meeting in January, “the MSC agreed that in many instances the MSC Standard for sustainable and well-managed fisheries is a suitable and robust tool for assessing the sustainability of an enhanced fishery,” the statement said. The council also recognised the need to develop further technical guidance.

Many new fisheries expected to be assessed

“This is an important clarification of the scope of the MSC Standard,” said MSC chief executive Rupert Howes. “While enhanced fisheries have always been represented within the MSC programme, the MSC has never defined the limits to the scope for enhanced fisheries to be assessed. The decision on enhanced fisheries draws a line in the sand that will inform potential fisheries as to whether or not they are now in scope for an MSC assessment. We believe many new fisheries will now move forward into assessment process now we have this clarification.” The MSC said it would closely follow assessments of enhanced fisheries over the next 6-24 months to ensure consistency of approach. “In some instances new guidance will be required as part of the full assessment process to ensure that the fishery impacts can be assessed,” the statement said. The council has a long history of engaging with fisheries that include some form of enhancement. These include the hatchery-based stocking components in the Alaska salmon fishery—certified in 2000 and again in 2007— and habitat modifications in a British cockle fishery that was first certified in 2001. In addition, the MSC is currently assessing clam aquaculture in Viet Nam for certification in a process that dates back to 2005 (see page 27). The estimated retail value of products bearing the MSC logo is estimated around US$1.4 billion a year. In April, MSC labelled products were available in 42 countries, up from 36 a year earlier. The top three markets were Germany, the United States and Britain.

strongly supported by Vietnamese authorities (see *Catch and Culture* Vol 13, No 2), either to be prohibited or have an undefined measure of similarity to wild stocks. This proposal was still under debate.

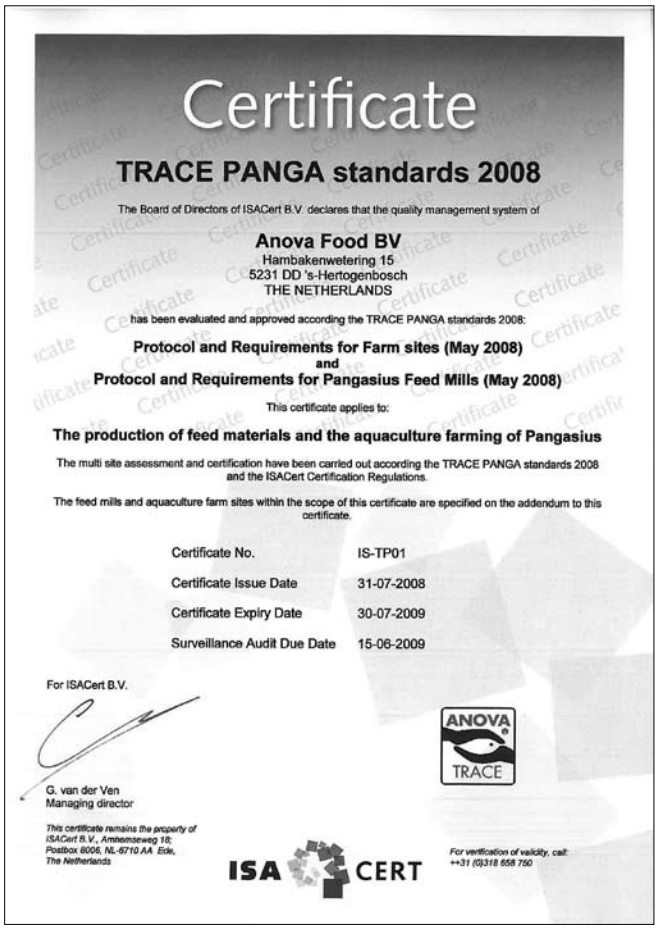
“Introducing a standard against selective breeding is impractical, hinders industry progress, and does not necessarily contribute to genetic and biodiversity integrity,” said Flavio Corsin, the senior aquaculture advisor to WWF. In a summary of the December meeting, he proposed that the issue could be addressed by additional better management practices to minimise the risk of selectively-bred pangasius escaping into the wild. Dr Corsin also noted that the indicators and standards proposed only dealt with pangasius genetics and did not cover biodiversity.

"New criteria, indicators and standards will need to be added to address this," he said. Moreover, "the idea of a risk assessment before allowing the introduction of a certain pangasius species to areas in which that species is neither native nor established is problematic. If the standards mean to prohibit farming in areas without native populations, we should simply do so. A higher degree of specificity for how the standards approach the concept of 'local' stock, 'local' farm, and 'river system' is required." He also questioned whether sterile hybrids or all-male production should be included and noted that some stakeholders felt that genetically-modified organisms should not be permitted even if they are sterile.

The other four principles governing the eight issues being addressed by the dialogue include locating and operating farms within established national and local legal frameworks. In addition, farms should be located, designed and built to minimise negative impacts on other users and the environment and farrners should use feed and feeding practices that make efficient use of valuable feed resources and minimise waste. To address social responsibility and user conflicts, farms should be developed and operated in a socially-responsible manner that contributes effectively to rural development and poverty alleviation.

Doing their own thing

In the meantime, Dutch importer Anova Food BV has sought its own certification for pangasius farming and feed production from ISACert, a Dutch auditing and certification body which specialises in standards for agriculture and food processing as well as packaging and logistics. The "Anova Trace" certification is designed to achieve total control of the food chain so that each frozen catfish fillet imported to Europe can be traced. The "Trace Panga Management Program" includes feed programs, veterinary controls, environmental awareness, bacterial controls, checks on water quality and social standards. The "Trace Panga Supply Chain Control" includes controls on pre-mix and feed suppliers with Anova staff in Ho Chi Minh City regularly auditing suppliers to meet traceability standards. The company also applies strict controls on veterinary products and requires farmers to maintain complete up-to-date records on the origin of juvenile fish as well as feed and biomass. In addition, processors are subject to checks and audits.
The certification, expected to be superseded when


Certificate

TRACE PANGA standards 2008

The Board of Directors of ISACert B.V. declares that the quality management system of

Anova Food BV
Hambakenwetering 15
5231 DD 's-Hertogenbosch
THE NETHERLANDS

has been evaluated and approved according the TRACE PANGA standards 2008:

Protocol and Requirements for Farm sites (May 2008)
and
Protocol and Requirements for Pangasius Feed Mills (May 2008)

This certificate applies to:

The production of feed materials and the aquaculture farming of Pangasius

The multi site assessment and certification have been carried out according the TRACE PANGA standards 2008 and the ISACert Certification Regulations.

The feed mills and aquaculture farm sites within the scope of this certificate are specified on the addendum to this certificate.

Certificate No.	IS-TP01
Certificate Issue Date	31-07-2008
Certificate Expiry Date	30-07-2009
Surveillance Audit Due Date	15-06-2009

For ISACert B.V.

G. van der Ven
Managing director

This certificate remains the property of ISACert B.V., Arnhemseweg 18, Postbox 6006, NL-6710 AA Ede, The Netherlands

ANOVA TRACE

ISA CERT

For verification of validity, call: ++31 (0)318 658 750

Anova Food's certificate

the global standards are in place, was announced in September last year, shortly after Anova signed a cooperation agreement with WWF to support sustainable fisheries in Indonesia, where the company buys tuna. Anova imports frozen Sutchi river catfish from Viet Nam, mainly skinless and boneless fillets but also fish that have had only their tails and fins removed. The Dutch company also imports frozen fillets of tilapia (*Oreochromis niloticus)* farmed in China and various cuts of freshly-caught Nile perch (*Lates niloticus*) from Lake Victoria in East Africa where it has an office in Kenya.

Further reading

http://www.worldwildlife.org/what/globalmarkets/aquaculture/pangasius-additionalresources.html

http://www.anovafood.com

MRC (2008) *An assessment of water quality in the Lower Mekong Basin*, MRC Technical Paper No. 19, Mekong River Commission, Vientiane, 70 pp

Identifying **significant** fish **spawning grounds** along the Mekong **mainstream**

By Suchart Ingthamjitr and Buoy Roitana*

A regional survey of fish larvae has started at 11 sites along the Mekong mainstream. The results are expected to help policymakers make informed decisions about the costs and benefits associated with hydropower development.

The recent focus on mainstream dam development has prompted the MRC Fisheries Programme to undertake a series of fast-tracked activities to improve regional understanding of the impacts of such projects on fisheries in the Lower Mekong Basin (see *Catch and Culture*, Vol 14, No 2). These activities include a survey of the geographical and seasonal distribution of fish larvae at 11 sites along the mainstream of the Mekong stretching from Luang Prabang to the Delta. The 12-month survey aims to identify significant spawning grounds that may be affected by mainstream dam development. It involves researchers from all four countries of the Lower Mekong Basin and has been designed with the assistance of Professor Ian Cowx of the Hull International Fisheries Institute. The Royal Thai Department of Fisheries is the focal point for auditing, storing and archiving the samples. In addition to larvae and juvenile collection, the survey will collect supplementary data such as water level, water velocity and water quality parameters like temperature, turbidity, pH and dissolved oxygen. Indigenous local knowledge of spawning areas will be collected by questionnaire.

Following two preparatory meetings and a five-day workshop during the second half of 2008, the survey is now underway. Larval sampling at six upstream stations in Lao PDR and Thailand started in February followed by five downstream sites in Cambodia and Viet Nam in March.

Sampling at each station will take place every second

Survey personnel at a December workshop organised at the Nongkhai Inland Fisheries Research and Development Centre in Thailand

PHOTO: SUCHART INGTHAMJITR

month over the course of the year. Although most Mekong fish species spawn during the wet season, year-long sampling is necessary since some flagship species, such as the Mekong giant catfish (*Pangasianodon hypophthalmus*) and the Isok barb (*Probarbus jullieni*), spawn in the dry season.

Bongo nets and seine nets

The survey involves sampling fish larvae with bongo nets and juvenile fishes with seine nets. Hand-held plankton nets are also being used in various habitats such as backwaters, shallow inshore areas, weed beds and rocks.

The bongo nets have a conical length of 5 m with a mesh size of 1 mm and a mouth opening of 100 cm in diameter. The large mouth is based on experience with similar sampling in the region which shows that a bigger opening increases the time the net can be set before it becomes clogged during the flood season.

Ideally, larval distribution in the water column should be taken into account and a stratified depth sampling strategy carried out. However, this is considered unrealistic during the Mekong flood season and impractical when using bongo nets from a

Sampling stations

Province or municipality	Location of station
Luang Prabang (Lao PDR)	Ban Sain Suok, northern Luang Prabang town
Nong Khai (Thailand)	Ban Hua Sai, Sri Chiang Mai district
Nakhon Phanom (Thailand)	Ban Tha Dog Kaew, Tha Utain district
Ubon Ratchathani (Thailand)	Ban Khoum, Khong Chiam district
Champasak (Lao PDR)	Ban Khon Lay, 4-5 km from Pakse
Champasak (Lao PDR)	Ban Don Sadam, 3-4 km below Khone Falls
Stung Treng (Cambodia)	Kang Memay village, 4-5 km south of Stung Treng town
Kratie (Cambodia)	Thmor Kreleu village, 4-5 km north of Kratie town
Phnom Penh (Cambodia)	Chong Chroy village, 8-10 km north of Phnom Penh
An Giang (Viet Nam)	Vinh Xuong, Mekong River
An Giang (Viet Nam)	Quoc Thai, Bassac River

pontoon or boat at a fixed location. The nets are therefore being set in the littoral zone of the river close to the shore at a depth of 2 m from the surface. This is both for safety reasons (it is too dangerous to sample mid-channel in the flood season) and because most larvae tend to drift close to the banks where the water is marginally less turbulent. Sampling by bongo net is taking place at six-hour intervals over a 24-hour period with a flow meter placed in the mouth of each net to quantify the volume of water being filtered. The sampling period is likely to last 10-15 minutes during the flood season and as long as 30 minutes or more in the dry season. If catches are low, duplicate samples are being taken.

The survey is also using seine nets in marginal areas to sample juvenile fishes more effectively and provide greater information about the growth and recruitment processes in different sections of the river in relation to habitat variability. The seine nets are 25 m long and 3 m deep with a 3-mm knot-to-knot mesh. At each site, two sweeps of the net are being made in different locations reflecting backwater or slow flow conditions. The seine nets are sampling a slightly different component of the fish community in that larger specimens are likely to be caught.

** Dr Suchart and Mr Roitana are the MRC Fisheries Programme officers responsible for coordinating the survey*

Practising bongo net sampling at the Nongkhai workshop

Photo: Suchart Ingthamjitr

Practising seine net operation at the Nonghkai workshop

Photo: Suchart Ingthamjitr

Freshwater aquatic **centre attracts tens of thousands** of visitors a month

By Peter Starr and Suchart Ingthamjitr *

Aquariums don't need brightly-coloured species and performing mammals to bring in the crowds. If properly managed, recent experience in Thailand shows that freshwater aquariums can generate significant tourism revenues and raise public awareness of fisheries at the same time.

A lake that loses most of it water in the dry season seems an unlikely place for Thailand's most extensive exhibition centre for freshwater fish and other aquatic animals, especially when it's 160 km from Bangkok. Yet that's what Bueng Chawak in Suphan Buri province has become since 1994 when then Prime Minister Banharn Silpa-archa designated the area as a Royal Development Project to prepare for celebrations marking the 50th anniversary of King Bhumibol Adulyadej ascending the throne in 1946.

The initial work involved excavating the lake to dam up to 10 million m³ of water to irrigate more than 1,000 ha of agricultural land. The next step was to develop the area around the lake in partnership with various departments of the Ministry of Agriculture and

Tourists line up to enter the two freshwater aquariums at the Bueng Chawak Exhibition Centre for Aquatic Animals during a weekday in March
Photo: Lem Chamnap

Cooperatives, notably the Department of Fisheries, which started building the Exhibition Centre for Aquatic Animals on an island in 1996. The main feature was a freshwater aquarium costing THB 33 million (about US$1.3 million at the time). Other departments of the ministry were involved in establishing a Wildlife Extension Centre and a Garden for Indigenous Vegetables along the lake's shore.

Two freshwater aquariums

Since opening to the public in 1998, the Bueng Chawak Exhibition Centre for Aquatic Animals has expanded significantly. While the initial aquarium contained about 50 species, it was considered too small. So in 2001, the Department of Fisheries decided to construct a second freshwater aquarium at a cost of THB 51 million ($1.6 million at today's exchange rate). The larger aquarium opened in 2003 and contains more than 60 species, mostly local but also some alien species. The expansion, however, raised operating costs, especially the monthly electricity bill but also labour costs, with the number of staff almost doubling from when the centre had only one aquarium. One option might have been to raise the modest entry fees of THB 30 ($0.90) for adults and THB 10 ($0.30) for children to levels more in line with other aquariums in Thailand. But since it was unable to collect fees to cover its expenses, the Department of Fisheries in Bangkok decided instead to transfer the aquaticcentre to the Suphan Buri Provincial Authority, although other parts of Bueng Chawak remain under the control of the Ministry of Agriculture.

Mr Prasit
Photo: Lem Chamnap

The center's low entry fees may be one of the reasons for its success. When *Catch and Culture* traveled to Bueng Chawak on a Tuesday in late March 2009, hundreds of tourists including older people and student groups were braving the intense heat to visit the two freshwater aquariums. According to Prasit Watprasit, a former Department of Fisheries biologist who now oversees the facility for the provincial authority, an average weekday sees about 1,000 visitors. The numbers swell to up to 3,000 a day on weekends and up to 5,000 on public holidays. As Prasit noted, the adult entry fee of THB30 is a bargain compared with

The Bottom Line

Costs of building and running the Bueng Chawak Exhibition Centre for Aquatic Anmials

Costs	THB	USD [1]
Construction costs		
1st aquarium (opened 1998)	33,000,000	1,320,000
2nd aquarium (opened 2004)	51,000,000	1,545,000
Total:	**84,000,000**	**2,865,000**
Monthly operating costs (2 aquariums, 3 quarantine facilities, 1 crocodile farm and landscaping)		
Electricity	300,000	9,090
Staff (28)[2]	140,000	4,242
Feed and maintenance	100,000	3,030
Total:	**540,000**	**16,362**

[1] Current rates except for 1st aquarium which is based on rate in 1996 when construction began

[2] Monthly salaries range from BHT 4,000 to 6,000 (US$120 to 180)

Thailand's oldest aquarium plans exhibitions for schools

Children visiting the Bangkok Aquarium
PHOTO: DEPARTMENT OF FISHERIES

The Bueng Chawak center opened 58 years after Thailand's first aquarium was established at Kasetsart University in Bangkok in 1940. Rebuilt with support from the Canadian government in 1973, the Bangkok Aquarium reopened in 1978 with the aim of contributing to public awareness of freshwater fisheries and promoting fisheries conservation among Thai people. According to Dr. Apichart Termvidchakorn, a fisheries expert at the Inland Fisheries Research and Development Bureau, it is also used to study freshwater species in captivity. The aquarium employs 15 full-time staff (including 4-5 on weekends) and contains more than 60 species including turtles and alien species, which are displayed in a separate section. Specimens are kept in a neighbouring building and are not normally on public display. Monthly operating costs for feed, chemicals and new fish are about THB 25,000 ($760). Additional costs for electricity, water and staff costs are covered by the Department of Fisheries. Dr Apichart says the aquarium receives 300-400 visitors a week, mainly primary schoolchildren. In 2010, he said, the Bangkok Aquarium plans to start special exhibitions for local schools on special themes such as mangroves and watersheds. The aquarium is open from 10 a.m.to 4 p.m. every day except Monday and charges THB 20 ($0.60) for adults and THB 10 ($0.30) for children.

marine aquariums in Bangkok (THB 450 or $13.60) and Pattaya (THB 250 or $7.60). And although the aquarium in Chiangmai has recently cut adult entries to THB 190, it remains more than six times more expensive to visit than the freshwater aquariums at the Bueng Chawak centre (which also features a crocodile park).

Tunnel vision, giant species

But cheap prices alone don't necessarily guarantee a successful aquarium. In one province in the Lower Mekong Basin, for example, the provincial authority offers free entry to its aquarium but rarely gets visitors as the tanks are poorly maintained. Moreover, making something free tends to generate a public perception that it's worthless. According to Mr Prasit, one of the most important factors behind an aquarium's success is to build a viewing tunnel, which is precisely what Bueng Chawak did with the largest tank in the second aquarium. "We received this idea from visitors," he said. Mr Prasit also emphasised the importance of stocking tanks with giant species. "These are seen as special and the public likes them." The largest tank in the second aquarium, which contains 400 tonnes of water compared with 28 tonnes in the biggest tank in the first aquarium, features several large species

Children visiting the aquariums at the Bueng Chawak centre In March
Photo: Lem Chamnap

including two Mekong giant catfish *(Pangasianodon gigas)* each weighing more than 110 kg.

In designing display tanks, Mr Prasit recommended using glass in smaller tanks holding 1, 2 or 3 tonnes of water and acrylic for larger tanks, especially those holding more than 10 tonnes. Another important factor is to keep the water as clean as possible. In the case of the Bueng Chawak centre, Prasit designed his own filtering system for individual tanks mounted into walls to replace a common filtering system used by all the tanks.

Political will

But perhaps the most important factor to ensure an aquarium's success is to have the political will to ensure that funds are available for maintenance to be carried out. In this case, the center still enjoys strong support from former Prime Minister Banharn, who usually visits Bueng Chawak every Sunday. He is usually accompanied by with Somwang Phimonbut, the former director of the Suphanburi Inland Fisheries Research and Development Centre who played a key role in establishing the Bueng Chawak centre and now heads the national Inland Fisheries Research and Development Bureau in Bangkok. He is also credited with pioneering Thailand's breeding of the soldier croaker *(Boesemania microlepis),* an indigenous Mekong species which is also native to Suphan Buri (so much so that a local area is named after the fish, known as *pla ma* or "horse fish" in Thai).

Bueng Chawak has meanwhile been promoting itself to domestic tourists through its own magazine published every second month. Available for THB 35 ($1.06), the glossy publication is now in its fifth year with Mr Banharn chairing the editorial panel. And while Suphan Buri may not be among the hot destinations for foreign tourists visiting Thailand, Mr Prasit says growing numbers of foreign tour groups have been coming to the centre over the past couple of years, mainly from China, Korea and Russia. Yet Bueng Chawak is not hedging its bets. In February this year, a third aquarium opened. Unlike the first two aquariums, the new one is devoted to marine species. While it commands higher entry prices of THB 120 ($3.60) for adults and THB 30 ($0.90) for children, the new marine aquarium still remains considerably cheaper than those in both Bangkok and Pattaya.

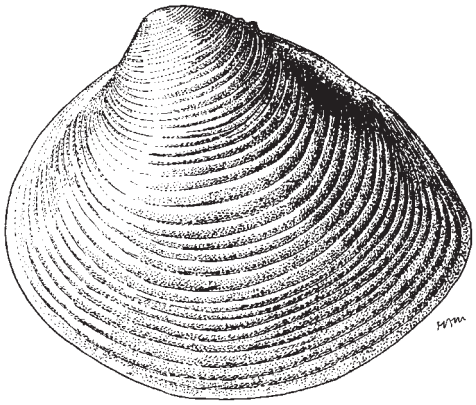
** Mr Starr is the editor of Catch and Culture and Dr Suchart is the coordinator of the Aquaculture of Indigenous Mekong Fish Species (AIMS) component of the MRC Fisheries Programme.*

Clams and **cockles** in the Mekong Delta

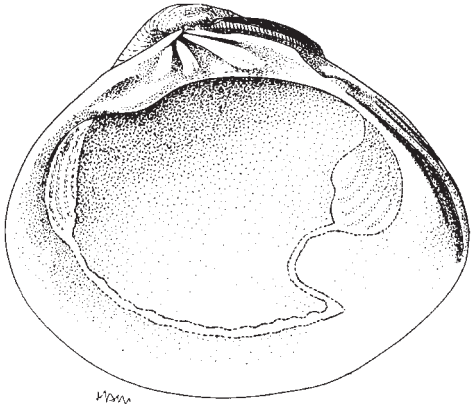
By Peter Starr *

Bivalve culture is a major source of income for many households in Ban Tre Province, Viet Nam

According to the Vietnamese Ministry of Agriculture and Rural Development, scientists have identified 800 species of mollusc in Viet Nam. Those of economic value are limited to 15 species of gastropods (snails and slugs) and 26 species of bivalves such as clams, cockles, mussels, scallops and oysters. Most live in marine waters, especially in central Viet Nam. But some bivalves are also found in estuarine tidal flats such as those of the Mekong Delta where they can tolerate water salinity as low as 7 grams of salt per litre (about one fifth the salinity of seawater).



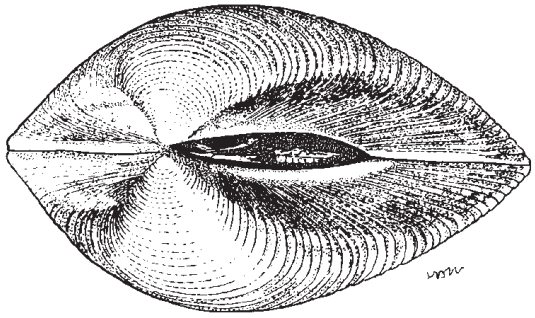
Exterior of left valve of Ben Tre clam
Source: FAO



Interior of right valve of Ben Tre clam
Source: FAO

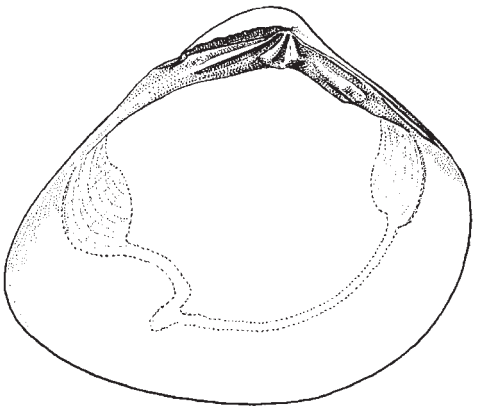
Such brackish waters are ideal habitats for two species from the venus clam family—the Ben Tre clam *(Meretrix lyrata*) and the Asiatic hard clam (*Meretrix meretrix*). The Ben Tre clam, also known as the lyrate

Meretrix lyrata (Sowerby, 1851)
Family: Veneridae (venus clams)
English: Ben Tre clam, Lyrate hard clam, hard clam
Vietnamese: Ngheu Ben Tre
World Distribution: Western Pacific from the Philippines to Thailand; north to Taiwan and south to Indonesia
Mekong Distribution: Ben Tre, Soc Trang, Tien Giang, Tra Vinh
Feeding: Filter feeder, mainly organic detritus and phytoplankton
Size: Up to 40-50 mm long, 40-45 mm high and 30-35 mm wide
Habitats
Meretrix lyrata lives in mud flats with sandy or muddy bottoms. The clams are either concentrated in big estuarine areas or scattered in small coastal sand dunes mixed with mud flats. The species can tolerate water salinity of 7-25 grams of salt per liter.
Life Cycle
Reproduction occurs between March and June, and is sometimes extended to October. Fast growth takes place in May and June, with slow growth occurring between October and May.
Culture
The culture of this species has developed in coastal alluvial grounds of Ben Tre, Soc Trang, Tien Giang and Tra Vinh provinces with yields of up to 50 tonnes/ha. Although the Research Institute for Aquaculture No. 2 has succeeded in artificial production of the clam seed, most of the seed is obtained from the wild. The harvest usually takes place in February and May. The clams are either gathered by hand or harvested with a hand rake attached to a net. Processed clams are an important export item for coastal provinces of the delta.
Sources: Fisheries Informatics Centre, FAO

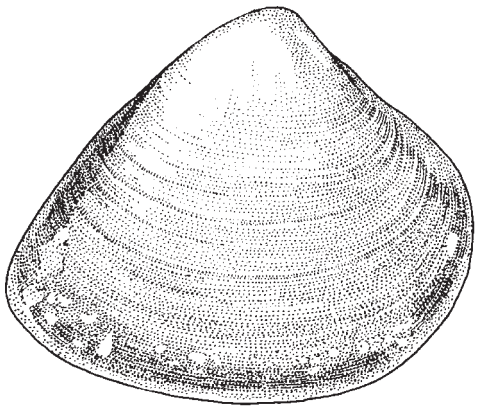


Dorsal view of both valves
Source: FAO

Meretrix meretrix (Linnaeus, 1758)
Family: Veneridae (venus clams)
English: Asiatic hard clam
Vietnamese: Ngao dau
World Distribution: Indo-West Pacific from East Africa to the Philippines; north to Japan and south to Indonesia
Mekong Distribution: Ben Tre, Tien Giang
Feeding: Filter feeder, mainly phytoplankton
Size: Up to 130 mm long, 110 mm high and 58 mm wide
Habitats
Meretrix meretrix lives at water depths of 1-2 m of water in tidal zones with sandy muddy bottoms. The clams bury themselves at depths of 3-4 cm and use a water-siphoning tube to get food from outside. The species tolerates temperatures of 20-30° and water salinity of 9-20 grams of salt per litre.
Life Cycle
The species reproduces once or twice a year between April and October. The clams are fast growing with juveniles of 5mm capable of reaching 5-70mm in 10 months.
Culture
The culture of this species mainly involves collecting seeds from the wild and releasing them into net enclosures placed on tidal flats at depths of 1-3m. The practice has proven effective and stable, yielding up to 25 tonnes/ha. The three-month harvest periods are usually from April to June and from October to December. Harvesting usually involves dredging. The species is processed for export.
Sources: Fisheries Informatics Centre, FAO



Interior of left valve of Asiatic hard clam
Source: FAO



Exterior of right valve of Asiatic hard clam
Source: FAO

hard clam, is distributed across the tropical waters of the Western Pacific as far north as Taiwan while the second species extends to East Africa and Japan. Another bivalve found in the Delta is the blood cockle (*Anadara granosa*), a species from the arc clam family with an even wider range extending from East Africa to Polynesia and as far south as Australia.

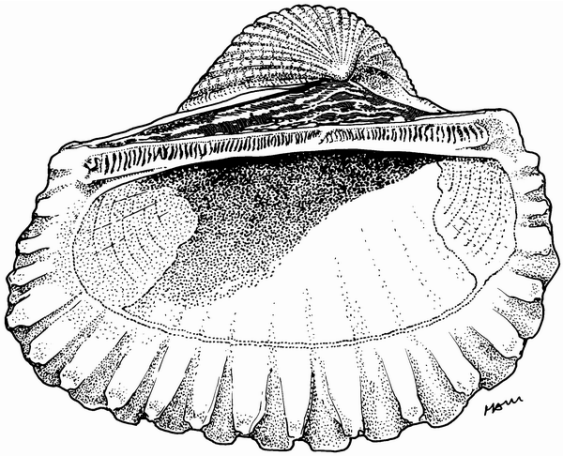
Viet Nam's overall mollusc production is estimated at 300,000-350,000 tonnes a year. Clam production is estimated at 50,000-60,000 tonnes while the production of blood cockles is estimated at 40,000-50,000 tonnes. In the Mekong Delta, production of these species is concentrated in five coastal provinces—mainly Ben Tre and Tien Giang but also Tra Vinh, Soc Trang and Kien Giang.

Although scientists from government research institutes in Ho Chi Minh City and Nha Trang have produced artificial seed with varying degrees of success, the semi-natural system of culturing clams and cockles in the Delta still relies mainly on wild seed.

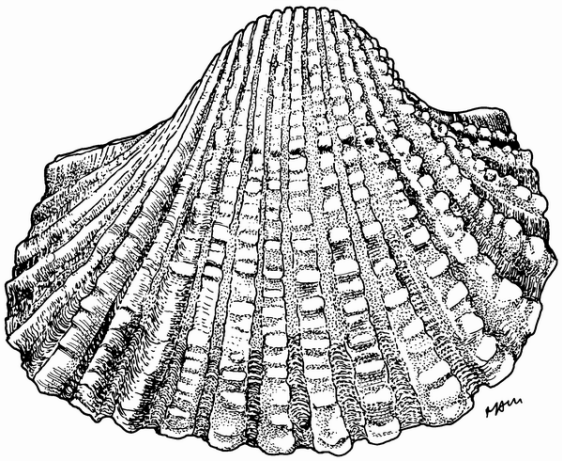
Ben Tre: coconuts, cocoa, clams and cockles

Ben Tre province, located about two hours south of Ho Chi Minh City, is perhaps best known as the coconut capital of Viet Nam, although it has recently attracted considerable attention for major investments in cocoa plantations. Clams and blood cockles are another important, and arguably more stable, source of income for the province. With yields exceeding 16,000 tonnes, bivalves accounted for almost 17 percent of the province's aquaculture production and 10 percent of its overall fisheries output including marine fisheries in 2007 (see table on page 32). Although yields were similar in 2008, the bivalve share of fisheries production declined last year as catfish production more than doubled. The 4,000 or so hectares set aside for bivalve culture has, however, remained stable at

Anadara granosa (Linnaeus, 1758)
Family: Arcidae (arc clams)
English: Blood cockle
Vietnamese: So huyet
World Distribution: Indo-West Pacific from East Africa to Polynesia; north to Japan and south to Australia
Mekong Distribution: Ben Tre, Kien Giang
Feeding: Filter feeder, including zooplankton and organic detritus
Size: Up to 60 mm long, 50 mm high
Habitats
Anadara granosa lives at water depths of 1-2 m of water in intertidal zones, especially estuarine areas affected by fresh water. The clams usually bury themselves in muddy bottoms and tolerate water salinity of 15-20 grams of salt per liter.
Life Cycle
Although the species can spawn all year round, the main spawning period is from April to August. After undergoing metamorphosis, the larvae moves to the bottom when its eye point appears.
Culture
Blood cockles are cultured on tidal flats with yields of about 60 tonnes/ha. Seeds are usually collected from the wild, although Resarch Institute No. 3 has had initial results in producing artificial seed. The species is harvested throughout the year with the main season running from June to September. Blood cockles are harvested manually or by dredging.
Sources: Fisheries Informatics Centre, FAO



Interior of blood cockle
Source: FAO



Exterior of blood cockle
Sorce: FAO

about 10 percent of the area allocated for aquaculture in the province, which is mostly devoted to marine shrimp farming and largely concentrated in two coastal districts (see table on page 33).

One of those districts is Binh Dai, where the main channel of the Mekong flows into the South China Sea. About 20 kilometres from the mouth of the river is the coastal hamlet of Thai Loi 1, home to the Rang Dong Fisheries Cooperative established in 1997. The co-op, whose name means “sunrise” in Vietnamese, is the biggest in Ben Tre with 64 staff and more than 1,000 households from Thai Lai 1 and five neighbouring hamlets in Thoi Thuan commune.

With a dozen security posts along its perimeter, the Rang Dong Co-Op oversees 900 hectares of coastal mud flats—more than 20% of the area allocated to bivalve culture in Ben Tre and only 60% of the potential area that could be locally exploited. In this case, the species being cultured is the Ben Tre clam, an important export item that fetches about VND 18,000/kg ($1.03) locally and as much as VND 25,000/kg ($1.43) in Ho Chi Minh City. According to locals, that compares with VND 1,500 to VND 2,000/kg a decade ago (which may help to explain why many Vietnamese city-dwellers complain they can no longer afford to eat this species).

The culture of Ben Tre clams is said to date back to 1965. Today, the area set aside for culturing the clams in Thoi Thuan commune extends as much as 5km offshore at low tide. Access is usually restricted to co-op members with identity cards and the mud flats are policed by uniformed staff. Seed is collected from the mud flats between April and October and the harvest usually takes place in February and May. Both men and women take part in the harvest which involves gathering the clams either by hand or a hand

rake attached to a net, known as *cao ngheu tit* in Vietnamese (a different type of rake called *cao ngheu giong* is used to collect juveniles). In late February, clam gatherers were being paid VND 40,000/20kg although each was limited to 60kg during each "shift" lasting about six hours. At that rate, a typical low-tide harvest of 15 tonnes for a single boat would require at least 250 people a shift. According to the co-op, the value of the clam harvest in 2008 was VND 48 billion.

Seeking certification

Binh Dai is not the only district in Ben Tre where this species is cultured. It is also raised in Bat Tri and Thanh Phu, two coastal districts further south, and the clam fishery in all three districts is now in the final phase of an assessment by the Marine Stewardship Council (MSC), a British-based global certification and eco-labelling programme for sustainable seafood production. In January, the MSC announced that the certification body Moody Marine Ltd had proposed two peer reviewers for its draft assessment of the Ben Tre clam fishery which evaluates its compliance with MSC standards for sustainable and well-managed fisheries.

At the same time, the Ben Tre clam fishery is undergoing a parallel assessment using a pilot method developed by the MSC to assess small-scale data-deficient fisheries. In assessing the management of the fishery, the MSC has already noted the complementary roles of the the central government, which limits the area where clams can be harvested, and the provincial government, which controls minimum landing size and equipment used.

The MSC was established to address the problem of overfishing and now covers more than 2,000 products worldwide. With offices on six continents, it is the only labelling program consistent with the code of the International Social and Environmental Accreditation Alliance (ISEAL) and FAO guidelines for fisheries cerification. The latter require certification and labelling schemes to include objective third-party assessments, transparent processes and standards based on the sustainability of target

Clam gatherers supplied this vessel with about 15 tonnes of Ben Tre clams during a single morning in February
Photo: Lem Chamnap

Members of the Rang Dong Fisheries Cooperative returning home after a morning gathering clams in Binh Dai district in Ben Tre province
Photo: Lem Chamnap

species, ecosystems and management practices. As of February, the programme had certified 41 certified fisheries of which only two were in Asia, both in Japan. Another 99 fisheries were being assessed including the Ben Tre clam fishery. The Vietnamese move to get the fishery certified dates back to 2005 when the then Vice Minister of Fisheries signed an agreement with the MSC to explore and encourage sustainable fishing practices. The agreement led to pilot projects to assess the Ben Tre clam fishery as well as an anchovy fishery on Phu Quoc, an island off the coast of Kien Giang province.

Among those who potentially stand to benefit from environmental certification are clam export processors such as Ben Tre Aquaproduct Import and Export Joint Stock Company (Aquatex Bentre) and Bentre Seafood Joint Stock Company (Beseaco). Listed on the Ho Chi Minh Stock Exchange at the end of 2006, Aquatex Bentre processes catfish and shrimp as well as clams with sales exceeding VND 400 billion ($23 million) in 2007.

With most of its processing business concentrated on clams, Beseaco has been less exposed to the recent turmoil in the catfish market (see *Catch and Culture,* Vol 14, No 2). According to the company's Vice Director Bui Van Kinh, Ben Tre clams account for about 80 percent of the company's business with Asiatic hard clams making up the remaining 20 percent. That's poised to change, however, following the opening of a catfish processing plant in October. Beseaco mostly exports cooked frozen clams to European markets, notably Italy and Spain, and currently processes about 20 tonnes a day at its plant in Ben Tre town which employs 350 workers in two shifts. According to Mr Kinh, the company's sales came to about $5 million or VND 90 billion in 2008.

Clam gatherer returns her ID card after a morning's work at low tide
Photo: Lem Chamnap

Beseaco workers sorting clams at the Ben Tre processing plant
Photo: Lem Chamnap

Bivalve production forecast to expand this year

While figures for the value of clam production in Ben Tre are not available, the provincial statistics office publishes annual data which show a significant increase in the value of overall fisheries production since 2000. According to preliminary figures, the total value of fisheries output in Ban Tre was VND 4,225 billion in 2007, equivalent to about $240 million at today's exchange rate and more than twice the value in 2000 (see table next page). During this period, the value of capture fisheries was more or less stable at around VND 1,000 billion a year. But the value of aquaculture production grew almost sixfold to more than VND 3,000 billion in 2007. As a result, the structure of fisheries production has changed dramatically since 2000 when capture fisheries accounted for two thirds of the overall value of fisheries output. Seven years later, the situation was reversed with capture fisheries representing 26% of the value while aquaculture accounted for 72% (the other 2% came from fisheries services).

Fisheries remains one of the three main contributors to the Ben Tre economy along with manufacturing and the cultivation of various crops including rice and fruit as well as coconuts and cocoa. According to preliminary figures for 2007, fisheries accounted for 18% of gross provincial product, making it the second most valuable economic activity after manufacturing (see chart on opposite page). In terms of jobs, however, fisheries ranked second only to agriculture, employing almost 61,000 people— almost 10% of the local workforce—compared to only 44,000 in manufacturing. At the same time, fisheries employed about the same number of people as the the wholesale and retail sectors and more than the hospitality, construction and education sectors combined.

In terms of volume, the Department of Fisheries in Ben Tre expects overall fisheries production to fall 12% this year after surging 38% from a year earlier to more than 239,000 tonnes in 2008. The expected decline reflects a lower forecast for the production of catfish, expected to fall about 30% from last year's levels. Marine shrimp production is also forecast to decline while production from capture fisheries and farmed freshwater prawns is expected to be almost unchanged.

On the other hand, bivalve culture is forecast to expand this year. After contracting slightly in 2008, the production of clams and cockles is expected to grow 8% to 18,000 tonnes in 2009. Based on recent prices for Ben Tre clams, that would be worth about VND

Packaged clams ready for freezing at the Beseaco plant
Photo: Lem Chamnap

Ben Tre Fisheries Production

Tonnes

Species	2007	2008	2009[1]
Marine shrimp	23,717	21,265	20,000
Freshwater prawn	1,449	1,696	1,700
Fish	56,950	118,508	88,500
of which Sutchi river catfish[2]	*(40,963)*	*(100,025)*	*(70,000)*
Bivalves	16,694	16,620	18,000
Other aquatic species	40	906	1,000
Total culture	98,850	158,995	129,200
Fish	55,788	63,588	63,500
Shrimp	4,262	1,478	1,500
Squid and other species	15,016	15,075	15,000
Total catch	75,066	80,141	80,000
Total production	**173,916**	**239,136**	**209,200**

[1] Projected
[2] *Pangasianodon hypophthalmus*
Source: Department of Fisheries, Ben Tre province

Aquaculture Area in Ben Tre

Hectares

Species	2007	2008	2009[1]
Marine shrimp	31,707	31,462	31,400
of which high or semi-high density	*(5,842)*	*(5,597)*	*(5,500)*
Freshwater prawn	2,245	2,261	2,300
Fish	3,607	3,986	3,900
of which species with no scales	*(468)*	*(650)*	*(550)*
Bivalves	4,114	4,210	4,200
Other species	178	187	200
Total area	41,851	42,106	42,000

[1] Projected
Source: Department of Fisheries, Ben Tre province

Value of Fisheries to Ben Tre

Current prices in billions of dong (figures rounded)

Activity	2000	2001	2002	2003	2004	2005	2006	2007
Culture	555	824	1,043	1,230	1,890	2,135	2,618	3,048
Catch	1,064	917	886	855	925	994	1,060	1,138
Services	Neg	Neg	Neg	12	13	33	68	39
Total	**1,620**	**1,742**	**1,930**	**2,096**	**2,828**	**3,163**	**3,747**	**4,225**

Source: Ben Tre Statistical Yearbook, 2007

Fisheries Contribution to Economy ...

Gross provincial output, 2007 (preliminary)

Economic activity	%
Manufacturing	20.7
Fisheries	18.0
Cultivation	16.8
Construction	8.4
Livestock	7.9
Wholesale and retail trade	5.9
Financial intermediation	4.2
Other	18.1
Total	100.0

Source: Ben Tre Statistical Yearbook, 2007

... and Employment

Employment by type of activity, 2007 (preliminary)

Economic activity	Persons employed
Agriculture	432,210
Fisheries	60,914
Wholesale and retail trade	60,872
Manufacturing	44,187
Hotels and restaurants	17,637
Construction	17,441
Education and training	15,540
Other	46,049
Total	**694,852**

Source: Ben Tre Statistical Yearbook, 2007

320 billion or almost $20 million a year to the local economy including almost $2 million for the people who harvest the clams. For the harvesters alone, that equates to average annual income of about $400 for each household in the Rang Dong Co-Op without taking into account additional income from collecting seed and value-added services such as storage, transport and wholesale trading.

In a country with a GDP of about $1,000 a head, the economic benefits of the Ben Tre clam fishery are easy to appreciate, especially when prices are 10 times higher than a decade ago. Whether clams are as well placed as catfish to weather the global economic downturn remains to be seen.

** Mr Starr is the editor of Catch and Culture*

Fisheries still among **top employers** and **drivers** of Cambodian **economy**

Number of people classified as fishers grows 32% in five years

According to government figures released by the International Monetary Fund (IMF) in February, the fisheries sector in Cambodia remained the fourth-largest employer and also the fourth-biggest contributor to gross domestic product (GDP) in 2007. the only sectors to employ more people or generate greater economic output were agriculture (crops, livestock and poultry), trade and manufacturing. Fisheries employed 385,000 people in 2007, up 2% from a year earlier and accounting for almost 5% of the Cambodian workforce (see Table 1 below). That compares with about 4% of the workforce in 2002 when fisheries employed only 291,000 people, marking an increase of 32% over five years (by comparison, the number of farmers growing crops and raising livestock or poultry rose by less than 4% over the same period).

Since they reflect the number of people who see themselves as primarily engaged in fisheries, the employment figures possibly indicate increased pressure on Cambodia's fish resources.

Fisheries meanwhile contributed more than KHR 2.4 trillion ($600 million) to GDP in 2007, almost 7% of the country's total output of goods and services. That amounted to more than half the value of tourism receipts collected during the year and was also more than half the output from textiles, apparel and footwear which together account for most manufacturing. The report also noted that fish exports climbed almost 17% from a year earlier to $105 million in 2007 (see Table 2 on page 35), equivalent to five times the export value of logs and sawn timber. The overall volume of fish and shrimp production grew 7% to 562,000 tonnes in the same period, amounting to five times the volume of soybeans produced. Crocodile production was, however, down 20% at 110,000 heads. That compares to about 800,000 heads of buffalo in 2007.

Table 1. Top Ten Employers by Sector, 2007

Sectoral employment and output at current prices

	Number employed	% of workforce	Output US$ millions	% of GDP
Agriculture[1]	4,224,000	50.6	1,699	19.9
Trade	1,196,000	14.3	762	8.9
Manufacturing	944,000	11.3	1,481	17.3
Fisheries	**385,000**	**4.6**	**601**	**6.9**
Construction	299,000	3.6	570	6.7
Transport and Communications	228,000	2.7	591	6.9
Public Administration[2]	185,000	2.2	168	1.9
Education	128,000	1.5	NA[3]	NA[3]
Social Services[4]	123,000	1.5	NA[3]	NA[3]
Hotels and Restaurants	86,000	1.0	370	4.3

[1]crops, livestock and poultry [2]including defence [3]disaggregated data not available [4]excluding heath and social work

Source: IMF

Table 2. Fisheries Production, Exports and Employment, 2002-07
Volumes, Values and Employment

	2002	2003	2004	2005	2006	2007
Fresh fish and shrimp (thousands of tonnes)	425	394	330	428	524	562
Crocodiles (thousands of heads)	51	78	75	120	138	110
Fisheries output (billions of riel at current prices)	1,704	1,721	1,754	1,892	2,160	2,435
Fish exports (millions of dollars)	73	76	69	76	90	105
Numbers employed (thousands)	291	323	360	400	376	385
Share of Workforce (%)	4.2	4.4	4.6	4.8	5.1	4.6

Source: IMF

Thai fisheries production seen slowing in 2009

Industry faces foreign competition at home and protectionism from abroad

Thailand's National Economic and Social Development Board (NESDB) says it expects fisheries production to slow in 2009 as free-trade agreements with China and ASEAN result in a "massive flow" of cheap fish products into the domestic market. However, shrimp production is expected to remain stable due to market uncertainties and increased prices.

In a statement released in February, the board said the main risk factors for fish exports this year were the global economic downturn and protectionist policies among trading partners, especially anti-dumping measures, apparently a reference to America's anti-dumping duties on shrimp (see Catch and Culture, Vol 11, No 11). Thai fisheries production came to to THB 104 billion ($3 billion) in 2008, up fractionally from 2007 and amounting to 1.1% of gross domestic product (GDP)

Has it peaked?
Thai Fisheries Output, 1993-2008

Year	Blns of baht
1993	67
1994	76
1995	84
1996	88
1997	95
1998	108
1999	104
2000	118
2001	111
2002	108
2003	109
2004	107
2005	104
2006	105
2007	106
2008	104

Source: NESDB

Table 3. Agricultural Production, 2002-07

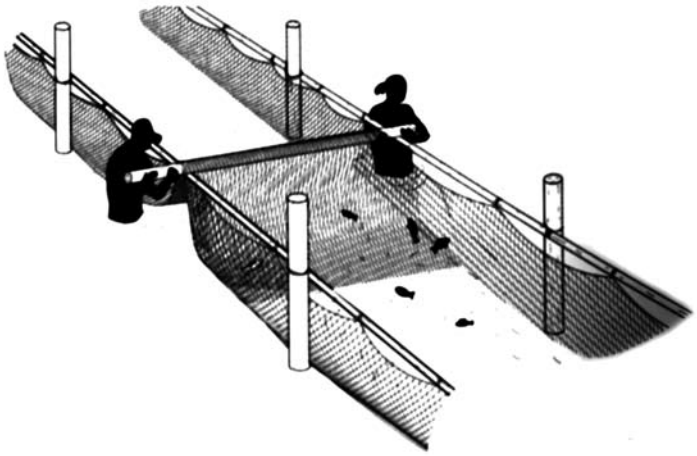
Contributions to GDP at current prices (%)

	2002	2003	2004	2005	2006	2007
Paddy rice	6.7	7.5	6.5	8.7	7.7	8.6
Fisheries	**10.2**	**9.3**	**8.2**	**7.3**	**7.2**	**6.9**
Non-Rice Crops	6.1	7.0	7.1	7.0	7.4	6.9
Livestock and Poultry	5.2	4.8	4.4	4.7	4.6	4.4
Forestry and Logging	3.0	3.4	3.2	3.0	3.1	2.9

Source: IMF

Importance of fisheries expected to increase

During the first half of of the decade, fisheries production exceeded rice output in terms of value (see Table 3 above and *Catch and Culture*, Vol 9, No 1). But following a poor rice harvest in 2004 and a sharp rebound in yields the following year, fisheries production has lagged rice production since 2005. At the same time, the contribution of fisheries to the economy has been dwarfed by double-digit GDP growth, especially in the garment, tourism and construction sectors. The relative importance



River barrages with bagnets *(yor)* are common on the Tonle Sap
Illustration: Arijan Jansonius

of fisheries to Cambodia is, however, expected to increase as the overall economy deteriorates in 2009.

In a separate statement in March, the IMF said Cambodia's economy was expected to shrink 0.5% this year as it becomes increasingly affected by the global economic contraction and financial crisis. The revised GDP projection reversed an earlier forecast for 4.8 % growth this year, down from an estimated 6.5% in 2008. The statement noted that garment exports were under pressure while growth in tourist arrivals had turned negative. At the same time, construction activity and foreign investment were slowing rapidly. And while agriculture performed better than anticipated in 2008, "the fall in global agricultural prices may limit further gains this year." The IMF and Cambodian authorities agreed that the projected decline in economic activity warranted a larger stimulus beyond that envisaged in the government's budget for 2009. Such a stimulus could raise the budget deficit to 4.75% of GDP without jeopardising recent fiscal gains or increasing external vulnerability (authorities had proposed a budget deficit of 4.25% of GDP in the preliminary budget for 2009, up from an estimated 1.75% in 2008). The IMF recommended that most of the additional stimulus should come from higher spending focussed on pro-poor social outlays and safety nets as well as "high-quality infrastructure projects that would strengthen competitiveness."

Further reading

http://www.imf.org/external/pubs/ft/scr/2009/cr0948.pdf
http://www.imf.org/external/pubs/ft/scr/2009/cr0947.pdf
http://www.imf.org/external/np/sec/pr/2009/pr0967.htm

Regional fisheries **cooperation** in the Lower Mekong Basin: **how did it start?**

By Jorgen G. Jensen *

As part of an occasional new series, the founding manager of the Mekong Fisheries Programme recalls the early days of regional fisheries cooperation and how the programme evolved after the Mekong River Commission was established in 1995.

In 1992, the secretariat of the Interim Mekong Committee in Bangkok contacted the Danish Embassy and asked for Danida support for fisheries development in the Mekong Basin. The reaction was positive and planning for the first three projects started immediately. In July 1993, I was assigned as senior programme officer for fisheries at the Mekong Secretariat in Bangkok where I was in charge of the first project, Institutional Support to Mekong Fisheries, and preparing for the next two projects, Management of Cambodian Capture Fisheries and Management of Mekong Reservoir Fisheries. In May 1994, we held our first "annual meeting" at the Hotel Princess in Bangkok where representatives of the four riparian countries agreed to the main principles of a Fisheries Programme for which I served as programme manager until returning to Danida in Copenhagen in July 2001.

Plenty of challenges—and scope for solutions

There were lots of challenges from the beginning. First of all, a general opinion reigned that the fish resources of the Mekong Basin were declining steadily year by year. For the whole basin, officially-registered fish production added up to only 356,000 tonnes per year. Although there was no regular comprehensive data collection, the figure tended to be adjusted downwards annually, fuelling an impression that the resources could not be rescued and that it was hardly worth trying. But in the case of fish production from the Tonle Sap Lake in Cambodia, this was clearly not true. Taking a closer look at the data, it appeared that official statistics in Thailand were based exclusively on the registered catch from big reservoirs while statistics in Cambodia were based on historical catch estimates

Recycling the 'Mekong spirit' in Central America

After leaving MRC Fisheries Programme in July 2001, Jorgen Jensen spent four years at the headquarters of Danida in Copenhagen, ultimately as Chief Advisor of the Agriculture, Forestry and Fisheries Section of Technical Advisory Services. In 2006, he moved to a field job in Guatemala as regional programme advisor coordinating the Danida-supported Regional Environment Programme in Central America, known as PREMACA in Spanish. The programme includes all seven Central American countries but mainly works with Guatemala, Honduras, El Salvador, Nicaragua and Costa Rica.

"The big issues here are the management of water resources, how to cope with increasing loads of garbage threatening the environment, how to develop a business sector based on a sustainable use of natural resources and how to include the indigenous Maya population in this development," he says. "The similarities between regional cooperation in Central America and the Mekong are many, and a lot of experience from Mekong is being recycled here, for instance the creation of an active regional coordination body similar to the TAB."

Mr Jensen (right) in Guatemala

from the 1950s which were widely cited but never verified. Establishing a solid database and calculating the real value of annual fish production became one of the programme's first priorities.

Another challenge was the lack of cooperation between the line agencies for fisheries in the four riparian countries. The agencies did not know each other and the first approaches towards cooperation seemed to reflect some degree of cautiousness. Hence, getting people together to talk about common problems and opportunities became another priority of the programme.

A dam on the Tonle Sap?

To improve cooperation, our first coup was to assign Sam Nuov as the first riparian fisheries officer in early 1994. As a Cambodian who had studied in Viet Nam and Thailand, he was able to speak all four riparian languages and English. We then started the Cambodian Capture Fisheries Project under the guidance of Niek van Zalinge and Mahfuz Ahmed and began collecting and analysing data. We initially thought that all plans for large dams—for which the Mekong Committee had originally been established in 1957—had already been dropped due to the huge negative side effects. But the wake-up call came when the Canadian team leader of a hydropower planning mission suddenly appeared. As one of 12 possible run-of-river hydropower dams on the mainstream, the Canadian asked what I thought about "a long, low, sling dam across the outflow from the Tonle Sap." The idea underscored the need to get to know the value of the resources and the impact of such projects.

Results come slowly … but they come

With the basin's total fish catch today estimated at more than two million tonnes with a first-sale value in the order of $2 billion, it may now seem strange that the programme's first real ground-breaking achievement was a much more cautious estimate. After much calculation, estimation and discussion, we published a front page article in *Catch and Culture* in August, 1996 (the newsletter was launched in 1995, the same year that the Mekong River Commission was founded, superseding the Interim Mekong Committee). The headline read "*1,000,000 tonnes of fish in the Mekong?*" and argued that new data accumulated by the programme pointed in that direction. This was maybe the first big eye-opener regarding the importance of Mekong fisheries resources. Within months, it was being cited in World Bank technical

Mr Jensen (second from left) at the first 'annual meeting' in Bangkok. The meeting brought together Cambodian, Lao, Thai and Vietnamese fisheries officials for the first time and pre-dated the Mekong Agreement by almost a year.

papers and the fisheries sector started to be included among the important economic sectors of the region whose development had to be taken into account.

The other important development was the establishment of the Technical Advisory Body for Fisheries Management. The TAB was conceived on a boat in the middle of the Nam Ngum Reservoir in Lao PDR in early 1998 during the first visit by senior fisheries officers from the four riparian countries to important fisheries sites in the basin. The Chief Executive Officer of the MRC and the annual meeting of the programme approved the TAB terms of reference in 1999. The new body gave national line agencies and the National Mekong Committees a central role in coordinating the management of the basin's fish resources and combining national capacities for such purposes. It also made the programme more sustainable in the event of donor withdrawal.

New and old challenges

New challenges are coming up all the time and some old ones require new answers. It seems that one of the most important challenges remains the need to strike a balance between maintaining fisheries resources as a vital source of food and income for the people of the basin and harnessing the potential for hydropower development. The issue is well presented in the December 2008 issue of *Catch and Culture.*

When the costs of negative side effects are taken into account, too many hydropower and other large-scale development projects have turned out as net losses to national or regional economies. Losses are frequently shouldered by the part of the population which benefits least from such investments.

For such reasons, it is very important for the Fisheries Programme and riparian institutions to continue their efforts to describe key fish habitats and migration routes and to get the size and the value of the resources right, giving governments an important decision-making tool for economic development in the basin. One of the most decisive factors in the economics of hydropower is the height of the "head" or vertical distance which may be utilised for power production. High heads are usually much easier to obtain in smaller tributaries rather than the slower flowing mainstream of a river or the lower parts of main tributaries. Still, some high reaches of tributaries may have unique faunas or roles in fish production which should be thoroughly investigated in advance of a decision. The Fisheries Programme and the Technical Advisory Body have a very important role to play in this context.

** Mr Jensen is based in Guatemala as regional programme advisor to PREMACA, the Danida-supported Regional Environment Programme in Central America*

Mr Jensen on a field visit in the early days of the programme.

Founding head of Lao research centre appointed as **Fisheries Programme coordinator**

The Mekong River Commission has appointed a senior official from the Lao Ministry of Agriculture and Forestry as the first Fisheries Programme Coordinator from a riparian country. Mr Xaypladeth Choulamany took up the position in January, succeeding Dr Chris Barlow who has become the programme's technical advisor.

For the past five years, Mr Xaypladeth has overseen international cooperation and investment in the agriculture and forestry sectors. This was initially as Deputy Permanent Secretary of the ministry and later as Deputy Director General of the Department of Planning and International Cooperation where he was mainly in charge of international cooperation and investment following the ministry's restructuring in 2007. Before that, he was actively involved in establishing the Living Aquatic Resource Research Center (LARReC) in Vientiane, serving as its founding director between 1999 and 2004. Mr Xaypladeth has also been active in developing numerous community fisheries programmes in the Lower Mekong Basin.

Xaypladeth Choulamany joined the Ministry of Agriculture and Forestry in 1982 after his return from the Soviet Union where he completed a master of science degree in agricultural economics at the Byelorussian Academy of Agriculture. After working as an assistant planning chief and head of procurement at the State Agro-Processing Enterprise, he was appointed deputy national project director of a Lao-Australian livestock feed project in 1985. Between 1991 and 1995, Mr Xaypladeth served as national director of the Xiengkhouang Highland Development Programme, a community-based rural development programme in collaboration with the International Fund for Agricultural Development (IFAD) and the United Nations International Drug Control Programme (UNDCP).

Mr Xaypladeth Choulamany

He has been actively involved in formulating national strategies for agricultural development, biodiversity, watershed-based development, wetland management and forestry in the ministry.

Mr Xaypladeth brings considerable regional and international experience to the Fisheries Programme. He was the Lao Senior Officials Meeting (SOM) Leader to the ASEAN Ministers for Agriculture and Forestry between 2004 and 2008. He has also served as member of the national team negotiating Lao accession to the World Trade Organisation (WTO), representing the Ministry of Agriculture and Forestry at four working party meetings in Geneva between 2004 and 2008 with responsibility for agricultural policies as well as sanitary and phytosanitary measures. In addition, Mr Xaypladeth headed the National Working Group on Agriculture and Forestry, Natural Resource Management and Environment to implement the principles of the Paris Declaration and the Vientiane Declaration on Aid Effectiveness.

In recent years, Mr Xaypladeth has been actively involved in gender issues. Since 2005, he has been helping the Lao Women's Union develop and implement gender-based rural development programmes for poverty alleviation. He has also served as vice chairman of the National Sub-Committee for Advancement of Women in Agriculture and Forestry (SCAW) and actively contributed to the

New advisory position

With the appointment of Mr Xaypladeth as Programme Coordinator, Chris Barlow has been appointed as Chief Technical Advisor to the Fisheries Programme. Dr Barlow joined the programme in Phnom Penh in 2001 and was appointed Manager in 2003, moving to Vientiane in 2004 when the MRC secretariat was relocated to Lao PDR. In his new role as technical advisor, he will oversee the programme's inputs to the assessments of water resource developments, especially those relating to dams on the mainstream of the Mekong. He will also continue to be responsible for communications and publications coming from the programme, as well as planning for Fisheries Programme Phase 3, which will cover the period 2011-2016.

Commenting on his new appointment, Dr Barlow said he was extremely pleased that he could remain involved in the programme at this time as the MRC Secretariat, along with fisheries, faces an unprecedented era of potentially big changes in the use of the river's water resources. He repeated an earlier comment in *Catch and Culture* that with good planning, the people of the region could enjoy the benefits of hydropower development while maintaining the current productivity of the river's fisheries.

"The fishery of the Mekong is hugely important for the nutrition and economy of the people in the region, particularly the rural poor. We need sound planning to both protect the natural wealth – the fisheries and associated wetlands – as well as generate new wealth from industries such as hydropower and irrigation. Finding the right balance is technically and politically difficult," Dr Barlow said. He further added that he personally considered it a privilege to be in a position to contribute to such debate.

ministry's SCAW and Gender Development Strategy and Action Plan.

As director of LARReC, Mr Xaypladeth prepared the aquatic resources component of the National Biodiversity Strategy in 2000. He also authored the report "Traditional Use and Availability of Aquatic Biodiversity in Rice-Based Ecosystems" in 2005.

Since 2006, Mr Xaypladeth has been a member of the board of trustees of the Regional Community Forestry Training Centre in Bangkok. He is also a member of the board of trustees of the Land Development and Service State Enterprise and vice president of the Labour Union of the ministry. In addition to his Soviet degree, he has a master of science degree in rural development planning and rural settlement programs from the Asian Institute of Technology in Bangkok.

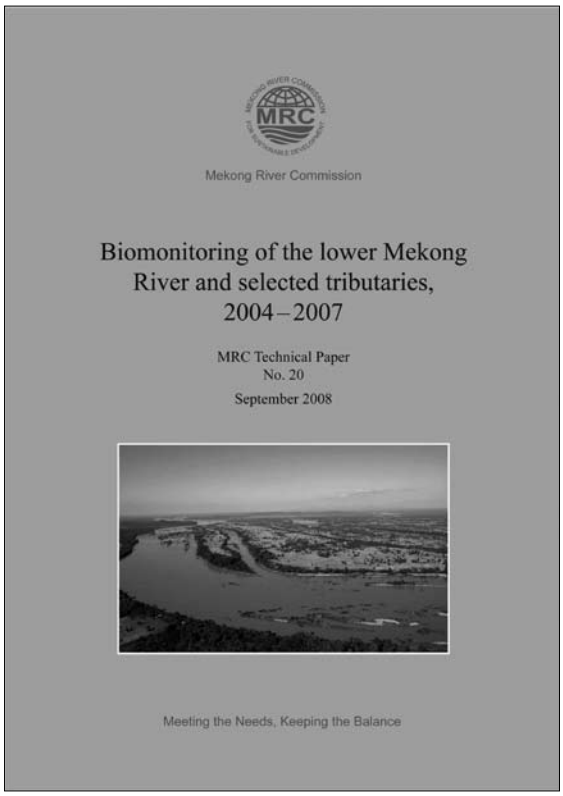
The Fisheries Programme is fortunate to have a person of Mr Xaypladeth's knowledge and experience in fisheries and international development leading the programme. His understanding of the importance of fisheries for the livelihoods of people in the region will be invaluable as the MRC undertakes strategic assessments in the near future of the development options for the water resources of the Mekong.

Dr Steen Christensen

Steen Christensen has returned to Denmark where has been working on the fisheries of the Baltic Sea with the European Commission. Since joining the MRC Fisheries Programme in 2007 as economics advisor to the Fisheries Ecology, Valuation and Mitigation Component, Dr Christensen was based at the Research Institute for Aquaculture No. 2 in Ho Chi Minh City. The major thrust of his research was working with colleagues from Cambodia, Lao PDR, Thailand and Viet Nam to review and synthesise information on the value of fisheries in the four countries on the Lower Mekong Basin. National reports have been completed and Dr Christensen is in the process of finalising the overall report which will provide greater insight into the economic valuation of fisheries in the region.

Biological monitoring in the **basin**

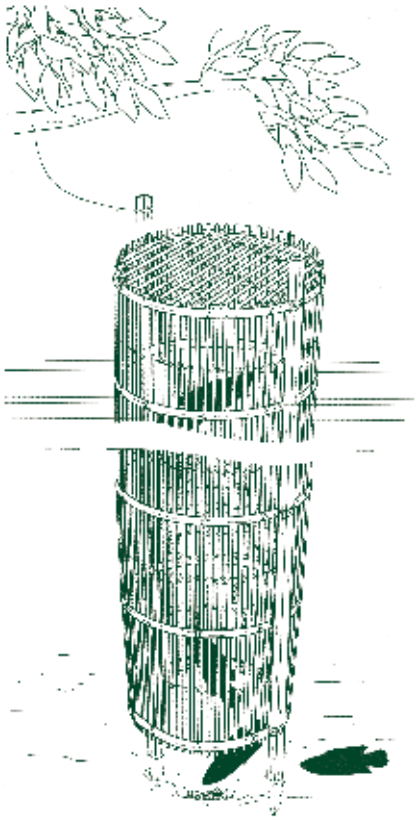
A new technical paper finds that the main rivers of the Lower Mekong Basin have not yet been severely harmed by water resource development or waste disposal. But some are showing signs of stress.



The Mekong River Commission established a biological monitoring programme in response to Article 9 of the agreement creating the commission in 1995. Groups of organisms to be monitored included diatoms, zooplankton and both littoral and macroinvertebrates. Full-scale data collection began with 20 sites sampled in 2004, 16 in 2005, 21 in 2006 and 20 in 2007. In total, 51 sites were sampled, some in two or more years. For the four groups of organisms, three indicators of ecological status were calculated for each sample (richness, abundance and average tolerance). Data from 14 reference sites were then used to generate 12 interim biological guidelines, similar to those proposed for the MRC water quality assessment programme (see *Catch and Culture*, Vol 14, No 3).

The results have recently been published as MRC Technical Paper No. 20, *Biological monitoring of the lower Mekong River and selected tributaries 2004-2007.* Of 77 samplings conducted over four years, 28 were considered excellent (with 10-12 guidelines met), 32 were good (7-9 guidelines met) and 17 were moderate (4-6 guidelines met). None were considered poor (0-3 guidelines met). “This rating suggests that the principal rivers of the Lower Mekong Basin have not yet suffered severe harm from the development of water resources of waste disposal. However, some rivers are shoing signs of stress,“ the paper finds.

Based on excerpts from the summary and outlook



Mekong **Fisheries Index**

Vietnamese catfish prices soar but farmers short of stock

Vietnam News Agency, 25 April 2009,

Catfish prices in the Mekong Delta surged by 20 percent at the end of April, leaving Vietnamese farmers and traders short of fish. The price topped VND19,000 (US$ 1.11) per kilo on 24 April and was expected to rise after hovering around VND14,000 (US$ 0.80) for the previous months. However, most catfish breeders in the region cannot take advantage of the higher prices because they have fewer fish left in their cages. Some provinces, such as An Giang Province in Viet Nam, which is the largest catfish farming province in the country, are only producing 10 percent of the fish they produced last year, leaving many farmers facing increased debt. Sales are falling short of processors' needs because farmers are deliberately holding back their product, waiting for the next price rise. The main force behind the in crease in price rise for catfish is said to be increased demand from the Russian, Middle Eastern and Eastern European Markets.

Viet Nam police seize over 35 tons of illegal blowfish

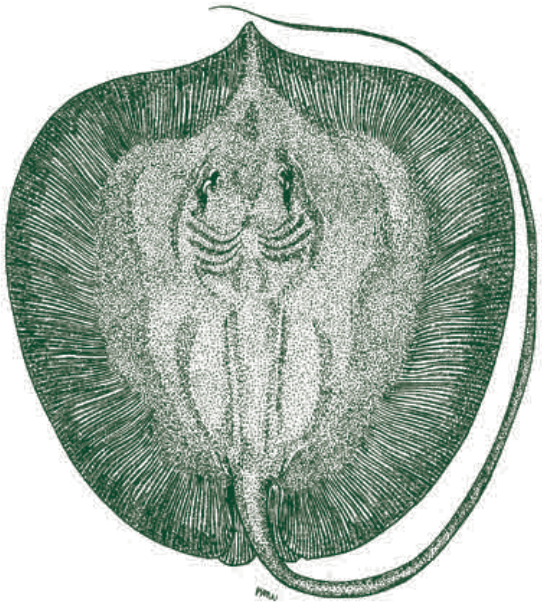
Thannien News, 24 April 2009

Police in the Vietnamese Mekong Delta province of Kien Giang have seized over 35 tons of illegally caught blowfish since February and admit they are having trouble controlling the racket in the poinsonous but endangered species. Le Thanh Liem, chief inspector of the provincial Health Department, said it was difficult to crack down on the racket with a coastline that is more than 200 kilometers long. Catching selling and processing of blowfish is illegal in several Vietnamese localities, including Kien Giang and Ho Chi Minh City. Chief inspector Liem said part of the problem was that the current fines of up to tens of millions of dong were not enough of a deterrent to the smugglers who make huge profits from poaching the fish. Blowfish, which live in both fresh and salt water, are the second most poisonous vertebrate in the world after the golden poison frog. The skin and certain internal organs are fatal to humans but the meat is considered a delicacy. Several people in Viet Nam have died as a result of eating the fish in recent months.

Giant stingray could be world's biggest

LabNews.co.uk, 29 April 2009

Scientists in Thailand have caught what they believe could be the world's biggest stingray. The fish was tagged and released in central Thailand during the National Geographic expedition, which seeks to find and protect specimens of the world's largest freshwater fish Conservation biologist and the lead researcher on the expedition, Zeb Hogan of the University of Nevada said: "In terms of disk width, this is the second largest stingray I've seen, the largest was in Cambodia in 2003." However, he said that the recently caught stingray was thicker, "so it may have weighed more." At up to 350 kg, this species of giant freshwater stingray has the potential to be the largest freshwater fish in the world. The current record holder for the world's largest freshwater fish is a 292 kg Mekong giant catfish caught by fishermen in northern Thailand in 2005. Freshwater giant stingrays are among the largest of the approximately 200 species of rays. They can be found in a handful of rivers in Southeast Asia and northern Australia.



200,000 endangered carp bred and released in the Mekong

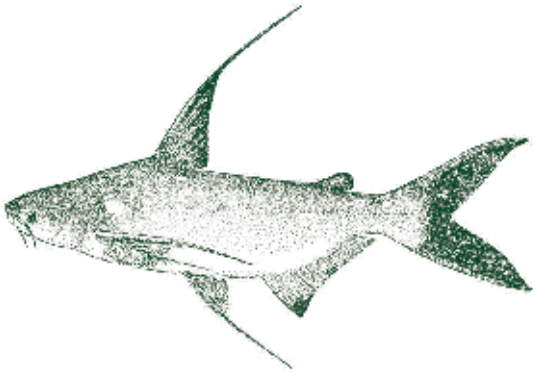
MRC, 22 April 2009

200,000 young fish that can grow to up to 70 kg in weight and over 1.65 metres in length were released into the Mekong as part of a Lao/Thai breeding programme. The endangered Jullien's golden carp *(Probarbus jullieni)*, were bred in Thailand by the Lao and Thai governments, with support from the Mekong River Commission (MRC). The two countries have established "breeding stations" for the fish along the Mekong River in Loei, Nongkhai, Mukdaharn, Nakornphanom and Champassak, where large numbers of fingerlings have been bred, as part of efforts to protect and preserve giant Mekong species. "Fish are extremely important in the diets of all those that live along the Mekong, providing more than 50 percent of annual protein," said Jeremy Bird, CEO of the MRC. "Releasing fish into the river system will help conserve vulnerable Mekong species, with a view to maintaining aquatic biodiversity, and guaranteeing the availability of fish today and for future generations." Jullien's golden carp is one of the largest fresh-water species in Southeast Asia. It migrates great distances up the Mekong to reproduce, with fish swimming from Kompong Cham in Cambodia to Chiang Khong in Thailand, and further up the Nam Ta in Laos to breed. It is a popular fish for eating, sometimes consumed raw and commands a high market price. But its popularity has an environmental toll – contributing directly to the low numbers of fish in the wild and prompting regional governments to classify it as an endangered species, with international trade banned.

Vietnamese increase efforts to promote catfish abroad

VOV News, 12 April 2009

At a recent conference in An Giang province in Viet Nam, the Prime Minister of Viet Nam directed his own government to take measures to increase the production and consumption of *basa* catfish, with the aim of turning it into one of the country's major exports. Basa fish is already one of Viet Nam's key aquatic export products. The Vietnamese Prime Minister cited the need to increase seafood export earnings and generate jobs for local people in the Mekong River Delta, which is the country's largest aquatic farming area. The industry has was hit by a reduction in demand, with several Egyptian newspapers reporting that Vietnamese *basa* fish live in contaminated rivers and contained antibiotic residue that could be harmful to consumers. However, the Vietnamese government has called this "misleading information."



Huge population of Rare dolphins discovered

ScienceDaily, 2 April 2009

The Wildlife Conservation Society (WCS) has announced the discovery of a huge population of rare Irrawaddy dolphins in South Asia. WCS researchers estimate that nearly 6,000 of the dolphins, which also populate the Mekong River, were found living in freshwater regions of Bangladesh's Sundarbans mangrove forest and adjacent waters of the Bay of Bengal. Very little marine mammal research has taken place in this region up to this point. Prior to this study, the largest known populations of Irrawaddy dolphins numbered in the low hundreds or less. In 2008, they were listed as vulnerable in the IUCN Red List based on population declines in known populations. "This discovery gives us great hope that there is a future for Irrawaddy dolphins," said Brian D. Smith, the study's lead author. "Bangladesh clearly serves as

an important sanctuary for Irrawaddy dolphins, and conservation in this region should be a top priority." The Irrawaddy dolphin grows to some 2 to 2.5 meters in length and frequents large rivers, estuaries, and freshwater lagoons in South and Southeast Asia. In Myanmar's Ayeyarwady River, these dolphins are known for "cooperative fishing" with humans.

New Mekong snow trout discovered

Practical fish keeping, 9 February 2009

Chinese ichthyologists have described a new species of Mekong dwelling snow trout in a paper published in a recent issue of the journal Zootaxa. *Schizothorax nudiventris* lives in the upper Mekong River drainage in southern China and has a blunt snout, thin upper lip, well-developed and trilobed lower lip, continuous postlabial groove and a scaleless abdomen in mature individuals. It has a soft last one-quarter of the last unbranched dorsal-fin ray, with 15−21 serrae along its posterior edge and a pelvic-fin that originates beneath or behind a vertical line through the dorsal-fin. It can be identified by irregular black spots on both sides of the body. *Schizothorax nudiventris* is named after its scaleless abdomen (latin nudus=naked and venter=abdomen). Jian Yang, Xiaoyong Chen and Junxing Yang discovered the species, along with two others types of Snow Trout, *Schizothorax beipanensis* and *Schizothorax heterophysallidos*, which live in the Beipan River and Nanpan River in Souther China respectively. For more information, see the paper: Yang, J, X-Y Chen and J-X Yang (2009) The identity of Schizothorax griseus Pellegrin, 1931, with descriptions of three new species of schizothoracine fishes (Teleostei: Cyprinidae) from China. Zootaxa 2006, pp. 23–40.

Short supply of fish, shrimp may cost thousands of Vietnamese jobs

Vietnam net bridge, 23 February 2009

Over 20,000 seafood processing factory workers in Viet Nam's Cuu Long Province in the Mekong Delta are at risk of losing their jobs, with most plants working at just 30-40 per cent capacity. Factories are blaming a reduction in catch, due to a drop in overseas demand for the shortage in supply of shrimp and fish for processing. This marks a huge difference from previous years when seafood processing firms typically suffered a dearth of workers in the days following the Tet (Lunar New Year) holiday. This year, most factories are not recruiting new workers and, plan to cut down on their existing workforce. For example, the shrimp processing factory of Sao Ta Co has a capacity of 40 tonnes of shrimp per day but its current intake is just one tonne per day. The firm has recently announced that it intents to cut 700 jobs. Many other seafood factories in the southernmost province of Ca Mau are operating at around 40 per cent of their capacity.

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