

Fisheries Research and Development in the Mekong Region

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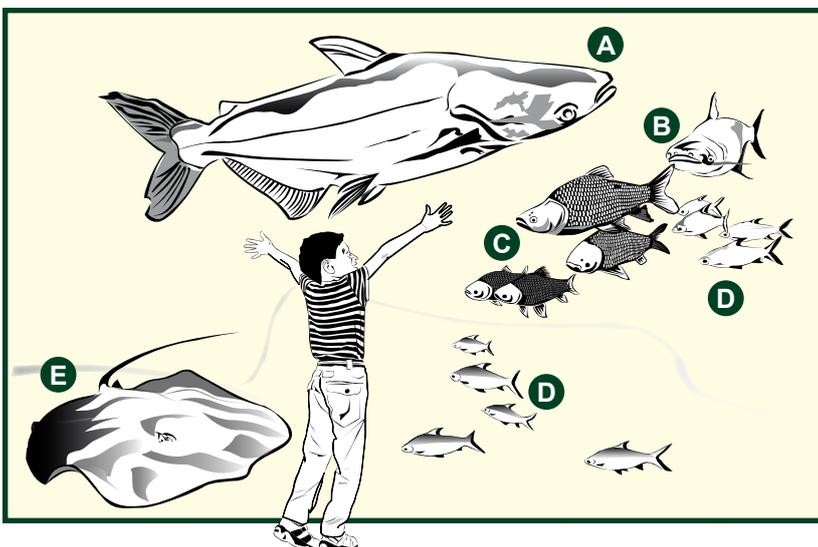
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Cover photo: Wildlife Reserves Singapore
Illustration at left: Chhut Chheana

- A** Mekong giant catfish (*Pangasianodon gigas*)
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With thanks to Chaiwut Grudpan, a taxonomy specialist working as a lecturer at Ubon Ratchathani University in Thailand

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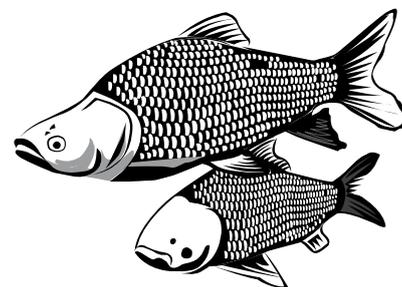
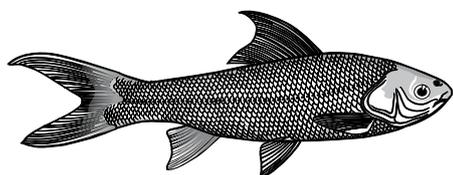
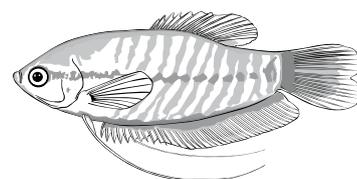
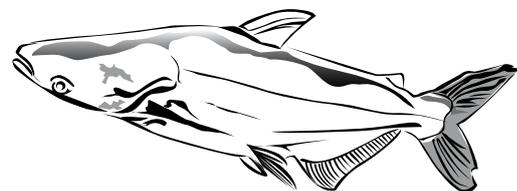
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Boosting the sustainability of the world's largest inland fishery

Momentous decisions remain to be made following the abolition of commercial fishing lots in Cambodia last year

In February 2012, Cambodia's Prime Minister Hun Sen cancelled all 80 commercial fishing lots in the Mekong River system including 38 in the Tonle Sap Lake, the world's largest inland fishery. Three quarters of the area has since been set aside for community use with the rest designated as conservation areas (see *Catch and Culture*, Vol 18, No 1).

A recent paper* in the *Cambodian Journal of Natural History* says the move may be an "essential first step" towards maintaining the productivity of the Tonle Sap Lake fishery, estimated at around 350,000 tonnes a year, and the biological diversity that supports it. To enhance the odds of success, the authors suggest drawing upon lessons from marine protected areas, adding protection for migratory species and governing against a "tragedy of the commons" scenario.

The former fishing lots cover about 20 percent of the area of the Tonle Sap Lake. The paper argues that the conservation parts of the 38 lots, extending to about 600 square kilometres, should be consolidated into a smaller number of large reserves along the southeast-northwest axis of the lake. These should include the mouth of the Tonle Sap River and other large tributaries such as the Pursat River and the Sangker River (see map on the opposite page). They should also include flooded forest areas and take into account circulation patterns in the lake which are likely to dictate high levels of larval settlement, retention and survival rates.

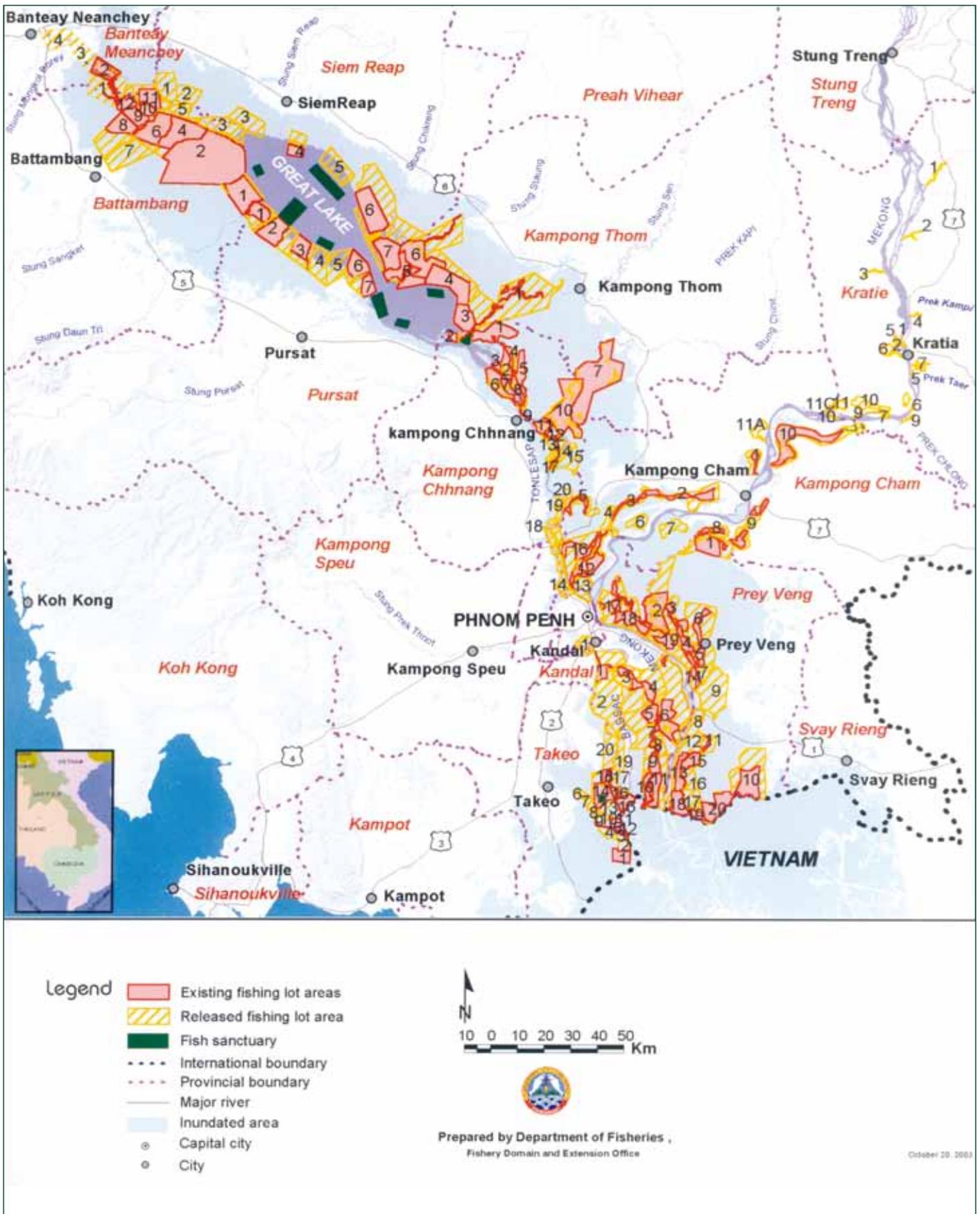
“Conservation reserves alone are unlikely to benefit the most valuable species”

Without additional protection, however, conservation reserves alone are unlikely to benefit the most valuable species, periodic breeders such



A medium-sized commercial barrage operation in Fishing Lot No 12 in Kampong Chhnang province, located on one of the many channels of the Tonle Sap

PHOTO: JOE GARRISON



Fishing lots after the first phase of Cambodia's fishery reforms in 2000 when the number of lots was reduced from 135 to 80, increasing the freehold area to more than half a million hectares

SOURCE: FISHING GEARS OF THE CAMBODIA MEKONG, PUBLISHED BY THE MEKONG RIVER COMMISSION, DEPARTMENT OF FISHERIES AND DANIDA



An aerial photo of the kill zone of a large fence trap array, located in the flooded forests near Chnok Trou on the southern edge of the Tonle Sap Lake in Kampong Chhnang province. The fishers have moved their houseboats to the fence trapping locations to make transporting their catch easier, sometimes storing live fish in cages under the houseboats.

PHOTO: JOE GARRISON

as the black-spotted catfish (*Pangasius larnaudii*) that mature at older ages and migrate long distances. The authors therefore call for periodic closure of the Tonle Sap River commercial *Dai* fishery, as recommended by the Inland Fisheries Research and Development Institute (IFReDI) of the Cambodian Fisheries Administration. Harvest restrictions and conservation areas in the deep pools of the Mekong are also seen benefitting migratory species.

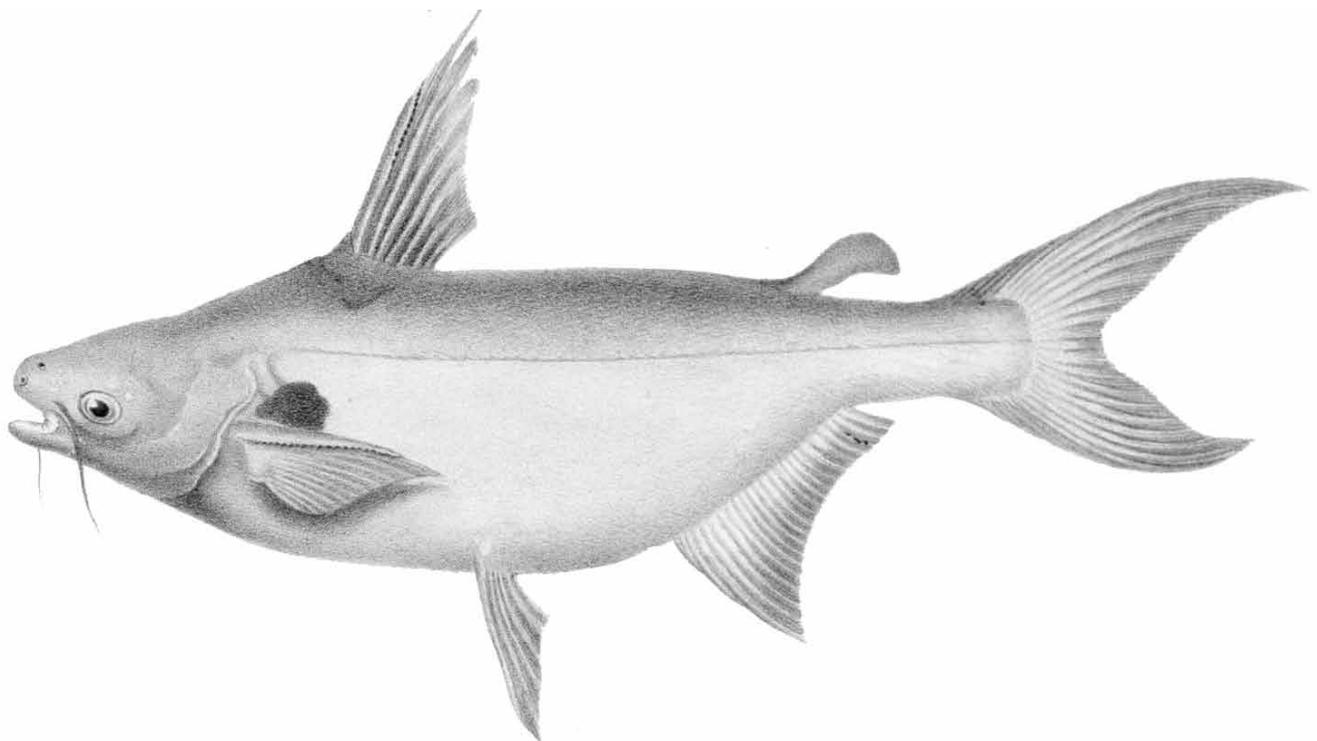
“The 'laudable first step' needs to be supported by complementary measures”

Proposed management measures include curtailing the use of poisons, explosives and ultra-effective fishing gear that catch entire schools of migrating fish. To limit the harvest of small or exceptionally large species, the paper recommends mesh-size regulations for gill nets. Rather than prohibiting undesirable fishing gear, the authors recommend trade-in programmes whereby such gear is exchanged for approved

gear at little or no cost to the owners.

Addressing how the Tonle Sap is managed and for what purposes is a "compelling need," the paper says, noting that "competing mandates and professional rivalries amongst multiple government agencies" have delayed the emergence of a unified vision. "Prime Minister Hun Sen should be applauded for moving boldly to address impending threats to Cambodia's freshwater fisheries," the paper says. But the "laudable first step" needs to be supported by complementary measures. "Momentous decisions remain to be made," the authors conclude. "Recent insights into the hallmarks of successful fishery management provide clear guidance that can be readily applied to the Tonle Sap."

* Cooperman, M., So N, M. Arias, T. Cochrane, V. Elliot, T. Hand, L. Hannah, G. Holtgrieve, L. Kaufman, A. Koenig, J. Koponen, V. Kum, K. McCann, P. McIntyre, B. Min, C. Ou, N. Rooney, K. Rose, J. Sabo, and K. Winemiller (2012). A watershed moment for the Mekong: New regulations may boost sustainability of the world's largest inland fisheries. *Cambodian Journal of Natural History*, 2012, 101-106



Periodic closures of the Tonle Sap River fishery are seen benefitting periodic breeders like the black-spotted catfish (*Pangasius larnaudii*), which matures at older ages and migrates long distances

ILLUSTRATION: NOUVELLES ARCHIVES DU MUSÉUM D'HISTOIRE NATURELLE

New park in Singapore showcases endangered Mekong fish species

Asia's first river-themed wildlife park also contains world's largest freshwater aquarium exhibit

Wildlife Reserves Singapore has opened Asia's first river-themed wildlife park featuring animals from the freshwater habitats of the Mekong and seven other rivers. River Safari park received almost 1,500 visitors on the first day on April 3 including school children, wildlife enthusiasts and tourists, the company said. The park is the newest addition to the company's portfolio of award-winning attractions which also include Singapore Zoo, Night Safari and the Jurong Bird Park.

The Mekong zone within River Safari includes a three-metre high aquarium with 540 cubic metres of water, company spokesman Shaiful Rizal said. The aquarium showcases several critically-endangered fish species including a Mekong giant catfish

(*Pangasianodon gigas*) obtained from Thailand in 2010. Other critically-endangered Mekong species include the Chao Phraya giant catfish (*Pangasius sanitwongsei*) and the giant barb (*Catlocarpio siamensis*).

Also showcased are the endangered freshwater giant stingray (*Himantura polyepis*), the Asian bonytongue (*Scleropages formosus*), the near-threatened wallago (*Wallago attu*) and the tricolor shark minnow or bala shark (*Balantiocheilos melanopterus*). The latter, originally from Borneo but now cultured in Thailand as an ornamental fish, is in the same genus as the blackfin shark minnow (*Balantiocheilos ambusticauda*), now extinct in Thailand and very rare in the Lower Mekong Basin. In addition, Mr Shaiful said River Safari featured terrestrial animals in an attempt to showcase entire ecosystems. The Mekong zone, for example, is also home to crab-eating macaques (*Macaca*



The critically-endangered Mekong giant catfish (*Pangasianodon gigas*) on display at Singapore's River Safari park

PHOTO: WILDLIFE RESERVES SINGAPORE



Singaporean schoolchildren visiting the Mekong River zone at River Safari park in April

PHOTO: WILDLIFE RESERVES SINGAPORE

fascicularis) and lesser adjutants storks (*Leptoptilus javanicus*) from the region.

River Safari's other aquatic sections are devoted to the Amazon, Congo, Ganges, Mississippi, Murray, Nile and Yangtze rivers. The Amazon section features a flooded forest submerged in more than 10 metres of water, making it the largest freshwater aquarium exhibit in the world, the company says. A boat ride is expected to start later this year.

"Occupying 12 hectares and developed at a cost of SGD 160 million (USD 128 million), the park is home to more than 150 plant species and 5,000 aquatic and terrestrial animals representing 300 species. The collection of freshwater animals is

said to be one of the world's largest.

According to Wildlife Reserves Singapore, "River Safari aims to inspire visitors to appreciate and protect fragile freshwater ecosystems." The company's overall goal is to manage world-class leisure attractions that foster education and research while educating visitors about animals and their habitats.

The company says its other attractions receive about 3.7 million visitors a year, equivalent to more than 10,000 people each day, with 1.7 million people visiting the Singapore Zoo alone. Night Safari attracts a further 1.1 million visitors a year while Jurong Bird Park brings in more than 900,000.

Fisheries development and management in lakes and reservoirs in Viet Nam

BY BUI THE ANH, NGUYEN HAI SON AND PHAN DINH PHUC *

Reservoir fisheries in Viet Nam have developed over the past 50 years. Most reservoirs were built after 1954 for purposes such as irrigation, hydropower, flood control and water use for domestic consumption and industry (Ngo and Le, 2001). Reservoirs are usually located in mountainous areas where most communities are poor. Reservoir fisheries have therefore played an important role in providing livelihoods to many, particularly displaced persons living near reservoirs. Such fisheries are, however, always a secondary activity (De Silva, 1996).

To meet the demands of national economic development over the past two decades, many reservoirs have been built throughout the 38 mountainous provinces of Viet Nam. However, reservoir fisheries potential has not been fully realised (Bui, 2006). Fisheries and aquaculture in lakes and reservoirs have helped eliminate hunger and reduced poverty. But their contribution to gross domestic product (GDP) has been limited (Ngo and Le, 2001).

Recognising the important role of reservoir fisheries, the Government of Viet Nam approved in 2010 a Master Action Plan for Fisheries and Aquaculture Development to 2020. Fisheries and aquaculture in lakes and reservoirs are therefore attracting government interest and investment.

Reservoir area and fisheries production

The Institute of Fisheries Economics and Planning has indicated that Viet Nam has about 397,500 ha of large water bodies including rivers, streams, lakes and reservoirs, accounting for 28 percent of total aquaculture area (IFEP, 1997). The institute has estimated that the country has 2,470 reservoirs covering 183,579 ha. But this area is thought to be underestimated. Nguyen *et al.* (1993) reported earlier that Viet Nam had 768 reservoirs covering 242,725 ha. Nguyen (2001) estimated 4,000 reservoirs, including 460 medium and large-sized reservoirs, with an area of 340,000 ha and a volume of more than one million

cubic metres. The Department of Water Resources (2010) has recorded the construction of 1,600 reservoirs over the past decade.

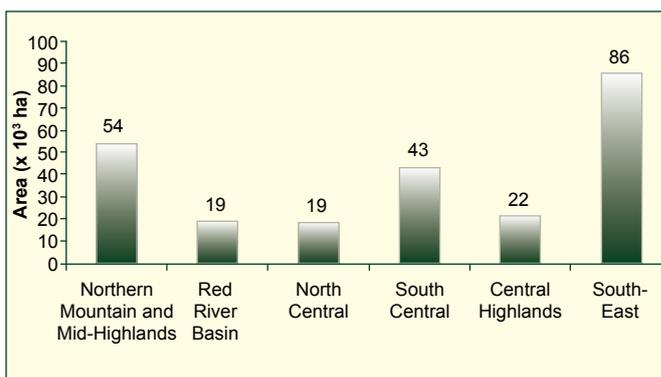
Inland water bodies of Viet Nam

Water Bodies	Area (ha)	%
Ponds	58,088	4
Large water bodies	397,500	28
Rice fields	548,050	39
Inter-tidal	290,700	21
Bays, lagoons	84,700	8

SOURCE: INSTITUTE OF FISHERIES ECONOMICS AND PLANNING (1997)

The northern mountains, mid-highlands and southeastern regions have the highest reservoir areas in the country (Figure 1). Nguyen (1999) and Ngo and Le (2001) classified reservoirs into large (>10,000 ha), medium (1,000-10,000 ha) and small (<1,000 ha).

Figure 1: Reservoir distribution by region



SOURCE: NGUYEN (1994), NGUYEN *ET AL.* (1993) AND NGUYEN *ET AL.* (1995)

Fish yields from reservoirs in Viet Nam have tended to be higher at the immediate post-impoundment phase. Yields decline as reservoirs mature, about five to eight years after the water regime stabilises. Nguyen *et al.* (2001) indicated annual reservoir yields at 5,050 tonnes or 43 kg/ha/year with larger reservoirs averaging 10-15 kg/ha/year and smaller reservoirs 100-150 kg/ha/year.

Reservoir fishery management systems have changed from time to time and region to region (Ngo and Le, 2001). However, fisheries management and development have been stable over the past ten years, albeit more oriented towards production than management (Ngo and Le, 2001). There have been no strong links between different sectors using water resources for purposes such as irrigation and industry. Ngo and Le (2001) identified three categories of reservoir fisheries management systems in Vietnam, namely government line management, co-operative line management and private-sector line management.

Government management

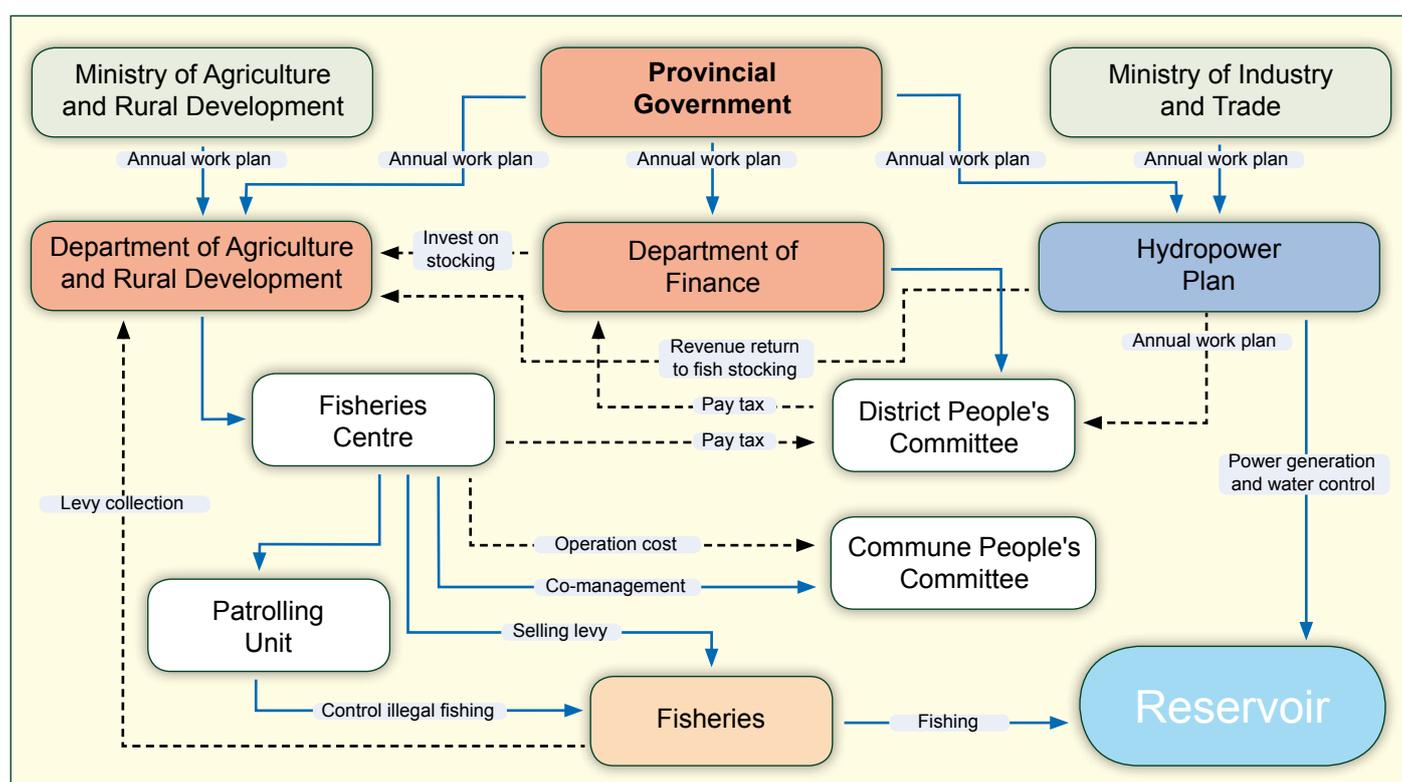
Ngo (2001) and Bui (2006) divided government line management into administrative, provincial, enterprise licensing and open-access management. To date, however, provincial-level management has not applied.

Under administrative management (see Figure 2 below), fisheries centres represent both the national and provincial governments. They have wide responsibilities for aquaculture and fisheries

development in reservoirs and the whole province. Communes are authorised to collect fishing fees depending on the size and number of boats owned, the amount of gear used (by type) and the number of cages being operated. Part of the income is given to the community and the rest is constituted as provincial taxes (Ngo and Le, 2001 and Nguyen, 2000). The provincial government, in turn, pays for wages and the centres bear all costs associated with stocking and extension activities in relation to aquaculture.

Enterprise licensing (see Figure 3 next page) is guided by the provincial Department of Agriculture and Rural Development to manage and develop reservoir fisheries and to help displaced and surrounding inhabitants exploit the resources. The enterprise sells daily and/or periodic fishing licenses to prospective fishers depending on the type of gear. The income is used for staff salaries, operating costs, taxes and stocking of fingerlings. The enterprise has major socio-economic links with the surrounding population whose livelihoods depend on the fishery resources in the reservoir. Although the right of fishery management has been transferred by provincial authorities,

Figure 2: **Government line reservoir fisheries management and enhancement in large and medium-sized reservoirs in Viet Nam**



SOURCE: BUI AND PHAN (2010)

the enterprise has no obligations with regard to conservation. Also, there are potential conflicts between different water users, particularly tourism operators, irrigation units and fishers.

Open access (see Figure 4 next page) falls under administrative management and occurs in many reservoirs across the country. Authorities have jurisdiction over the area, water use and transport, allowing fishers to access freely the reservoir resources. There are no management activities and stocking in such reservoirs has been terminated for more than eight years. In this form of management, several organisations share the waters but fisheries never have the highest priority in controlling the resource. There are conflicts between official organisations for fisheries management. Open access to the water is still maintained.

Cooperative management

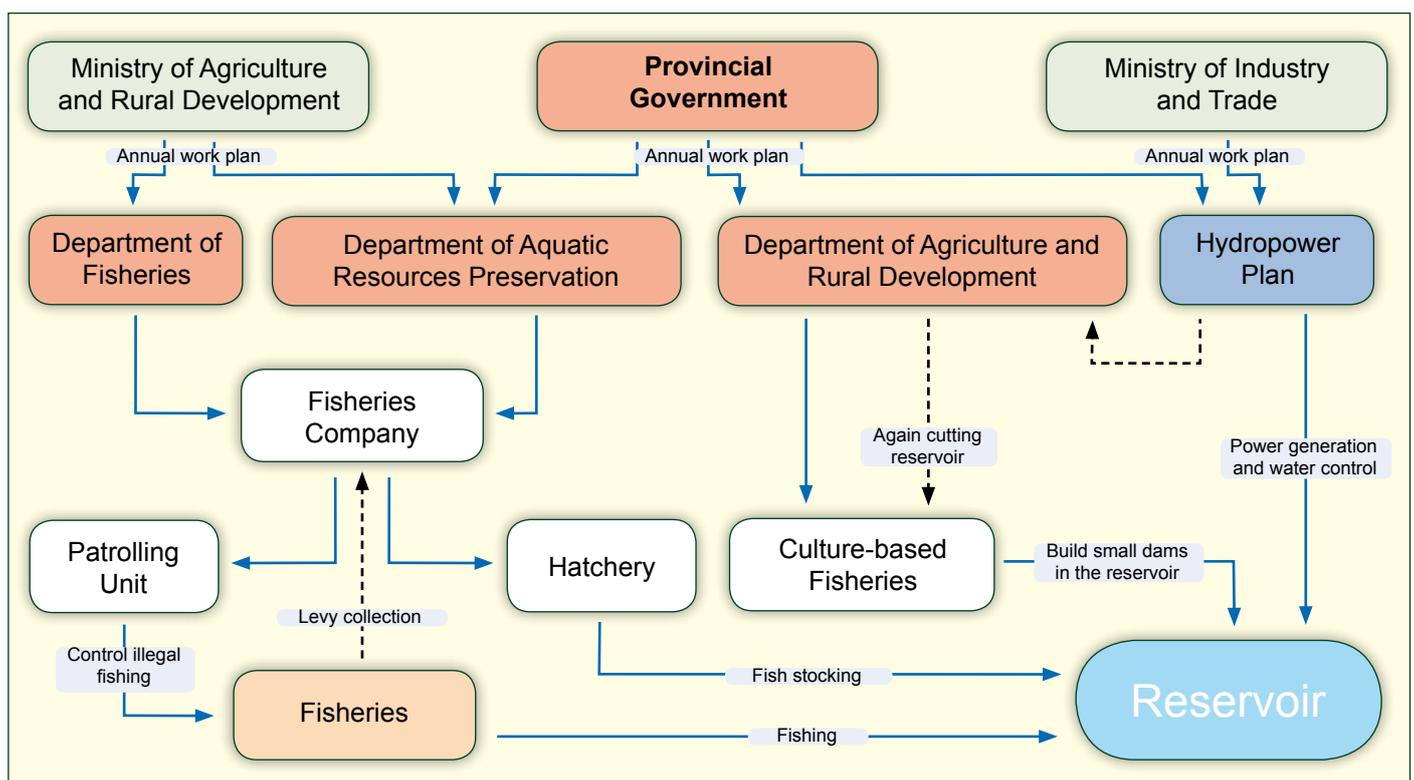
Such management is seen in some medium-sized reservoirs, such as Phu Ninh Reservoir in Quang Nam province, where individual households are unable to invest and the reservoir is managed as a cooperative. In such cases, a group will form a small production unit responsible for running the business

including stocking, harvesting and marketing. The management unit pays a levy to the provincial government to control fishery activities in the water body. Members of the group work together and make investment and planning decisions while sharing responsibilities and income. Under this system, fish production tends to be higher (Nguyen, 1997).

Private-sector management

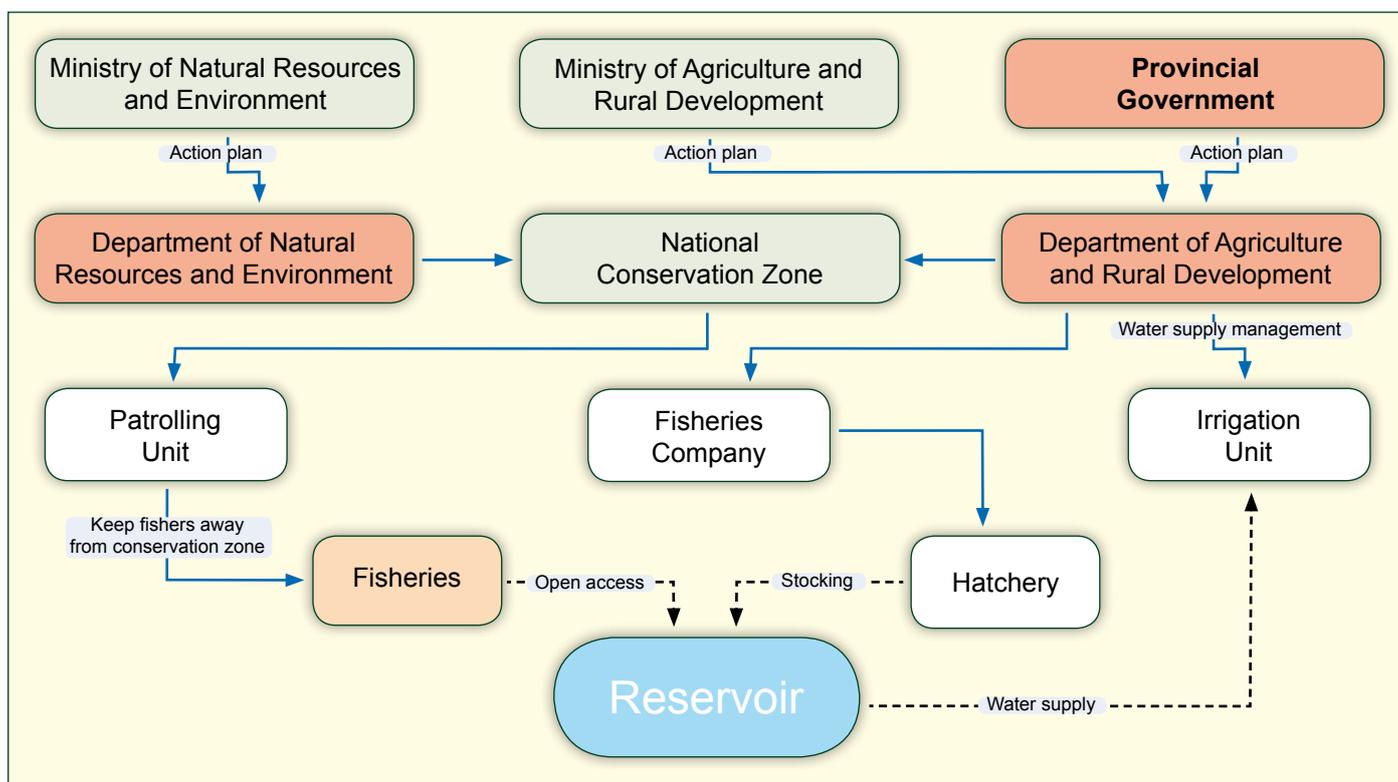
Under this system, reservoirs are leased and managed by individual households. The provincial government is responsible for reservoir maintenance and regulating water for irrigation. In many cases, the household also gets medium-term contracts to use the reservoir for fish culture. In essence, the reservoir is considered a big pond. The intensity of household fish culture is based on investment capacity and experience. In some medium-sized reservoirs, individuals get leases from provincial governments to invest and manage them for 5 to 10 years. Managers can make plans and invest as they wish and they own all the stock. Most of these reservoirs have their own hatchery to provide fingerlings. Households need to renew the contract every 5 to 10 years.

Figure 3: Fisheries management and enhancement of local enterprise in Viet Nam



SOURCE: BUI AND PHAN (2010)

Figure 4: Open-access reservoir fisheries in Viet Nam



SOURCE: BUI AND PHAN (2010)

Newly-introduced species

In large and medium-sized reservoirs, new fish species introduced in recent years have contributed significantly to reservoir fisheries development. These species have also created new fisheries that have helped many local inhabitants earn money from reservoir resources.

In 2003, a Chinese enterprise introduced Chinese icefish (*Neosalanx tangkahkeii*) into Viet Nam. The species developed well after four years, especially in the central and upstream areas of reservoirs. Icefish production in Thac Ba Reservoir increased rapidly in 2006-2007 and then dropped slightly to 10-15 tonnes in 2007-2008 due to overfishing. Since 2009, annual yields have stabilised at around 20 tonnes due to new regulations imposed by the local fisheries authority to control catches (Nguyen *et al.*, 2011).

Research and technology transfers led to the high potential of cold water aquaculture being realised in highland areas of northern Viet Nam and the central plateau between 2002 and 2005 with introductions of sturgeon (*Acipenser* spp. and *Huso huso*) and rainbow trout (*Oncorhynchus*



Icefish (*Neosalanx tangkahkeii*) in Thac Ba Reservoir in Viet Nam

PHOTO: NGUYEN HAI SON



Rainbow trout (*Oncorhynchus mykiss*)

ILLUSTRATION: NGUYEN HAI SON

mykiss). Dinh (2008) found that sturgeon could be cultured in cages in many large and medium-sized reservoirs, which have suitable temperatures and areas. This species has created an industry that provides high-quality food to the domestic market and helps develop aquaculture in reservoirs that now produce more than 3,000 tonnes of sturgeon a year (Bui *et al.*, 2007).

Tilapia (*Oreochromis* spp.) has meanwhile continued to be introduced as the major species for cage culture in reservoirs. The Government of Viet Nam indicated in 2010 that tilapia would be the major species to supply raw material for export and domestic markets. Constraints include high feed costs and short culture duration, especially in northern Viet Nam.

Cooperatives emerge as new factor



Sturgeon species culture in Viet Nam

PHOTO: NGUYEN HAI SON

Over the past decade, culture-based fisheries have been developed in some small-sized reservoirs for enhancement purposes and supplying seed to neighbouring farmers. Nguyen (2006b) indicated that most small irrigation reservoirs are seen as appropriate for developing culture-based fisheries in Viet Nam. Such fisheries could therefore provide a means for producing cheap animal protein to meet the increasing demand for food in rural areas.

The species stocked in such reservoirs are mainly grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), big head carp (*Hypophthalmichthys nobilis*), mrigal (*Cirrhinus cirrhosus*) and silver barb (*Barbus gonionotus*). According to Nguyen *et al.* (2001, 2005), stocked species contribute more than 80 percent of total weight at harvest.

Most small irrigation reservoirs have been leased to farmers, groups of farmers or cooperatives for aquaculture. Bui *et al.* (2011) emphasised that most fisheries cooperatives with reservoirs for aquaculture consider cage culture and culture-based fisheries for development. Aquaculture is becoming a major source of income, with cage culture and culture-based fisheries in such reservoirs accounting for 15 to 30 percent of annual income. Recreational fishing by visitors has recently become a good additional source of income for local people.

Co-management of reservoir fisheries

Fisheries co-management (see Figure 5 below) has been implemented widely across Viet Nam with much support from international and non-governmental organisations as well as the central and local governments (Truong *et al.*, 2010, IFEP 2010, Le, 2009, Truong *et al.*, 2001). According to Le (2009), co-management can be classified into two major domains:

- production domains mainly concentrating on capture fisheries and resource conservation (inland and marine), aquaculture in all environments and sea conservation zones; and
- management domains focusing on co-management based on different models of associations, club or community groups and cooperatives.

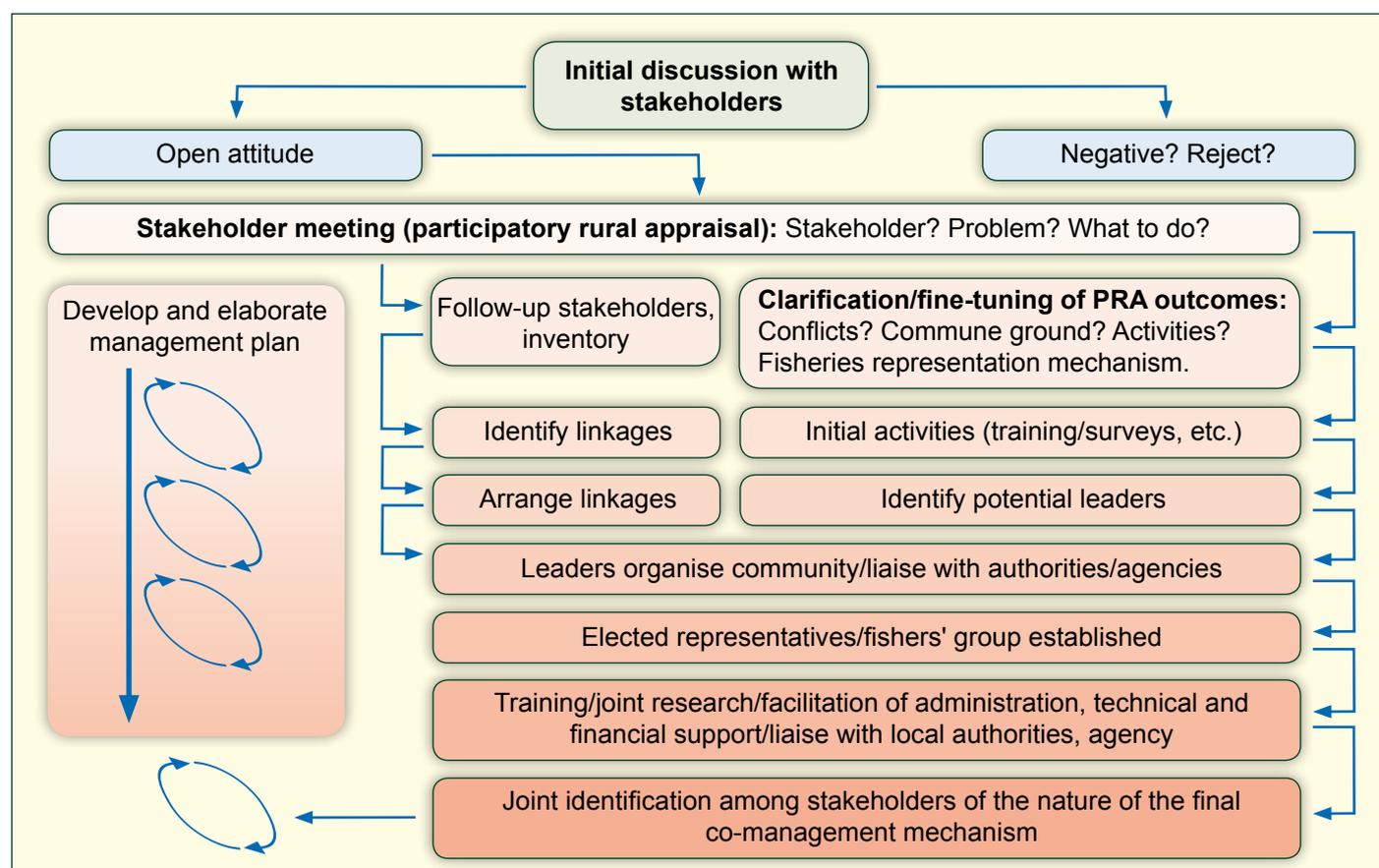
Truong *et al.* (2010) found that co-management does not take place without adequate support from local authorities and that establishing co-management activities depends entirely on

the attitudes of local stakeholders. Le (2009) mentioned that co-management was a new concept that faces implementation challenges in developing regulations and partnerships between the community, government and relevant stakeholders or between communities. Many models have not clarified the limits of water areas under their administrative management. Co-management, especially in reservoirs and inland waters, therefore needs support from both central and provincial governments for good models and legal documents (IFEP 2010, Le 2009, Phan *et al.*, 2009a, Truong *et al.*, 2010).

Government policies and future scenario

There is very little scientific literature available on the inland fishes and fisheries of Viet Nam, and even less so on rural areas. Many seminars and workshops have been organised to discuss development strategies (Nguyen, 2001, Nguyen *et al.*, 2001). But management strategies such as stocking (species, size and density), harvesting, cage culture and marketing are not being addressed in detail for reservoirs.

Figure 5: Fisheries co-management process in Central Plateau of Viet Nam



SOURCE: NGUYEN *AT EL.* 2000

The Government has conceded that reservoir fisheries should play an important role in increasing freshwater fish production to supply high-protein food and create job opportunities for poor and displaced people (Nguyen 2001, Nguyen *et al.*, 2001). According to the Master Aquaculture Plan approved in 2010, Viet Nam needs to develop aquaculture and fisheries in reservoirs and rivers while protecting resources to eliminate hunger and reduce poverty. So the development of aquaculture and fisheries in the period of 2011-2020 can be listed as:

- industrialised and modernised fisheries continuing to develop sustainably and becoming a mass-producing, efficient world-class industry;
- fisheries accounting for 30-35 percent of agricultural output, with production value increasing at an annual rate of 8-10 percent to reach \$8-\$9 billion and 6.5-7 million tonnes a year (of which aquaculture is 65-70 percent); and
- creating five million jobs with income three times higher than at present.

For the highland and rural areas of the north, central and central plateau, the strategies are:

- developing fisheries in reservoirs and rivers, together with protection and development of aquatic resources to eliminate hunger and reduce poverty;
- building and developing inland aquatic resource protection areas to protect, reproduce and develop indigenous species; and
- while recognising major species as traditional species of fish and shrimp as well as specialties such as turtle and frog, the Government will invest in developing species such as sturgeon and rainbow trout for the tourism industry and domestic markets.

Based on the strategies, there are some programmes and projects that the highland areas can join:

- tilapia culture development to 2020 in mountainous areas concentrated in cage

culture in reservoirs to create large quantities for export; and

- training in human resource development for the fisheries sector to 2020 with universities and high schools supplying training programs at different levels (master/university/high school/technical labourer/ farmer).

The Master Aquaculture Plan also mentions building activities and models for fisheries co-management for reservoirs and inland resource protection areas as well as mid and upstream areas of big rivers to:

- cooperate with institutions to introduce high-value indigenous species and protect aquatic resources;
- transfer aquaculture technology on indigenous and cold-water species to increase the value of using land and water in the mid-highland areas;
- build models for fisheries and aquaculture cooperatives in reservoirs; and
- build fishing-control forces for large-sized reservoirs, aquatic resource protection areas, and mid and upstream areas of big rivers.

With these strategies, fisheries and aquaculture in lakes and reservoirs in Viet Nam can hopefully be improved in the new period of development.

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Exotic species in southern Viet Nam

BY VU VI AN, DOAN VAN TIEN, NGOR PENG BUN, NGUYEN HAI SON AND SO NAM *

In a preliminary assessment, the Vietnamese Ministry of Agriculture and Rural Development starts classifying introduced species

Introducing exotic fish species is an important way of increasing fisheries production and economic output in Viet Nam. Good examples are silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idella*) from China and rohu (*Labeo rohia*), migral carp (*Cirrhinus cirrhosis*) and catla (*Catla catla*) from India. These species have been introduced into most areas of the country. Since 1980, the introduction of non-native aquatic species in Viet Nam has been extensive and rapid, mainly due to the growth of aquaculture and stock enhancement in natural water bodies.

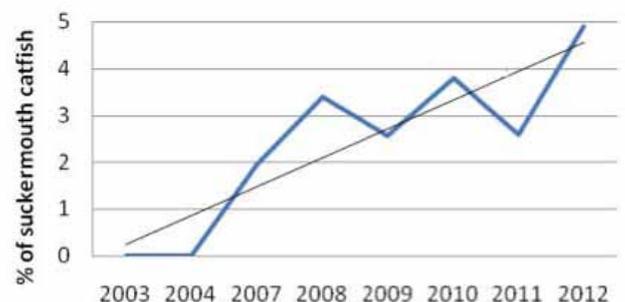
By 2002, an estimated 171 aquatic exotic species had been introduced into Viet Nam. These included 17 freshwater fishes, 10 brackish water fishes, 40 aquarium fishes, three freshwater prawns, five marine shrimps, four molluscs, four invertebrates, 14 freshwater phytoplankton species, 15 marine phytoplankton species and two marine zooplankton species (Pham, 2002). Le (2008) indicated that only 41 exotic aquatic animal species distributed throughout Viet Nam had been recently encountered. These included eight species from China, seven each from the United States and South America, six from Africa, three each from Europe and India, and one each from Cuba, Japan, Indonesia, Malaysia and Nepal. Some have become important species for aquaculture without any impact on the environment. Others, however, have proven to be invasive, becoming established and reproducing in the wild. Others disappeared because the environment was not suitable. Of the 41 species studied, nine were classified in a white list meaning no impact. Twenty-three were put on a grey list indicating potential impact and nine were placed on a black list for invasive species with severe impact. For southern Vietnam alone, the Ministry of Agriculture and Rural Development has recently identified at least 18 species of exotic aquatic animals (see table opposite).

Suckermouth catfish (*Pterygoplichthys disjunctivus*)

The species is widespread, very common and now considered one of the most invasive species in the Mekong Delta. It is increasingly abundant and its impacts on aquatic ecosystems are becoming more obvious. In An Giang province, for example, three fishers involved in monitoring fish catches for the MRC Fisheries Programme report that catches of suckermouth catfish are showing an increasing trend (see chart below).

Proportion in catches

Data based on three fishers supported by MRC Fisheries Programme to record daily catches in An Giang province between 2003 and 2004 and between 2007 and 2012.



The proportion in brush-park catches can be much higher than other fishing gear. For example, two years of monitoring catches from a the same brush park in Dong Thap province showed that suckermouth catfish made up of 23.4 percent of the total catch (17.6 – 27.4 percent) (Khanh and Vinh, 2005). In the flood season, the species accounts for about 25 percent of catches with fyke nets (see photo on page 20).

The suckermouth catfish occurs accidentally in almost every farming pond in the Mekong Delta, with farmers harvesting from several to hundreds of individuals from their ponds. One pangasiid farmer in An Giang province stated that nearly 400 kg of suckermouth catfish were harvested from a pond of 1,200 square metres (Vinh, 2003). Local people consume the species as fish paste, boiled or steamed with herbs, grilled, fried or as feed for

Eighteen exotic species in southern Viet Nam

No	Common name	Feeding type	Reproduction in natural water bodies
1	Suckermouth catfish <i>Pterygoplichthys disjunctivus</i>	Omnivorous	Yes
2	Peacock bass <i>Cichla ocellatus</i>	Carnivorous/ Omnivorous	Yes
3	Apple snail (mollusc) <i>Pomacea canaliculata</i>	Aquatic plants	Yes
4	African catfish <i>Clarias gariepinus</i>	Omnivorous	Yes
5	Red-eared slider (turtle) <i>Trachemys scripta elegans</i>	-	Yes
6	Red swamp crayfish (crustacean) <i>Procambarus clarkii</i>	-	Unknown
7	Pirapatinga (Red bellied pacu) <i>Piaractus brachypomus</i>	Omnivorous	Yes
8	Tilapia <i>Oreochromis spp.</i>	Omnivorous	Yes
9	Mosquito fish <i>Gambusia affinis</i>	Omnivorous	Yes
10	Catla <i>Catla catla</i>	Omnivorous	Yes
11	Common carp <i>Cyprinus carpio</i>	Omnivorous	Yes
12	Silver carp <i>Hypophthalmichthys molitrix</i>	Herbivorous/Omnivorous	Unknown
13	Bighead carp <i>Hypophthalmichthys nobilis</i>	Omnivorous	Unknown
14	Mrigal <i>Cirrhinus mrigala</i>	Omnivorous	Unknown
15	Rohu <i>Labeo rohita</i>	Herbivorous	Unknown
16	Kissing gourami <i>Helostoma temminckii</i>	Omnivorous	Yes
17	Giant gourami <i>Osphronemus goramy</i>	Omnivorous	Yes
18	Grass carp <i>Ctenopharyngodon idellus</i>	Herbivorous	Unknown

SOURCE: MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT



A typical fyke-net catch in the flood season. The suckermouth catfish (black and white) makes up of about 25 percent of the total catch.

PHOTO: VU VI AN

aquaculture or livestock. The species is also sold cheaply in some local markets but it is not popular due to its very hard skin and scales. Some fishers and farmers discard the fish which can survive for a day out of water.

The species has become quite well established in almost all habitats in the Mekong Delta. It feeds mainly on detritus and algae and can spawn at 150 grams, producing more than 8,000 eggs). The species is very tolerant of severe environments such as low dissolved oxygen, pollution and limited food (Khanh and Vinh, 2005). Local farmers and fishers say the fish often burrows in

river and pond banks for reproduction, destroying banks and paddy fields. In summary, the high population density and feeding behaviour of the species causes negative impacts on aquatic ecosystems by competing with indigenous species for food and habitats, disrupting aquatic food chains, changing aquatic plant communities and eroding banks.

Peacock bass (*Cichla ocellatus*)

This species is distributed in Tri An Reservoir in Dong Nai province but not in the Mekong Delta. It was first introduced accidentally through ornamental fish culture in 1996 and is now widespread in the reservoir. The species is carnivorous, fast swimming and feeds mainly on shrimp, fish and even themselves (see photo next page). The biggest specimen recorded was 1.1 kg. Fecundity has been reported at 14,999 eggs/kg (An *et al.*, 2009).

Daily monitoring for almost two years showed that peacock bass made up 7 – 9 percent of total fish landings. This is a high-value species, with fillet comprising 44 percent of the total weight, and is consumed by local people. Fishers have blamed overfishing and illegal fishing gear for decreases in daily catches. Seven percent of fishers believe



Peacock bass caught in 2009

PHOTO: VU VI AN



Peacock bass fingerling in the stomach of a peacock bass adult

PHOTO: VU VI AN

that the decrease in catch and number of species in the reservoir is caused by peacock bass as a predator (An *et al.*, 2009). The species is colourful and voracious, making it of interest to anglers. The reservoir's management board and the local government should invest in recreational fishing facilities to control the population as much as possible.

Apple snail (*Pomacea canaliculata*)

The apple snail is widespread in the whole Mekong Delta at very high densities. It can mature and reproduce after three to four months and has multiple spawning, allowing the population to increase rapidly. The snail provides food and employment for local people and is also used as feed for farmed fish and livestock such as ducks and pigs. However, it is considered a pest by rice farmers in Viet Nam and other countries as it eats germinating rice seeds, leading to massive damage. A farmer in Can Tho province estimated that a single snail could destroy two - three square metres of rice seed area in 24 hours. Farmers use pesticides and chemicals to get rid of the snail, which reduces profits from farming and has negative impacts on the environment including aquatic animals. Impacts on native snail species in terms of competing for food and habitat as well as hybridisation are a potential concern.

Red-eared slider (*Trachemys scripta elegans*)

The red-eared slider was imported into the



Apple snail

PHOTO: VU VI AN



Red-eared slider

ILLUSTRATION: MAXIMILIAN ZU WIED-NEUWIED

Mekong Delta for aquaculture and now occurs in the wild. Local people are accustomed to releasing the turtle into the wild after praying for good luck at temples. The species has competitive advantages over indigenous turtle species due to lower age at maturity and higher fecundity. The turtle consumes aquatic animals and plants including lotuses in ponds next to temples in the Mekong Delta. Disease transmission is a concern — the red-eared slider is known to carry nematodes, leading to high risk of parasite transmission to native species.

Pirapatinga
(*Piaractus brachypomus*)

Pirapatinga, also known as red-bellied pacu, is a cultured species that was accidentally released into the wild in the Mekong Delta. It has become more abundant in recent years. Several fishers have recorded low percentages of pirapatinga in their catches. One, who fishes for large fish (average about 400 grams) with large-mesh nets in the mainstream about 60 km from the sea, reported that the species accounted for 11.7 percent of the catch (FEVM, 2012). The species is carnivorous and has sharp teeth, particularly the large specimens. While swimming in the river, three people in Dong Thap province were recently

attacked by unknown species believed to be the pirapatinga (Tai, 2012).

Tilapia
(*Oreochromis spp.*)

Tilapia had become a popular fish for aquaculture in Lower Mekong Basin countries. It is well established in natural water bodies throughout the Mekong Basin (Hortle *et al.*, 2011). The presence of tilapia in the wild is attributed to escapees from farms and stock enhancement in some water

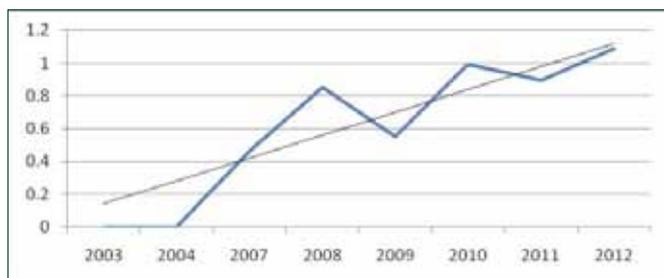


Pirapatinga caught in southern Viet Nam

PHOTO: VU VI AN

Proportion in catches

Data based on three fishers supported by MRC Fisheries Programme to record daily catches in An Giang Province between 2003 and 2004 and between 2007 and 2012.



bodies. Fishers in An Giang province report an increasing trend of tilapia in their catches.

In addition to the Chinese and Indian carps mentioned above, other exotic species that are common, popular and important in aquaculture in the Mekong Delta include the North African catfish (*Clarias gariepinus*), the common carp (*Cyprinus carpio*), the kissing gourami (*Helostoma temminckii*) and the giant gourami (*Osphronemus goramy*). Rainbow trout (*Oncorhynchus mykiss*) and sturgeon (*Acipenser* spp.) were first introduced into northern Viet Nam and then into Lam Dong province in the Central Highlands (see page 24). Pilot studies succeeded in inducing artificial reproduction which will contribute to aquaculture development in cold-water areas (Trung *et al.*, 2009).

In general, the introduction of new species, especially high-value species, is important to diversify aquaculture. Before decisions on introductions are made, however, the Government should review and assess the impacts with universities and research institutes to prevent the sorts of adverse consequences to natural ecosystems and indigenous species that the apple snail has caused in the Mekong Delta. A coordinating body should be established and action plans prepared and implemented at national and regional levels to prevent the introduction of invasive species and manage those that have been already introduced.

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Tilapia

PHOTO: VU VI AN

programme officer at the MRC Fisheries Programme. Dr So Nam is coordinator of the programme.

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Sturgeon brings economic benefits to untapped water resources in Viet Nam

BY TRAN DINH LUAN *

Viet Nam introduced Siberian sturgeon into cold-water areas in 2005. Four species are being farmed today, making the country one of the world's top ten producers of these valuable cold-water fishes.

Sturgeons are high-value species, especially their roe which is made into caviar. They have been introduced into aquaculture in Viet Nam since 2005 and have become a major cultured fish in the highland and mountainous areas. With the development of sturgeon aquaculture in the cold-water areas of the north, north-central and central highland provinces across the country, Viet Nam has made its way into the top ten of sturgeon producers in the world along with China, Russia, Italy, Bulgaria, Iran, United States, France, Poland and Germany, according to FAO.

There are four sturgeon species cultured in Viet Nam i.e. Siberian sturgeon (*Acipenser baeri*), beluga (*Huso huso*), Russian sturgeon (*A. gueldenstaedtii*) and sterlet (*A. ruthenus*). Siberian sturgeon is the most popular. Chinese sturgeon (*A. sinensis*) was also introduced into Viet Nam a few years ago but has not been as successful as Siberian sturgeon or the others because of its slow growth rate.

Beluga is the species with the fastest growing rate in Viet Nam. The fish can attain 1.9 – 3.2 kilograms in the first year, 4.7 – 6.9 kilograms in the second year and 7.0 – 10.2 kilograms in the third. However, this species has very late maturation (10 – 15 years of age). Russian sturgeon weighs about 1.2 – 2.2 kilograms in the first year, 2.4 – 3.8 kilograms in second year



Soviet and Iranian fisheries long dominated world landings of the 25 species in the sturgeon family (Acipenseridae). According to the Food and Agriculture Organisation, the global catch—mostly from the Caspian Sea—peaked at 32,078 tonnes in 1977 and had collapsed to 2,658 tonnes by 2000. By this stage, countries such as Russia, Italy, Poland, Spain France and Uruguay had emerged as major players in farming these threatened species. FAO figures show that the combined Russian and Italian production alone in 2000 was almost as much as the diminished global catch.

and 4.0 – 6.5 kilograms in the third. As for caviar quality, it ranks second only to beluga. In farm conditions, Russian sturgeon has early maturity (3-4 years of age).

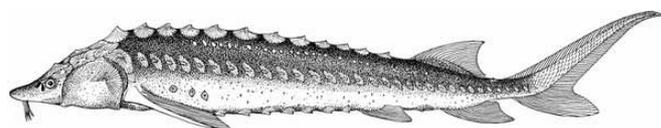
Siberian sturgeon grows as fast as Russian sturgeon or even a little bit faster. There is no difference in the value of meat and caviar between these two species, but the maturity age of Siberian sturgeon is about 1-2 years later than Russian sturgeon. Sterlet has a slow growth rate and small size compared to three above species.

Siberian sturgeon was the first species introduced into Viet Nam from Russia by the Research Institute for Aquaculture No. 1 (RIA-1). The fertilised eggs were hatched and reared successfully in many areas such as Sa Pa (Lao Cai province), Na Hang (Tuyen Quang province), Thac Ba Reservoir (Yen Bai province), Da Lat (Lam Dong province) and Da Mi Reservoir (Binh Thuan province).

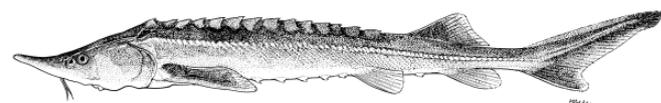
In 2007, the Ha Quang Company cooperated with experts from Russia to carry out trials on egg hatching and grow-out of Siberian sturgeons, Russian sturgeons, and sterlets in Tuyen Lam Lake (Da Lat, Lam Dong province). In 2008, the Viet Nam Sturgeon Company applied the new technology to culture the four species in Da Mi Reservoir (Binh Thuan province). Surprisingly, more than 20,000 Siberian sturgeons, Russian sturgeons, and sterlets grew well at 30.5 degrees water temperature during the summer of 2008. The Viet Nam Sturgeon Company is estimated to have produced about 300 tonnes of the fish in 2009 and 800-1,000 tonnes in 2010. The company is also looking to produce caviar for export to



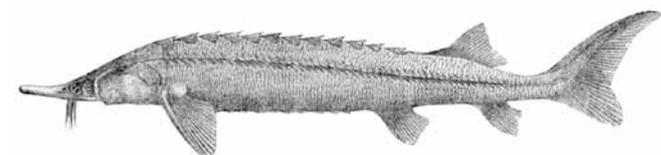
Beluga (*Huso huso*)



Russian sturgeon (*Acipenser gueldenstaedtii*)



Siberian sturgeon (*Acipenser baerii*)



Sterlet (*Acipenser ruthenus*)

markets such as Japan, the United States and Russia in the next few years.

Another private company, the Northern Sturgeon Joint Stock Company (Yen Bai province), has built a sturgeon nursery in Van Chan district and grown Siberian and Russian sturgeons in Thac Bac Reservoir. The model has so far yielded thousands of fingerlings and raised seven cages of sturgeon with a value of VND 1 billion (\$50,000) each. The company produced 200-300 tonnes in 2010, and selected about 1,000 broodstock for artificial propagation.

Sturgeons introduced into Viet Nam

Species	Distribution	Maximum size	Status
Beluga (<i>Huso huso</i>)	Black, Azov, Caspian (more numerous) and Adriatic (very rare) Seas	6.0 m	Critically endangered
Chinese sturgeon (<i>Acipenser sinensis</i>)	Yangtze (mainstream) and Pearl Rivers, East and South China Seas	0.4 m	Critically endangered
Russian sturgeon (<i>Acipenser gueldenstaedtii</i>)	Caspian, Black and Azov Seas and rivers that empty into them	3.0 m	Critically endangered
Siberian sturgeon (<i>Acipenser baerii</i>)	Main Siberian rivers from Ob to Kolyma, Lake Baikal, Pechora River	2.0 m	Endangered
Sterlet (<i>Acipenser ruthenus</i>)	Rivers flowing into Caspian, Black, Azov, Baltic, White, Barents and Kara Seas	0.1 m	Vulnerable

Source: Food and Agriculture Organization, International Union for the Conservation of Nature

The private sector has mainly contributed to sturgeon aquaculture development in Viet Nam. Many other private companies such as Giang Ly Company (Lam Dong province), Thien Ha Company (Lao Cai province) and Chu Va Hydropower Company have also invested in this business but on a smaller scale.

“Sturgeons cultured in Viet Nam grow 1.5-2 times faster than in their countries of origin”

There are many sturgeon farming systems in Viet Nam such as tanks, ponds and cages. The local temperatures range between 16 and 18 degrees. As a result, sturgeons cultured in Viet Nam grow 1.5-2 times faster than in their countries of origin. They also have lower feed conversion ratios (FCR) and shorter farming periods and thus reduced labour costs. Therefore, Viet Nam’s sturgeon can

compete with products from the temperate zone. The fish productivity has significantly increased in the last five years, from 7-10 kilograms per cubic metre at the beginning to 20-30 kilograms today thanks to improved farming systems and technologies.

The Research Institute for Aquaculture No. 3 (RIA-3) has completed a study on the technical procedure for intensive grow-out of sturgeon in recirculation systems. This yields about 61.67 kilograms of sturgeon per cubic metre with a 95.7 percent survival rate, FCR of 1.036 and average daily growth of 8.46 grams. These results are higher than cage culture, which yields 33.72 kilograms per cubic metre at a survival rate of 88.7 percent with FCR of 1.033 and average daily growth of 7.86 grams. The technology dissemination is expected to help promote sturgeon farming and form a caviar industry in Viet Nam.



Sturgeon cage operated by Viet Nam Sturgeon Company

PHOTO: VIET NAM STURGEON COMPANY



Phu Ninh Lake in Quang Nam province

PHOTO: VIET TRINH QUOC

Seed production

Sturgeon-fertilised eggs are imported from Russia, Germany and Ukraine for seed production in Viet Nam. RIA-1 successfully incubated the first batch of Siberian sturgeon eggs imported from Russia with a hatching rate of 70 percent in Lao Cai province in 2005.

At the beginning, about 10 percent of the fry survived until fingerlings and only 20 percent of the juveniles were qualified. However, the mortality rate has been reduced through good management and improved feeding in the nursing phase. Today, the survival rate is more than 80 percent from egg incubation until juveniles.

Fry of Russian sturgeon, beluga and sterlet have also been produced from imported fertilised eggs. Now, RIA-1, RIA-3 and some private companies in the north and Central Highlands such as Viet Nam Sturgeon Company, Northern Sturgeon Joint Stock Company and Viet-Germany Company, are major suppliers of sturgeon juveniles. These organisations have gradually constructed their research stations, built hatcheries and carried out

broodstock grow-out and artificial seed production programmes.

Sturgeon seed production has been studied in recent years. RIA-1 was the first to use sturgeon broodstock cultured since 2005 for this purpose. This institute also studied feeds for different phases of sturgeon broodstock development in the environmental conditions of Viet Nam. The initial results showed that a lot of females had eggs stage III from the fourth year and the quality got better in the fifth year. From October, 2009 to January, 2010, the eggs reached stage IV with a diameter of about 2.5-3.0 mm. The evaluation of the maturity of fish eggs by Polarization Index method showed 75 percent of sturgeon females having eggs with PI of less than 0.1. The maturity ratio ranged from about 10 to 13 percent. Besides, there was quite a high percentage of females having eggs stage III.

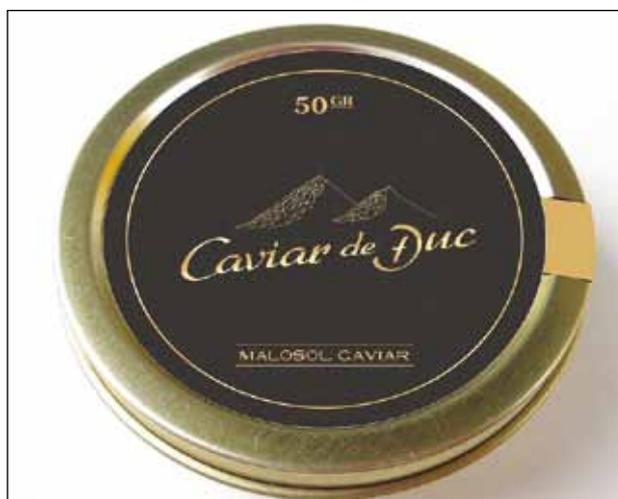
These results show that there are some reproduction differences between Siberian sturgeon in Viet Nam and those cultured in the temperate countries. For example, Viet Nam's

sturgeon females reach maturity at 5 years of age with a rate of 10 percent while in temperate countries it is more than 6 years. Besides, Russian researchers have found that in temperate countries the fish mature and spawn in spring, from February to April, at water temperatures of 13-16 degrees, and from January to May at 9-22 degrees. But in Viet Nam, Siberian sturgeon can deliver eggs in both spring (January-March) and the autumn (October-December).

RIA-3 has cooperated with scientists from the Russian Southern Academy of Sciences to carry out research on Siberian and Russian sturgeon grow-out and seed production in the Central Highlands of Viet Nam. The project has achieved some very good initial results. Some private companies such as Northern Sturgeon Joint Stock Company, Viet Nam Sturgeon Company and Viet Nam Caviar Production Company are progressively constructing their own hatcheries and growing broodstock of different sturgeon species. These enterprises have made good achievements in trial culture of sterlet or Russian sturgeon for caviar over the last six years. Recently, the Northern Sturgeon Joint Stock Company has also worked with RIA-1 to study Siberian sturgeon reproduction in local conditions.

“The juvenile supply still depends on fertilised eggs imported from foreign countries”

Sturgeon culture has developed very fast in



Vietnamese caviar marketed by Viet Nam Sturgeon Company

PHOTOS: VIET NAM STURGEON COMPANY



Vietnamese sturgeon competes with inferior quality sturgeon illegally imported from China

both scale and quantity over the last few years. However, the juvenile supply still depends on fertilised eggs imported from foreign countries. Demand for sturgeon juveniles in 2009 reached approximately 500,000 in the Central Highlands, 50,000-70,000 in the north and predictably 2-3 million for the next 5-10 years.

Sturgeon seed production activity in Viet Nam is now facing some difficulties. First, the time of sex determination is not yet defined and further study is needed in this field. Second, there are no completed broodstock grow-out procedures for each species. Finally, the specific feed formulas for each stage of sturgeon development in local conditions have not been developed.

Grow-out

Sturgeon is a cold-water species but tolerates a wider range of temperatures than rainbow trout





Sturgeon can now be found in Vietnamese markets

PHOTO: SAI GON GIAI PHONG

— another exotic species successfully introduced into aquaculture in Viet Nam at the same time as sturgeon (see pages 14 and 23). Therefore, the sturgeon farming area is likely to expand. However, there have been no state plans for species culture, supporting logistics, post-harvest preservation or marketing services.

Locally-cultured sturgeon has been popular in the domestic market, especially tourist destinations as well as supermarkets, hotels and restaurants in the big cities of Ha Noi, Hai Phong and Ho Chi Minh City and provinces such as Quang Ninh, Hai Duong, Bac Ninh and Bac Giang. They are sold live, fresh, chilled and frozen whole or in chunks. The prices for live fish range from VND 200,000 to 300,000 (\$10-15) per kilogram. However, Viet Nam's sturgeon is competing with a huge volume of inferior quality sturgeon illegally imported from China.

“Imported pellet is the main feed for sturgeon cultured in Viet Nam although the use of locally- produced feed is on the increase”

Now, imported pellet is the main feed for sturgeon cultured in Viet Nam although the use of locally-produced feed is on the increase. Feed made in Viet Nam is found to have quite high moisture (>11 percent) that affects fish digestion and results in higher FCR compared with imported feed.

Although a lot of sturgeon have died in many farms over the years, the pathogen has not

been defined. It is necessary to strengthen the management and supervision of fish health in the farms to minimise the risks posed by the environment and climate changes.

“It is important that there is a detailed development plan for this business in Viet Nam”

Sturgeon culture in Viet Nam brings high value and illustrates a successful story on how untapped water resources can be used for economic benefits. Recently, Viet Nam has been ranked as the eighth producer of sturgeon in the world. It is important that there is a detailed development plan for this business in Viet Nam.

** Dr Luan is vice director of the Department of Animal Health at the Vietnamese Ministry of Agriculture and Rural Development. He was previously deputy director at the Research Institute for Aquaculture No. 1 in Bac Ninh province. This article is an edited version of the original published in Vietfish International in December last year.*



Vietnamese caviar marketed by Viet Nam Sturgeon Company

PHOTOS: VIET NAM STURGEON COMPANY

Researchers catch more than 125 species from experimental fishways on reservoir

Australian-Lao research project conducts new tests

Australian and Lao researchers caught more than 125 migrating fish species from a series of experimental fishways on the Pak Peung Reservoir in the central Lao province of Bolikamxay during last year's wet season. The team has also completed assessments of vertical slot, rock ramp, cone and submerged orifice fishway designs under an Australian-Lao project recently extended for five years (see *Catch and Culture*, Vol 18, No 1).

Douangkham Singhanouvong, deputy director of the Living Aquatic Resource Research Center (LARReC) in Vientiane, said researchers used

traps above and below the fishways to catch more than 40,000 fish during the experiments. Speaking at a fisheries technical symposium in Pakse in February, he said Mekong species accounted for 69 percent of the catch and the biggest trap catch. The biggest trap catch was more than 50 kg.

“Fish passage development is one way to increase wild fish populations”

The most common species caught was *Parambassis siamensis* from the Asiatic glassfish family. Overall, however, most of the catch comprised carps, notably the silver barb (*Barbonymus gonionotus*) and the rosefin rasbora



The cone fishway under construction in Pak San district

PHOTO: DOUANGKHAM SINGHANOUVONG



Researchers retrieving a trap from the completed fishway in Pak San district

PHOTO: DOUANGKHAM SINGHANOUVONG

(*Rasbora dusonensis*). The most common fishes caught after the carps were species from the loach, gourami and bagrid catfish families (see table).

Mr Douangkham said the results of the experiments would be used in future fishway design as well as community fishery management and other extension work. He noted, however, that Lao experiments were so far limited to low-gradient fishways specifically designed for wetland regulators and that other suitable fishways needed to be studied, particularly in northern and southern Lao PDR.

"Increased development of water resources may affect fish migration and reduce wild fish populations in the future," the LARReC deputy director told the symposium. "Fish passage development is one way to increase wild fish populations and a form of sustainable management of natural resources."

Experimental fishway catch

Carps (Cyprinidae)
Loaches (Cobitidae)
Gouramies (Osphronemidae)
Bagrid catfishes (Bagridae)
Spiny eels (Mastacembelidae)
River loaches (Balitoridae)
Puffers (Tetraodontidae)
Featherbacks (Notopteridae)
Asian leaf fishes (Nandidae)
Herrings (Clupeidae)
Stone loaches (Nemacheilidae)
Algae eaters (Gyrinocheilidae)
Sleepers (Eleotridae)
Freshwater tripletails (Datnioididae)
Cichlids (Cichlidae)
Needlefishes (Belonidae)
Chameleon fishes (Badidae)
Climbing gouramies (Anabantidae)
Asiatic glassfishes (Ambassidae)

Cambodia's *dai* (stationary trawl) fishery in the 2012-2013 season

BY CHHENG PHEN, SO NAM, NGOR PENG BUN AND NAO THUOK *

The 64 units of *dai* (stationary trawl nets) located along a 50-kilometre stretch of the Tonle Sap River upstream from Phnom Penh harvested 13,186 tonnes of fish with a first-sale value of \$5.5 million in the 2012-13 season. The latest catch was 5.2% higher than the average catch for the 17 fishing seasons from 1995-96 to 2011-12 (see chart). However, it was only about a quarter of the record catch in the previous season (see *Catch and Culture*, Vol 18, No 1).

Cyprinids (small mud carps) remained abundant in the latest season, but individual sizes of these species were observed to be smaller. The maximal flooding level of the Tonle Sap River for the latest season was 8.54 m which was 2.32 m lower than the previous season. Moreover, the reverse flow of the Tonle Sap Lake started 15 days earlier than usual. These factors are believed to have caused the sharp decline in the *dai* yield in the 2012-13 season. Trends of the *dai* fishery yield otherwise remain closely correlated with the maximal flooding level of the Tonle Sap

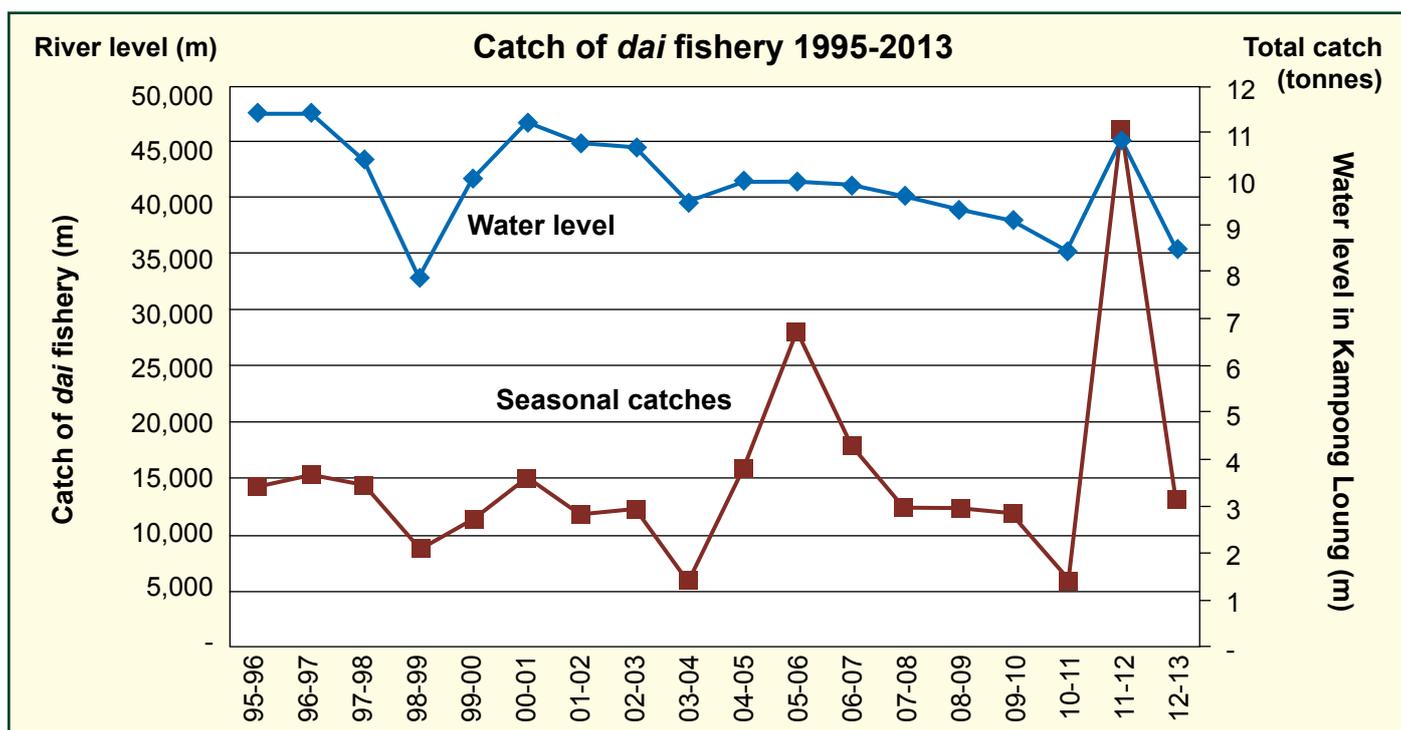


Prahoc making activity during the peak catch of *dai* in January at *dai* Row No 2 at Russey Keo in Phnom Penh. *Prahoc* is a Khmer traditional fish paste which is an ingredient for most Khmer traditional dishes.

PHOTO: NGOR PENG BUN

River (in Kampong Loung) for the past 19 years.

* Mr Chheng Phen is acting director of Cambodia's Inland Fisheries Research and Development Institute (IFReDI), Dr So Nam is coordinator of the MRC Fisheries Programme, Mr Ngor Peng Bun is the programme's capture fisheries and Dr Nao Thuok is director general of the Fisheries Administration of the Cambodian Ministry of Agriculture, Forestry and Fisheries





The *dai* stationary trawl fishery on the Tonle Sap River uses three types of nets. The U-shaped nets above with top ropes to maintain buoyancy are known as *yor* and are used in low-flow periods which sometimes occur between January and March. To haul the fish, the U-shaped net is dragged from the mouth to the cod end, the narrowest part of a tapered trawl net. Two other types, *dai chieu* and *dai nheuk*, are used in accordance with the changing hydrological conditions and sizes of migrating fishes. *Dai chieu* have large mesh-size nets targeting medium and large-sized fish species in October and November when the water velocity is strong. *Dai nheuk* have smaller mesh sizes targeting smaller species, especially in December and January.

PHOTO: NGOR PENG BUN



Fishers unloading a catch during a peak period in January from a *dai* unit, Row No 5, Khan Russey Keo, Phnom Penh

PHOTO: NGOR PENG BUN

Sap Kunthal



Ms Sap Kunthal

PHOTO: CHHUT CHHEANA

Sap Kunthal has been appointed Secretary of the Fisheries Programme at the MRC Secretariat in Phnom Penh. Ms Kunthal previously worked for nine years as administrative assistant and librarian for the Cambodia office of the Fisheries Programme, located at the Inland Fisheries Research and Development Institute (IFReDI) of the Cambodian Fisheries Administration. Before that, she worked for TWD Forwarders and Movers Co Ltd in Phnom Penh for three years. Ms Kunthal graduated from the National University of Management in Phnom Penh in 2006 with a Bachelor of Business Administration degree majoring in accounting.



Teeth of the pirapatinga (*Piaractus brachypomus*), a carnivorous species from the Amazon and Orinoco Basins in South America that has been introduced into the Lower Mekong Basin (see page 22). A Vietnamese newspaper reported last year that three people swimming in Dong Thap province had been attacked by an unknown species believed to be the pirapatinga. According to Fishbase, the fish has "powerful dentition that can cause serious bites." It was introduced from Brazil through Hong Kong and Taiwan to China in 1985, and from China to Viet Nam in 1999. The fish was also introduced from Thailand to Myanmar in 2002 and from Viet Nam to Cambodia in 2003.

PHOTO: US GEOLOGICAL SURVEY



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