

**IMPERILED GIANT FISH AND MAINSTREAM DAMS IN  
THE LOWER MEKONG BASIN: ASSESSMENT OF CURRENT  
STATUS, THREATS, AND MITIGATION**

**Report prepared by**

**Zeb Hogan, Ph.D.  
University of Nevada, Reno  
Reno, U.S.A.**

**Director, National Geographic Society Megafishes Project  
National Geographic Society Fellow  
United Nations Convention on Migratory Species Scientific Councilor for Fish**

**April 15 2011**

## **Executive Summary**

This report focuses on the impacts of the Xayaburi dam on five of the Mekong's largest fish and provides a short discussion about potential impacts to other threatened and migratory species. From a biodiversity and fisheries perspective, the environmental impact assessment (EIA) of the dam developer (Ch. Karnchang Public Company Limited) has a number of serious shortcomings. The field portion of the fisheries assessment was completed extremely quickly, relied on a very limited number of sampling techniques, and consisted of only 6 sampling locations spread over just 22 km of river. Given the high diversity of Mekong fish, the seasonality of catches, their migratory nature, and – in the case of threatened species – their rarity, the field survey methodology was grossly inadequate. The developer's EIA cannot be used to predict with any accuracy the serious impacts of the Xayaburi dam on threatened or migratory fish. All available evidence suggests the Xayaburi dam will have serious negative impacts on the migratory and imperiled fish of the lower Mekong River and may drive the Mekong's two largest freshwater fish species, the Mekong giant catfish and the giant pangasius catfish to extinction.

## **Introduction**

The Mekong River is one of the most biodiverse and productive rivers on Earth. The river is a global hotspot for freshwater fishes: almost 1000 species have been recorded from the Mekong, second only to the Amazon (Baran and Myschowoda 2009). The Mekong is also home to more species of giant freshwater fish than any river on Earth (Stone 2007). At least seven species of giant fish inhabit the Mekong, including the Critically Endangered Mekong giant catfish *Pangasianodon gigas*, the Critically Endangered giant pangasius *Pangasius sanitwongsei*, the Endangered seven-striped barb *Probarbus jullieni*, and the Endangered giant barb *Catlocarpio siamensis*. The Mekong River is also the most productive inland fishery in the world. The total harvest of approximately 2.5 million metric tons per year is valued at US\$3,600,000,000-6,500,000,000 dollars annually (Ferguson et al. 2011). Migratory fish make up an estimated 40-70% of the harvest (Barlow et al. 2008).

## **Background**

In September 2010 plans for a new mainstream Mekong dam, called the Xayaburi Dam after the Lao province where the dam will be located, were submitted for approval through a formal process facilitated by a regional body, the Mekong River Commission. An EIA of the Xayaburi dam was completed by the project developer in 2010 (Consulting and Engineering Management Co. 2010). The developer's EIA summarizes the existing environmental conditions, evaluates the environmental impact of the dam, and suggests measures to mitigate impacts.

From a biodiversity and fisheries perspective, the developer's EIA has a number of serious shortcomings. The field portion of the fisheries assessment was completed extremely quickly (3 days in the rainy season, 5 days in the dry season), relied on a very limited number of sampling techniques (gill netting) and consisted of only 6 sampling locations spread over just 22 km of river. Given the high diversity of Mekong fish, the seasonality of catches, their migratory nature, and – in the case of threatened species – their rarity, the methods used in the field survey were without question inadequate. For example, the survey failed to detect species that the report's own literature review states are among the most important fisheries species (catfish in the family Pangasiidae) and disregards the findings of prior, more robust research (Poulsen et al. 2000, Poulsen et al. 2004).

A recent critique of the fish and fisheries aspects of the developer's EIA found that “the description of the Mekong fish migrations in the EIA is very poor: the literature review consists of 3 references (whereas more than 28 studies on Mekong fish migrations were available), and the EIA mentions only 5 migratory fish from a list compiled in 1994. In contrast, ongoing research shows that 229 fish species exploit habitats upstream of the dam site for spawning and/or dry season refuge, 70 of them being migratory species” (Baran et al. 2011). The developer's EIA only covers an area of 22 km despite the fact that Mekong species have been shown to migrate over 700 km and probably migrate over greater distances (Hogan et al. 2007).

The developer's EIA also concludes that “none of the fish species found in the project area are considered rare or internationally endangered based on IUCN and CITES lists. For the Mekong giant catfish, it is also not found in the project area”. These conclusions are not justified given the extremely limited sampling conducted as part of the developer EIA. Baran et al. (2011) identified 19 threatened fish species that will likely be impacted by construction of the Xayaburi dam. At least three threatened giant fish species, including two of the world's largest (the Critically Endangered Mekong giant catfish and the Critically Endangered giant pangasius) almost certainly occur in the area and could be seriously impacted by the Xayaburi dam.

In that context, this report focuses on the possible impacts of the Xayaburi dam on five of the Mekong's largest fish – the imperiled giants of the Mekong - including the Critically Endangered Mekong giant catfish, the Critically Endangered giant pangasius, the Endangered seven-striped barb. This report also briefly discusses the Xayaburi dam's likely impacts on other threatened and migratory fish.

## **Results**

### Mekong giant catfish *Pangasianodon gigas*:

Distribution and ecology: The Mekong giant catfish, a Mekong endemic, is one of the largest freshwater fish in the world, reaching a maximum length of 300 cm and a total weight exceeding 300 kg (Smith 1945). Historically, Mekong giant

catfish occurred throughout the large rivers of the Mekong River Basin in Vietnam, Cambodia, Lao PDR, Thailand, and possibly Burma and southwestern China (Giles 1935). Due primarily to over-fishing, regular catch of the Mekong giant catfish now appears limited to small stretches of the Mekong and its tributaries in Cambodia, Lao PDR, and Thailand (Hogan *et al.* 2004). Fishermen report giant catfish occasionally (once every few years) in Neak Loeung, Kampong Cham, Kratie, Stung Treng, the Khone Falls, the Mun River, the Songkhram River, Luang Prabang, and Pak Beng. Based on catch data and genetic studies, it is likely that the Mekong giant catfish though extremely rare, remains widespread throughout the basin.

The only known spawning site for the Mekong giant catfish is located in the Mekong River upstream of Chiang Khong in northern Thailand. In northern Thailand and Lao PDR, *P. gigas* apparently spawns at the beginning of the rainy season in June. Mengumpun (2000) reports that giant catfish spawn in Chiang Rai Province in June. Young fish occur far downstream in the floodplains of the Songkhram River of Thailand and the Tonle Sap Lake in Cambodia.

Population status: The Mekong giant catfish is listed as Critically Endangered by IUCN. The Mekong giant catfish is listed on CITES Appendix I and on Appendix I of the Convention on Migratory Species. Based on catch data from Thailand, Lao PDR, and Cambodia, populations of the Mekong giant catfish are declining rapidly. The total number of fish in the basin is believed to have decreased by over 90% over the past 50 years and this downward population trend continues today (Hogan *et al.* 2007).

Probable impacts of the Xayaburi dam: Based on catch records, genetic, and studies of other catfish in the family Pangasiidae, it appears likely that the Mekong giant catfish uses the stretch of river of the Xayaburi dam as a migration corridor (Hogan *et al.* 2004, Hogan *et al.* 2007, Na-Nakorn 2006). Adult fish likely pass this area on their migration from floodplain rearing areas to upstream spawning sites. There is a chance that the Mekong giant catfish spawns in this area. If the Xayaburi dam is built, it could alter Mekong flows and disrupt spawning cues, block spawning migrations, and slow downstream dispersal (increasing mortality of young fish). Mortality is likely if fish pass through dam turbines. Based on experiences in the upper Mekong and many other river basins, the cumulative impacts of the dam are a serious threat to a rare, large-bodied migratory species like the Mekong giant catfish. Impacts from the dam could conceivably cause the extinction of the species.

Mitigation measures: The Mekong giant catfish is migratory, needs specific cues to spawn, and cannot reproduce in reservoirs. This suggests that mitigation measures should include environmental flows, upstream fish passage for adult Mekong giant catfish, and downstream passage for young fish. As currently designed, the Xayaburi dam will be an essentially impassable barrier to large-bodied fish (ICEM 2010). Given the extremely large size of the Mekong giant catfish and other Mekong species the mitigation measures approved in the official EIA will need to be re-worked and new mitigation measures developed to accommodate large, migratory catfish (and dozens of other migratory fish in the

area). Mitigation measures must be based on a better understanding of the migratory fish in the area and developed before dam construction. Recent studies suggest that such mitigation measures may not exist and will require large scale investment in new technology (Dugan et al. 2010).

Giant pangasius *Pangasius sanitwongsei*:

Distribution and ecology: The giant pangasius catfish, also known as the “dog-eating” catfish, is one of the largest freshwater fish on Earth, measuring up to 3 meters and 300 kilograms. It once occurred in both the Chao Phraya and Mekong rivers, but wild self-sustaining populations are now limited to the Mekong. The giant pangasius catfish is a main river species. Adults seem to favor the deep pool areas of Chiang Saen, Chiang Khong, Loei, Xayaburi, Stung Treng, and Kratie while the young are widespread in the main channel especially along the Thai-Lao border and in Cambodia downstream of Kratie. Spawning occurs in April and May. Poulsen et al. (2004) reports that the population may be divided into two breeding groups, one distributed from Chau Doc, Vietnam to the Khone Falls in Laos and the other distributed along the Thai-Lao Mekong from Nakorn Phanom to Chiang Saen. Giant pangasius is carnivorous, feeding on fish, shrimp, and crabs. Giant pangasius may also scavenge and there are various reports of large adults feeding on dogs.

Population status: The giant pangasius is listed as Critically Endangered by IUCN. Due to decline in harvest and shrinking distribution, some Thai fishers believe that the giant pangasius is now rarer than the Critically Endangered and closely related species Mekong giant catfish. Once a regular catch in the Chao Phraya and Mekong Rivers, the abundance of giant pangasius has declined steadily over the past several decades (Humphrey and Bain 1990). Wild self-sustaining populations of giant pangasius no longer occur in the Chao Phraya River, primarily due to dams and pollution (Na-Nakorn 2006, Hogan et al. 2009). Along the northern Thai Mekong River in Chiang Rai and Loei Provinces, fishermen report declining catch.

Probable impacts of the Xayaburi dam: The giant pangasius, like many fish species in the Mekong River, migrates between habitats, requires specific water quality and flow, and has a complex life history dependent on migration and seasonal floods. Mature fish migrate up the Mekong River and spawn in April and May at unknown spawning grounds. Adult fish occur in both Chiang Rai and Loei Provinces, Thailand and young fish occur along the Thai-Lao border from Nong Khai to Nakorn Phanom. This suggests not only that giant pangasius occur at the Xayaburi site, but that the Xayaburi site is within the migratory corridor and may be in the vicinity of a spawning area. More information is needed about the exact distribution and behavior of giant pangasius but it appears very likely that the Xayaburi dam site is critical habitat for the species. Construction of the dam could disrupt migratory behavior and spawning. Once the dam is built, it may alter water flows and cues to migration, block upstream spawning migrations, and slow downstream dispersal. Some mortality may also occur if fish pass through dam turbines. Based on experiences in the upper Mekong and many other river basins, the cumulative impacts of the dam are a serious threat

to a rare, large-bodied migratory species like the giant pangasius (Kang et al. 2009). Impacts from the dam could conceivably cause the extinction of the species unless a separate population exists in the Cambodian Mekong.

Mitigation measures: There is very little information available about the ecology or migratory behavior of giant pangasius. Evidence suggests that giant pangasius occurs in the area of the Xayaburi dam and uses the area as a migratory corridor, possible dry season refuge, and spawning ground. The status of the fish warrants extreme caution until the ecology, habitat, and population status of the fish is better understood. Study of adult fish and their spawning behavior is particularly important due to the lack of knowledge of migratory pathways and spawning habitat. In the absence of more detailed information about the life cycle of species, mitigation efforts should focus on maintenance of environmental flows to cue spawning, reduction of mortality of fish passing through the dam, and connectivity between what appear to be upstream spawning areas and downstream rearing grounds for young fish. Effective fish passage technologies do not exist for large-bodied Mekong catfish and will require significant upfront investment to develop appropriate technology.

Seven-striped barb *Probarbus jullieni*:

Distribution and ecology: The seven-striped barb occurred historically in Mekong, Chao Phraya and Meklong basins in Southeast Asia and the Pahang and Perak basins of Malaysia. Adult seven-striped barb appear to prefer main river habitats, whereas juveniles will enter floodplain habitats during the rainy season. The seven-striped barb is omnivorous, feeding on zooplankton, aquatic plants, fruits, invertebrates, mollusks, shrimp, and crabs (Poulsen et al. 2004). Age at maturity is unclear. Mattson et al. (2002) reports that mature males weigh 5-20kg; mature females weigh 10-50kg. In captivity, male broodstock mature at 2-7kg while female broodstock mature at 5-15kg (Mattson et al. 2002). The seven-striped barb spawns during the dry season between November and February (Poulsen et al. 2004). Several spawning sites have been identified within the Mekong River Basin including the Ou River in northern Lao PDR (Viravong 1996), Loei province in northeast Thailand, and Nam Lim in central Lao PDR. Young seven-striped barb move out of the Tonle Sap River and into the Mekong River in October and November (Hogan et al. 2006). Adult fish make upstream spawning migrations. One tagged seven-striped barb moved 135km upstream from the Tonle Sap River up the Mekong River (Hogan et al. 2006).

Population status: The seven-striped barb is listed as Endangered by IUCN. CITES Appendix I. Self-sustaining populations of seven-striped barb may no longer occur in the Chao Phraya or Meklong River Basins. In the Pahang River Basin of Malaysia, the seven-striped barb is either extirpated or extremely rare (Baird 2006). Populations have dropped significantly in the Perak River Basin due to hydropower development and subsequent changes in stream hydrology (Baird 2006). Baird (2006) states that the Mekong River supports the last relatively healthy population of seven-striped barb. As recently as 1989, the seven-striped barb was reported as "extremely abundant" in the Mekong, but

subsequent accounts indicate a significant drop in abundance since 1989 (Roberts and Warren 1994, Roberts and Baird 1995, Singhanouvong et al. 1996).

Probable impacts of the Xayaburi dam: Based on reports from Poulsen et al. 2004, Viravong 1996, and Baird 2006 the seven-striped barb occurs in the area that will be impacted by the Xayaburi dam. The seven-striped barb is a migratory species: adult fish migrate upstream to spawn. Fish also move into deep pools during the dry season. Large fish remain in deep pools during low water. Young fish enter floodplain habitats during the rainy season (Poulsen et al. 2004). The Xayaburi dam could impact spawning sites, upstream migration of adults, and downstream dispersal of young. Operation of the dam (variable flows) could also impact spawning triggers and dry season habitat. Depending on the exact location of the spawning sites of seven-striped barb and the distance the species migrates, the Xayaburi dam could impact seven-striped barb populations within several hundred kilometers of the dam site. Depending on the scale of migrations and location of spawning sites, the Xayaburi could cause the extirpation of the species over a fairly large (hundreds of kilometers) area and put the species on a steep trajectory of decline.

Mitigation measures: Mitigation measures should include environmental flows, upstream fish passage for adult Mekong giant catfish, and downstream passage for young fish. Several recent reviews suggest that the current plans for Xayaburi dam do not adequately address these issues (ICEM 2010, Baran et al. 2011).

Bagrid (goonch) catfish *Bagarius yarrelli*:

Distribution and ecology: The bagrid or “goonch” catfish *Bagarius yarrelli* is a large, predatory catfish that is widespread in Asia. In India, it occurs in the Indus, Ganges, and Brahmaputra river basins (Froese and Pauly 2010). In the Mekong, the goonch is found mainly in rapids of the main river and its largest tributaries. It can attain sizes over 2 m and 100 kg in the Mekong River, but large adults are extremely rare. The species is not thought to migrate long distances (Poulsen et al. 2004) but it does appear to migrate short distances in search of prey.

Population status: The goonch is listed as Near Threatened by IUCN. Based on available data, it appears that populations of the goonch in the Indus and Ganges drainages have declined significantly since 1980 (V. Badola, Otter Reserves, personal communication). Likewise, Sheikh et al. (1997) report that abundance of large-sized goonch has declined dramatically in certain sections of Brahmaputra. In the early 1980's, Sheikh et al. (1997) found goonch weighing up to 300 kg, but by the early 1990's, the size of fish had decreased significantly. During one month of monitoring along an approximately 100 km stretch of the Mekong River in northern Thailand (May 2006), the largest fish harvested by fishers weighed 30 kg (Hogan, unpublished data).

Probable impacts of the Xayaburi dam: While little is known about the ecology or life cycle of the goonch, evidence from other areas including China and India

suggest that populations have declined due to the impacts of dams (Kang et al. 2009, V. Badola, Otter Reserves, personal communication). As a large species the goonch is at high risk of localized extirpation and will likely be incrementally impacted if additional dams (other than Xayaburi) are constructed on the Mekong. The goonch will probably also be more susceptible to fishing pressure below dams, and mortality from turbines, as a result of dam construction.

Mitigation measures: The lack of empirical data on the goonch's life cycle makes the design of effective mitigation measures very difficult.

#### Giant wallago catfish *Wallago attu*:

Distribution and ecology: The wallago catfish is a large, predatory catfish, attaining lengths of up to 2.4 m (Pethiyagoda 1991). It occurs in freshwaters from Pakistan to Vietnam (Figure 4). The wallago catfish occurs throughout the Mekong basin. The wallago catfish is not thought to migrate long distances (Poulsen et al. 2004) although wallago catfish did migrate approximately 30 km upstream in a trial tagging study in the Thai Mekong in 2008 (Hogan unpublished data). As with many Mekong species, the ecology of wallago catfish is not well understood.

Population status: The IUCN lists *W. attu* as Near Threatened. Due to these threats and declining abundance, the species is considered endangered in India (Sarkar et al. 2008). In the Cambodian Mekong, fishers reported a decline in abundance of 58% since 1980 (Hogan, unpublished data).

Probable impacts of the Xayaburi dam: The impacts of Xayaburi dam on wallago catfish are unclear. On one hand, the species is said to adapt well to impoundments (Poulsen et al. 2004). On the other hand, it has disappeared from many areas that have been heavily impacted by dams. Wallago catfish may be impacted if populations of prey species decline as a result of the dam.

Mitigation measures: Since wallago catfish is said to adapt well to impoundments, a species specific mitigation plan may not be necessary for *W. attu*. Reference to studies in India and Pakistan may be useful for more information.

## **Discussion**

The Xayaburi Dam will block the Mekong mainstream and therefore act as an impassable barrier to endangered, large-bodied fish. Existing technologies are thought to be incapable of mitigating these impacts. Developing new technologies, if possible at all, will be costly and require extensive further research.

At least five species of giant fish occur in the vicinity of the Xayaburi site and the three largest and most endangered, the Mekong giant catfish, giant pangasius, and seven-striped barb will suffer the most serious consequences if the dam is built. The Xayaburi dam will also directly impact several other fish species,



including several species of highly migratory and commercially important catfish and many additional IUCN Red List threatened species.

Pangasiid catfish, recognized as one of the most important fish groups in the Xayaburi region (and the Mekong River basin as a whole), are well known for long distance migrations, moving extensively between Vietnam, Cambodia, Lao PDR, and Thailand (Hogan et al. 2007). These catfish are particularly vulnerable to threats from dams because of their migratory behavior, requirements for specific water quality and flow, and complex life history dependent on the seasonal floods (Mekong River Commission 1992; Roberts 1993; Hill and Hill 1994). Pangasiid catfish may be capable of migrations between the Mekong delta and the Xayaburi site, meaning the impacts of the Xayaburi dam could be felt over a very large area from northern Thailand, to northeastern Thailand, southern Laos, Cambodia, and Vietnam. The official EIA ignores these transboundary impacts.

Baran et al. (2011) identifies a further 19 species of endangered species that could be impacted by the dam. These endangered species are especially vulnerable to the impacts of the dam since they have been previously identified as being at elevated risk of extinction. Any additional negative impacts will exacerbate their already perilous situation.

## **Recommendations**

The author of this report agrees with the recommendations of the MRC Strategic Environmental Assessment that construction of mainstream dams should be postponed until the impact of mainstream dams can be mitigated in some meaningful way. As currently designed, the Xayaburi dam could cause the extinction of several species of fish and irreparable damage to Mekong fisheries. The developer's EIA is grossly inadequate and does not accurately describe the true environmental cost of the Xayaburi dam.

Recent reviews of the impacts of the Xayaburi dam provide many recommendations for improvement of dam design and operation (ICEM 2010, Baran et al 2011). In the context of the Mekong's poorly studied giant fish, there are several basic actions that would improve the chances of these species' persistence:

- Rigorous environmental impact assessment of large-scale mainstream projects on the Mekong: Several studies have shown that mainstream dams will seriously impact fisheries (Kang et al. 2009, Ferguson et al. 2011, Baran and Myschowoda 2009). Without well planned fish passage/ladders, appropriate environmental flows, and better information on fish ecology, the Xayaburi dams' impacts will be very difficult to prevent (Dugan et al. 2010). These realities are not captured in the current EIA (Consulting and Engineering Management Co. 2010). A new environmental impact assessment is necessary that fully addresses the impact of the Xayaburi dam on threatened and migratory fish. The risk of permanent damage to Mekong biodiversity and fisheries

production is too great, and the cost too high, to move forward based on inadequate information.

- Research (and decision making based on the best available information): Research on the ecology and conservation status of Mekong fish is urgently needed. The giant pangasius catfish is an excellent case in point: we know almost nothing about its ecology or conservation status and yet it is undoubtedly one of the largest, rarest, and most vulnerable fish in all of SE Asia. It is very difficult to mitigate threats like those posed by Xayaburi dam without detailed information on the ecology of Mekong fish.
- Maintenance of connectivity between spawning grounds and rearing habitat: Many species of Mekong fish have complex life cycles that involve long distance migrations. Migratory fish represent 40-70% of the Mekong's freshwater fish production (Barlow et al 2008). Maintenance of migratory pathways is crucial.
- Management of the river for environmental flows: Both fish and fisherfolk rely on the natural dry season / rainy season cycle of the Mekong. Flows often cue fish to migrate or spawn and the high flows of the rainy season open up vast habitats for feeding fish. Likewise local people have invented all manners of ingenious ways of catching fish and most of these methods are adapted to a specific site, flow and time of year. Changes to the natural flow of the river, especially artificial fluctuations in flow, low floods, shorter floods, or late floods, will decrease fish catch (Baran and Myschowoda 2009).

## **Conclusions**

The Xayaburi dam is likely to have serious negative impacts on several species of large-bodied Mekong fish. It may drive the two largest and most imperiled – the Mekong giant catfish and giant pangasius – to extinction.

While the Mekong giants and other threatened species are some of the most vulnerable, they will not be the only Mekong species impacted by the Xayaburi dam. The dam, as currently designed, will block migrations, fragment river habitat, alter flow, reduce fisheries productivity, and alter upstream and downstream river conditions and habitat.

One look at the ecology of Mekong fish and there is reason to be seriously concerned. Over 100 species, including the Mekong giant catfish and most other important fisheries species, have complex life cycles involving long-distance migrations triggered by seasonal fluctuation of flows or the annual flood pulse.

Fisheries production is also dependent on the conditions found in a free flowing river. A recent Mekong River Commission study reports that the cumulative impacts of the planned dams in Lao PDR could disrupt the lifecycles of migratory fish, block access or destroy spawning grounds, and reduce catch by 270,000-600,000 metric tons.

The fisheries section of the official EIA of the Xayaburi dam is woefully inadequate: it is based on very little data, does not include any discussion of several threatened species (nor fully account for the dam's impact on threatened species) and does not provide mitigation measures that are likely to be effective for large-bodied migratory fish. These are all serious deficiencies since the long-term viability of vulnerable fish populations is dependent on the ability to minimize the impacts of any mainstream dams built on the lower Mekong River.

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