Conservation strategy for the Mekong giant catfish *Pangasianodon gigas*

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Preparation of this document

This conservation strategy has been developed by the Mekong Giant Catfish Working Group. The group met in a series of workshops from 2005 to 2007 in order to coordinate research activities, synthesize information, and develop this conservation strategy. Financial support from the Darwin Initiative, Mekong River Commission, UNDP/IUCN/MRC Mekong Wetlands Biodiversity Programme, Thai Department of Fisheries, and WWF International is gratefully acknowledged.

Executive summary

Species and importance: The Mekong giant catfish (MGC) *Pangasianodon gigas* is one of the world's largest freshwater fish. A charismatic animal revered throughout the lower Mekong region, the species is of great cultural importance. It is also widely recognized as an indicator of ecological integrity of the Mekong ecosystem, due to its long-distance migrations, size and longevity. Owing to its rarity, the species does not contribute significantly to the Mekong fisheries catch in biomass or value (but is highly sensitive to fishing). The species is herbivorous and unlikely to exert an important influence on ecosystem structure or functioning. The species is listed as critically endangered in the 2003 IUCN Red List.

Legal status: The species is protected by national law in Cambodia (where it must be released if caught in fisheries) and in Thailand (where fishing for the giant catfish is prohibited, but special permission can be granted by the Department of Fisheries). In the Lao PDR, no specific legal protection exists for the species, but it is protected alongside other aquatic resources by the general provisions of the environment law, water resources law and forestry law. In Vietnam, the species is listed in the Red Book and thus afforded special legal protection.

Population status: The species appears to be naturally rare, and is likely to have maintained a small but stable population throughout much of the 20^{th} century. Reconstructed spawner abundance was relatively stable at about 250 animals prior to 1983 (11-71% of unexploited abundance). The population then declined dramatically to just 50 spawners in 1995 (2-14% of unexploited abundance). The Chiang Khong fishing 'boom' thus reduced spawner abundance by about 80% in just ten years. The population has since recovered to about 145 animals (7-40% of unexploited abundance) by 2006. Much of this predicted recovery is based on maturation of fish that were spawned about 20 years previously, and would occur even if for any reason reproduction had failed in the recent past. Spawner abundance in the absence of fishing has been estimated at 355-2200 animals.

Conservation vision and goals: The core conservation vision or goal of the Mekong Giant Catfish Conservation Group is the maintenance of a viable wild population of Mekong giant catfish and the restoration of its historical distribution. Maintenance of a genetically representative captive population is crucial as 'insurance' against possible (if not likely) extinction in the wild. Maintenance of critical habitats and ecosystem processes in the Mekong basin is clearly important if a wild population is to be maintained. The presumed transboundary migrations and reliance on a variety of habitats of the MGC make it an ideal flagship species for ecosystem conservation in the Mekong. In this context, maintenance of the MGC's social and cultural importance is in itself a goal of conservation initiatives.

Factors affecting the population: Habitat and environmental change in the Mekong basin has been gradual and of moderate magnitude until the very recent past, and it is unlikely that this has been a significant factor in past population change. More dramatic changes may have occurred in the very recent past. Recent 'rapid blasting' and the commissioning of several dams in the upper river may have affected physical habitat structure, and increasingly affect flow patterns and water levels in the future. Fishing can be identified as the main driver of past changes in population abundance and structure. The exceptionally intensive Chiang Khong fishery in the 1980s and 90s in particular is likely to account for the dramatic population decline observed over this period. Interactions with other species, either native or non-native, are unlikely to have played a significant role in past population change, and there are no known issues in this regard for the future. Interactions with cultured fish are unlikely to have played a significant role in past population change, but may become a major issue in the future due to both intentional and accidental releases. At present the cultured population is likely to exceed the wild population in abundance.

Conservation strategy: Fishing. Fishing mortality on the recruited population should be maintained at very low levels. For the next two decades, catches should not exceed 10 mature fish per year in order to allow some population recovery. The legal mechanisms for harvest regulation are in place in Cambodia and Thailand, but need to be strengthened in the Lao PDR. Habitat conservation. Maintaining the overall Mekong ecosystem (flows, physical habitats and connectivity) clearly is important to ensuring the long-term survival of the species in the wild. Given that habitat use and migration patterns of the species are largely unknown, no essential habitat can be identified except for the spawning area. The spawning area is very likely to be located within some 50 miles north of Chiang Khong, and it can be clearly identified as essential habitat. An immediate priority should be to protect this habitat. There have been some suggestions that a second spawning area may be located neat the Cambodian town of Stung Treng, but this has not been confirmed by direct observations. Captive breeding. The captive population of MGC maintained by the Thai Department of Fisheries provides a vital 'insurance', safeguarding the survival of the species should it become extinct in the wild. The captive population should be managed carefully so as to conserve its genetic diversity, should re-introduction become necessary. For the time being, captive-bred fish should not (or only in very low numbers) be released into the Mekong or its tributaries because the wild population is likely to recover naturally. Releases would have no net benefit but could compromise this process through ecological and genetic interactions with captive-bred fish. Aquaculture. Escapes of MGC grown in commercial aquaculture could pose a significant threat to the wild population. Measures should be taken to minimize the risk of such escapes occurring. It should be noted that, because the wild population carrying capacity appears to be quite low, releases of even low numbers of captive-bred fish can have significant impacts on the wild population.

Monitoring, research and adaptive management: Monitoring should encompass factors affecting the wild population, the status of the wild population, and the status of the captive population. Monitoring of factors affecting the population is particularly important because it will allow identifying and alleviating risks well before population impacts would become measurable. Monitoring of the population itself is possible only on the basis of fisheries data from traditional targeted and incidental fisheries (principally in Chiang Khong and the Tonle Sap River, respectively). There is thus a tradeoff between minimising harvest and maximising monitoring information, but maintenance of a low level of traditional harvesting is deemed not to pose a great risk to the population. Monitoring of the captive population should cover its demography and breeding practice in relation to the genetic management plan. Further molecular genetic analysis will be required approximately every 5 years in order to extend the breeding plan to newly maturing fish. Further research is required on habitat use and movement of wild and released captive-bred fish with a view to identifying key habitats and supporting a re-introduction programme should this become necessary. Adaptive management entails responding to new monitoring information in a way that promotes long-term persistence of the wild population.

Implementation: The strategy will be implemented by multiple institutions. The MRC Technical Advisory Board for Fisheries (MRC-TAB) will assume a coordinating function and conduct annual reviews and assessments of monitoring information. The Royal Cambodian Fisheries Administration will continue to restrict harvesting of the giant catfish and minimise its incidental capture. The Lao Department of Livestock and Fisheries, and LARReC will strive to increase legal protection of the species from unsustainable harvesting. The Royal Thai Department of Fisheries will maintain its captive population of giant catfish and apply improved breeding protocols based on molecular genetic analysis. It will also continue to regulate the harvest of giant catfish with a view to conserving the wild population while also providing population monitoring data and maintaining the indicator value of the species.

Contents

1 Introduction

The Mekong giant catfish (MGC), *Pangasianodon gigas*, is one of the largest freshwater fishes in the world, measuring up to three meters in length and weighing in excess of 300 kilograms. It is a Mekong endemic (i.e. it occurs naturally only in the Mekong River Basin). A charismatic animal revered throughout the lower Mekong region, the species is of great cultural importance. It is also widely recognized as an indicator of ecological integrity of the Mekong ecosystem, due to its long-distance migrations, size and longevity.

The giant catfish is mentioned in the World Conservation Union (IUCN) Red List of Endangered Species, the Convention on the Conservation of Migratory Species (CMS), the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species (CITES) and the Food and Agricultural Organization's Code of Conduct for Responsible Fishing.

The status of Mekong giant catfish is believed to be precarious, owing to historical overfishing and the impacts of recent and likely future habitat alterations. The species is listed as critically endangered in the 2003 IUCN Red List. A range of conservation measures are being implemented, including harvest restrictions, captive breeding, and conservation of habitats.

The purpose of this conservation strategy is to assess current population status and the nature of threats, and to identify effective conservation actions. The strategy has been developed by the Mekong Giant Catfish Working Group, a working party of representatives from the Fisheries Departments of the lower Mekong countries (Cambodia, Lao PDR, Thailand and Vietnam), regional organisations, and the conservation NGOs (see Appendix 1 for a list of members).

1.1 Importance of the Mekong giant catfish

The Mekong giant catfish is important primarily for its existence, cultural and indicator/information value. Its importance as a fisheries resource is low, and the species is unlikely to play an important role in the functioning of the Mekong river ecosystem.

A charismatic animal revered throughout the lower Mekong region, the species is of **great cultural importance**. There is a long tradition of fishing for the species, possibly going back over 3000 years as indicated by depiction of the species on cave paintings near Ubon Ratchathani. Traditional fishing targets the spawning migration of the giant catfish, it is highly seasonal and preceded by an elaborate ceremony. Traditional fishing is now largely restricted to the town of Chiang Khong, the last place in Thailand where the Mekong giant catfish was caught in any appreciable numbers until very recently. Presently only a very limited level of 'demonstration fishing' is carried out at Chiang Khong. The town attracts several hundred visitors every year during the catfish ceremony, in which the whole town participates.

The giant catfish is widely recognized as an **indicator of ecological integrity of the Mekong** ecosystem, due to its long-distance migrations, size and longevity. Hence many organisations have adopted the giant catfish as a flagship species to promote conservation of the wider Mekong ecosystem.

Owing to its rarity, the species does not contribute significantly to the overall Mekong **fisheries catch in biomass or value**. Basin-wide catches are likely to have remained below 150/year throughout documented history, and currently do not exceed 20/year. Hence even though the individual fish can be worth up to US$ 3000.-, the market value of the overall catch is small compared to the basin total. There are no people whose livelihoods depend strongly on exploiting the species.

The species is herbivorous and, despite its large size, is unlikely to exert an important influence on the structure or functioning of the Mekong ecosystem.

1.2 Conservation vision

The core conservation vision of the Mekong Giant Catfish Conservation Group, which underpins the conservation strategy, is the maintenance of a viable wild population of Mekong giant catfish. Maintenance of critical habitats and ecosystem processes in the Mekong basin is clearly important if a wild population is to be maintained. The presumed transboundary migrations and reliance on a variety of habitats of the MGC make it an ideal flagship species for ecosystem conservation in the Mekong. In this context, maintenance of the MGC's social and cultural importance is in itself a goal of conservation initiatives.

1.3 Legal provisions

There are a number of legal provisions for, or affecting the conservation of the giant catfish. The species is protected by national law in Cambodia (where it must be released if caught in fisheries) and in Thailand (where fishing for the giant catfish is prohibited, but special permission can be granted by the Department of Fisheries). No specific legal protection exists in the Lao PDR. The species is further protected, implicitly or explicitly, by regional and international agreements.

1.3.1 National Level policies and legal instruments

<u>Cambodia</u>

Under the Fisheries Law, the MGC is recognized as an Endangered Species. Although under Article 23, transporting, processing, buying, selling, and stocking endangered fishery resources is possible with permission, no such permission has been granted for giant catfish. Specific regulations are in place to facilitate the implementation of the Fisheries Law. These regulations include the need to release specified endangered fish species including the giant catfish if they are captured.

<u>Lao PDR</u>

Due to the non-existence of specific legislation related to fisheries, the Forestry Law (1996) is the most relevant piece of legislation. There is no specific mention of giant catfish within the Forestry Law but relevant 'Articles' make reference to wildlife and fish. E.g. Article 39 indicates that the sate is responsible for categorising the protection status of species; whilst Article 40 mentions that some endangered species are subject protection. The MGC is not afforded any protection status in Lao PDR under any specific legislation.

<u>Thailand</u>

In Thailand, fishing for Mekong giant catfish is illegal. Thai fisheries law, under Article 32 (5), (6), and (7) prohibits the capture of giant catfish in the Mekong River, except with the written permission of the Director of the Department of Fisheries. The law absolutely prohibits anybody to conduct giant catfish fisheries in the Mekong river - in the area of Nongkai, Loei, Mukdaharn, Nakornpanom, Ubonratchathani, and Chaingrai provinces - except with a written permission from Fisheries Department. Where permits are issues these must specify the types, size, number, and time that the fisheries will be permitted. Up to 2005, the Thai Department of Fisheries issued special permits for the giant catfish fishing in Chiang Khong in order to allow establishment of a genetically viable captive population. No such permit has been issued in 2006, when a voluntary agreement was signed by the fishers for cessation of catfish fishing in Chiang Khong.

The Mekong giant catfish may also be protected by the Wildlife Protection and Conservation Act (February 25, 1992).

Vietnam

In Vietnam, the species is listed in the Red Book and thus afforded special legal protection. Vietnam is at the edge of the species' range, and no recent captures or sightings have been reported. It is thus unlikely that further, specific protection is required in Vietnam.

1.3.2 Regional and international level agreements and legislative instruments

The Mekong Agreement and related provisions

The Mekong Agreement of 1995 is the foundation for the Mekong River Commission (MRC) and is therefore of paramount importance to the four member countries. In Article 3, parties agree "To protect the environment, natural resources, aquatic life and conditions, and ecological balance of the Mekong River Basin from pollution and other harmful effects". The two upstream countries, China and Myanmar, are not signatories and thus threats originating upstream or stocks with distribution ranges beyond the jurisdiction of the four member countries are not fully considered by this legal instrument.

An agreement on the procedures concerning the maintenance of flows on the Mekong mainstream has been signed on 22 June 2006. The agreement requires the member states to co-operate in the maintenance of acceptable minimum monthly flows in the dry season; acceptable natural reverse flow of the Tonle Sap during the wet season; and prevention of peak flows greater than those which occur naturally. The procedures clarify the related provisions of the Mekong Agreement through further defining the objectives, principles and scope of their application, as well as the roles and responsibilities required of the various parties for their implementation, including the MRC Council, the MRC Joint Committee, the National Mekong Committees and the MRC Secretariat.

Convention on Biological Diversity (CBD)

One of the most important international legal frameworks of relevance for the management of migratory, transboundary species is the Convention on Biological Diversity (CBD). All Mekong riparian countries have signed and ratified the Convention. The CBD commits the states to the objective of "…the conservation of biodiversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources…". It further makes special reference to the need for states to manage transboundary stocks (e.g. Article 3: "..contracting parties shall ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction"). The Convention specifically refers to the cooperation, among contracting parties, in research, management and monitoring of biodiversity, including migratory, transboundary elements of biodiversity. The CBD is a very comprehensive, legally binding international instrument and, importantly, also includes the establishment of a financial mechanism for the provision of financial resources to developing country parties (Article 21 of the CBD).

Convention on International Trade in Endangered Species (CITES)

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES accords varying degrees of protection to more than 30,000 species of animals and plants.

CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-export and introduction from the sea of species covered by the Convention has to be authorized through a licensing system. The species covered by CITES are listed in three Appendices, according to the degree of protection they need. The Mekong giant catfish is listed in

CITES Appendixes I, which includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances.

A specimen of a CITES-listed species may be imported into or exported (or re-exported) from a State party to the Convention only if the appropriate document has been obtained and presented for clearance at the port of entry or exit. For Appendix-I specimens, an export permit may be issued only if the specimen was legally obtained and the trade will not be detrimental to the survival of the species.

Convention on Migratory Species (CMS)

Another relevant international legal instrument of relevance is the Convention on the Conservation of Migratory Species of Wild Animals (CMS). The CMS is a framework Convention under which contracting parties (nations) can develop specific measures for individual species or species groups within their range. The CMS is, by nature, based on a species approach to conservation, but it also recognises the importance of preserving habitats and ecosystems as a means to conserve migratory animal species. The Convention lists endangered migratory species (i.e. species of high priority for the Convention) in its Appendix I and species with "unfavourable conservation status" in its Appendix II. The Mekong Giant Catfish is one of the four fish species world-wide listed on Appendix I. However, none of the six riparian nations have signed the Convention although efforts are underway to increase its profile in the region.

The Ramsar Convention on Wetlands

All Mekong riparian States (apart from Lao PDR) are signatories to the Ramsar Convention on wetlands. Signatories are obliged to make wise use of their wetlands and aquatic ecosystems within their territories and trans-boundary systems. Specific criteria are provided for the nomination of wetlands or aquatic ecosystems based on threatened fish species (of which the MGC qualifies) or if wetlands are important for particular life cycles of fish. In addition, at the most recent Conference of Parties (COP 9 in Kampala, Uganda, 2005), a resolution was passed on the conservation, production and sustainable use of fisheries resources. Ramsar sites at which the giant catfish occurs include those along mainstream Mekong in Cambodia, and in the Tonle Sap lake.

The Code of Conduct for Responsible Fisheries

The Code of Conduct for Responsible fisheries (adopted on 31 October 1995 by the FAO Conference), sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Code recognises the nutritional, economic, social, environmental and cultural importance of fisheries, and the interests of all those concerned with the fishery sector. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users. States and all those involved in fisheries are 'encouraged to apply' the Code and give effect to it.

1.3.3. Regional level agreements that may affect the giant catfish population

Upper Mekong Navigation Improvement Agreement

The agreement between the four Upper Mekong countries, China, Lao PDR, Myanmar and Thailand was signed on 20 April 2000 with a view towards developing international passenger and cargo transportation on the Lancang-Mekong to promote and facilitate trade and tourism and to strengthen cooperation in commercial navigation. The Lancang-Mekong Navigation Channel Improvement Project, funded by the Chinese government, is part of a grand scheme to allow large ships to freely navigate from Simao, China to Luang Prabang in Lao PDR. This agreement and the activities that are underway may have significant impacts on physical habitats that are believed to be critical to the MGC population, such as spawning grounds.

A number of other infrastructure investment/ development programmes for the Mekong Region are underway through ADB and World Bank. These include the Mekong water transfer and hydropower projects that could potentially interfere with the flow regime and therefore the migration cycle of the giant catfish. It is also likely that navigational improvements will increase the volume of shipped of potentially dangerous cargo such as oil and chemicals that could be released e.g. due to groundings of vessels.

2 Population status

2.1 Life cycle and biology

The Mekong giant catfish is rare but widely distributed throughout the lower Mekong basin, including the Tonle Sap in Cambodia. Adult fish appear to inhabit the main channels of the Mekong River and its tributaries, while juveniles may also utilise other wetland areas in the basin. A spawning area has been identified in Northern Thailand and Laos, and a further such area may exist in the north of Cambodia but has not been confirmed.

Mature fish undergo long-distance migrations up-river during the dry season, and spawn at the beginning of the wet season. Eggs and larvae are likely to be transported downstream where junveniles may disperse into floodplain and other wetland areas. Small juveniles have only very rarely been observed and not much is known about their ecology.

It appears likely that there is a single population of MGC in the Mekong, with spawning grounds located north of Chiang Khong in northern Thailand. The possibility of two separate populations above and below the Khone falls has been discussed, but genetic analyses so far do not provide support for this idea. Unconfirmed reports of occasional catches of MGC at the Khone Falls suggest (but do not prove) that fish from Cambodia may be able to negotiate the falls and migrate to the Chiang Khong spawning area. It is also possible, however, that the lower basin acts as a 'sink' supplied with juveniles from the upper basin population, but with adults unable to return to spawning grounds. There has also been some indication in local fisher's knowledge of a possible spawning area located below the Khone Falls, near the Cambodian town of Stung Treng. Quantitative information on population status and recovery used in this strategy document is based on the assumption of a single population with a spawning area in Northern Thailand.

Giant catfish reach a maximum length of about 3 metres, and weight of over 300kg. Maturation occurs at a length of about 2.2 m, most likely corresponding to an age of 16-20 years. Mature fish suffer a natural mortality of about 10-15% per year, and it is likely that fish of 16-25 years of age constitute the bulk of the spawning population.

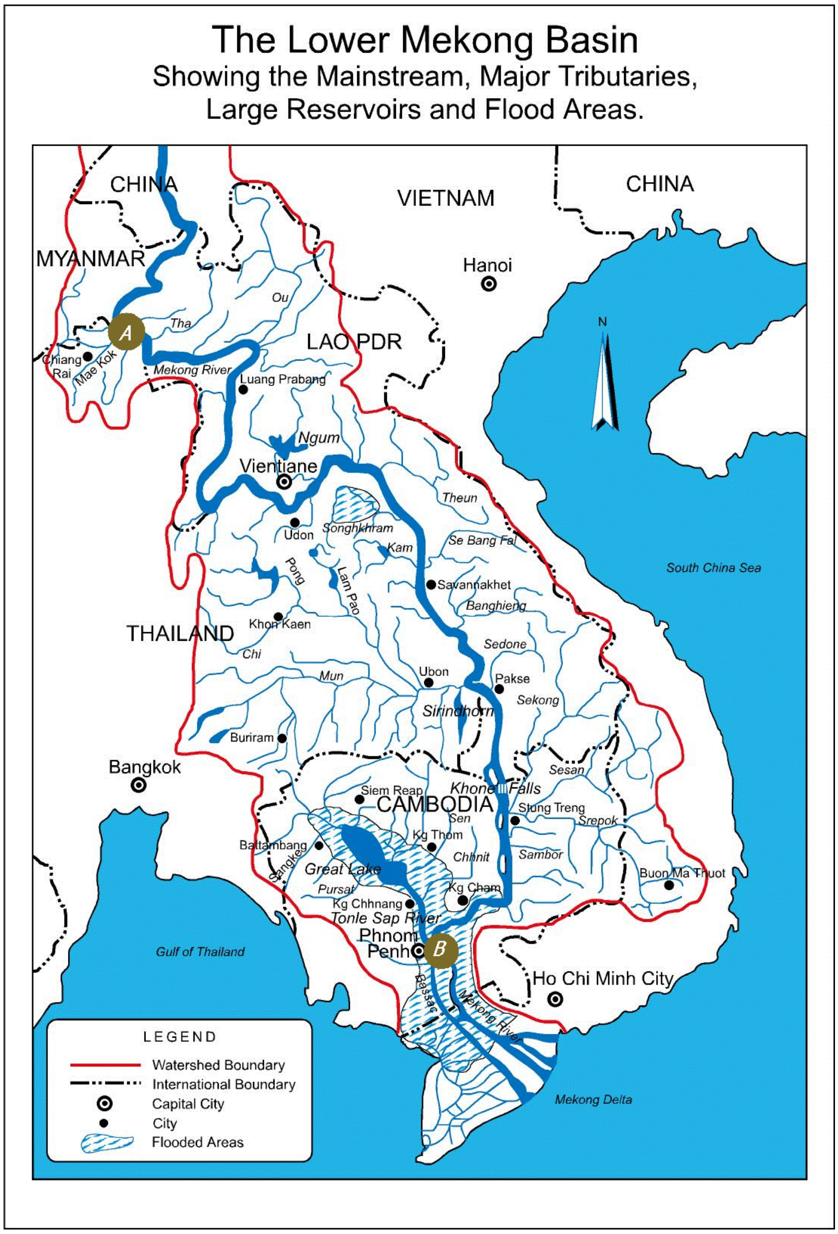

Figure 1. Map of the lower Mekong basin. Green circles indicate the locations where Mekong giant catfish have been regularly caught in fisheries in recent years: (A) Chiang Khong/Huay Xai in Northern Thailand and Laos, and the Tonle Sap River in Cambodia. (Map courtesy of Mekong River Commission).

2.2 Population and threat history

Fisheries catches provide the only source of information for population assessment. Quantitative information on catches is available intermittently for the past 100 years, with a fairly continuous record for the Northern Thai/Lao fishery since 1970. The records suggest that catches over the past 100 years have been low (below 40 per year) but fairly stable, i.e. there is no evidence of continuous long-term decline in catches as has sometimes been suggested. In the 1970s, catches appear to have been stable at an average of about 20-30 fish per year. Catches increased substantially, up to a maximum of 90 per year in the late 1980s, driven mainly by the high profile government-supported fishery in Chiang Khong (Northern Thailand). Catches declined again in the 1990s, dropping below 1970s 'pre-Chiang Khong fishery expansion' levels in 2000.

The current status of the MGC population has been assessed quantitatively by fitting a mathematical population model to fisheries data. The model was then used to predict the likely future population development for alternative conservation scenarios. Full details of the analysis can be found in Lorenzen et al. (2006).

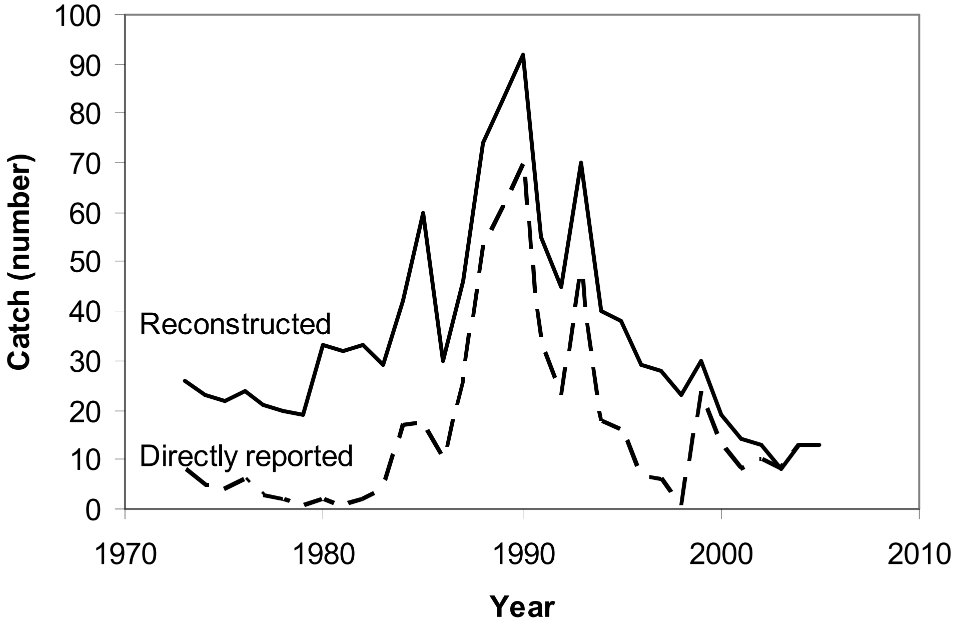

Figure 2. Directly reported catches and reconstructed catch history. The reconstructed history takes into account reported 'average' catches for locations and periods where no direct records exist.

Historically, fishing has been the main threat to the MGC population. The intensification of fishing in Northern Thailand and Laos during the 1980s can clearly be identified as the main driver of population decline over this period. Aquatic habitats in the Mekong have remained largely intact until the very recent past, and even land use changes in the catchment have been moderate and gradual. Hence habitat modification is unlikely to have acted as an important driver of past population change.

There is only moderate uncertainty about the pattern of population abundance over the past 30 years because intensive fishing in Northern Thailand and Laos has led to a strong reduction in catch per unit of effort, an index of relative abundance. Because both, the catches and the impact of those catches on relative population abundance are well documented, it is possible to estimate absolute population abundance with a high degree of confidence. However, because population changes were driven mostly by fishing rather than biological processes such as recruitment, the data provide only limited information on the latter. Therefore, although we know the current population status quite well, there is uncertainty about long-term population trends, unexploited population abundance, and maximum sustainable catches. The key biological parameters that account for much of this uncertainty are the natural mortality rate of mature fish, and the level of recruitment compensation. Comparative information suggests that the natural mortality rate of mature MGC may be about 0.06 to 0.12 per year. Juvenile survival in fish populations is subject to compensatory density-dependence, i.e. the lower the number of eggs produced by the spawning stock, the higher their survival to recruitment will be. The increase in juvenile survival with decreasing egg production can be quantified by the compensation ratio K, the ratio of juvenile survival at very low spawner population size (and thus, egg production) to juvenile survival at unexploited spawner population size (carrying capacity). On average in fish populations, K=5, but values can range from very low compensation (K=2) to very high (K=100). The higher the recruitment compensation ratio, the less recruitment declines when spawner population abundance is reduced and the more resilient the population is to harvesting or disturbances. To account for uncertainties, population analyses were conducted for mortality rates of mature fish Mr=0.06 and 0.12 per year; and compensation ratios of K=2, 5 and 100.

All analyses predicted a spawner abundance of about 250 fish at the start of the Chiang Khong fishing boom. Estimates of unexploited spawner abundance varied from 355 to 2200 fish, depending on the assumed natural mortality and recruitment compensation values. Hence the abundance at the start of the Chiang Khong fishing boom represents between 11% and 71% of the unexploited abundance. The population then declines dramatically to just 50 spawners in 1995 (2-14% of unexploited abundance). The Chiang Khong fishing 'boom' thus reduced spawner abundance by about 80% in just ten years. However, the model predicts that the population has since recovered significantly. The predicted current (2006) level of spawner abundance is estimated at 145 animals (7-40% of unexploited abundance).

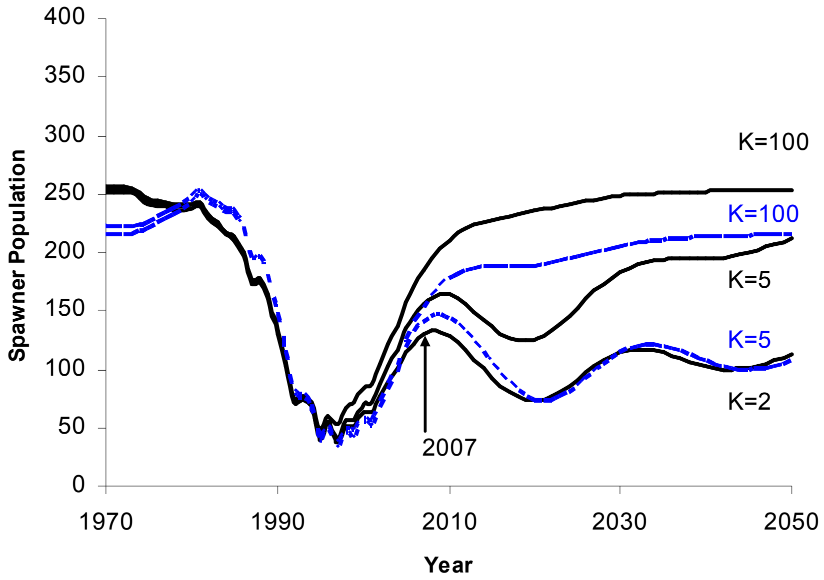

Figure 3. Spawner population abundance reconstructed by the population model. The figure shows predicted recovery trajectories for different levels of compensatory density-dependence in recruitment. Predictions for natural mortality rates M_r = 0.12 year^{-1} (black solid lines) and M_r = 0.12 year^{-1} (blue dotted lines).

The predicted recovery of spawner numbers up to about 2010 is based largely on growth and maturation of fish spawned before the period of intensive fishing, and would occur even if there had been no successful reproduction since 1990. Subsequent population development depends on reproduction during and after the period of very low spawner abundance. Unless recruitment compensation is extremely high (K=100, Fig. 12), spawner abundance is predicted to decline again between 2010 and 2020 as a result of low spawner abundance and thus reproductive output during the 1990s. If reproduction had failed entirely from 1990 onwards (e.g. as a result of Allee effects, or due to environmental factors), this would become apparent only after 2010.

The model-based population reconstruction also provides us with direct estimates of fishing mortality rates. The fishing mortality pattern (Fig. 4) clearly shows a dramatic increase in fishing pressure on the mature population between 1983 and the early 1990s. Fishing mortality rates then declined and returned to pre-1983 levels by 2004. Instantaneous fishing mortality rates F can be translated into proportional harvest rates H, i.e. the proportion of the available population harvested in the fishery. The fishery pre-1983 and post-2004 removed about 10% of the population per year. During 1990-2000, over 50% of the available population was harvested annually, with a maximum of 96% in 1995.

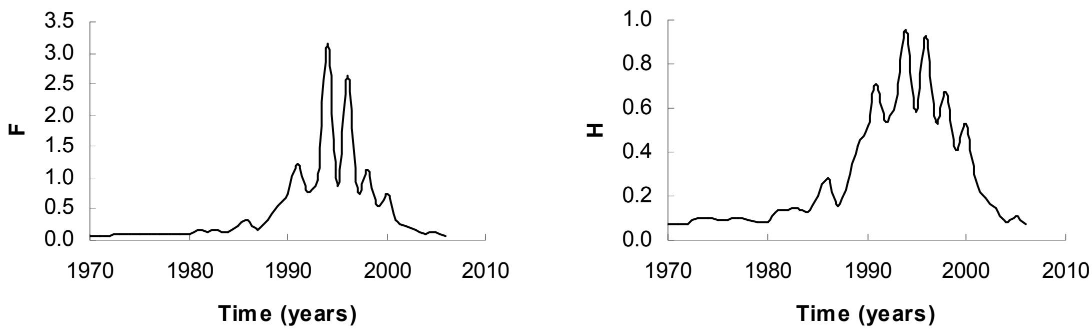

Figure 4. Reconstructed fishing mortality F (left) and the corresponding proportion of the available population harvested H (right) for the period 1970 to 2006.

2.3 Population status

Population status and future development are assessed in terms of abundance predicted from a deterministic population model, and in terms of extinction risk and genetic diversity as assessed using a stochastic individual-based model.

Future population development will depend on factors such as:

- Availability of habitat
- Exploitation by fisheries
- Intentional or accidental release of captive-bred/cultured fish
- Occurrence of complete recruitment failure or other catastrophic events

Because the future change in these factors is uncertain, population development is predicted for different scenarios.

2.3.1 Wild population abundance and trend

As mentioned above, the current (2006) level of spawner abundance is estimated at about 145 animals, representing corresponding to (7-40%) of unexploited abundance. This represents a substantial increase from the very low spawner population abundance (50 animals) estimated for the 1990s. The predicted recovery to about 145 animals is based largely on growth and maturation of fish spawned before the period of intensive fishing, and would occur even if reproduction had failed for the past 20 years. The recovery to about 145 animals has been predicted by the population model and is consistent with the (limited) fishing catch and effort data available, but longer term monitoring is required to confirm that the population is indeed recovering as predicted.

Future development of the population will depend on the level of fishing and on continued, successful reproduction (which could be affected by loss of spawning or nursery habitat, or Allee effects related to the very low spawner abundance in the 1990s). Possible population trajectories are shown in Figure 5, for different scenarios and levels of recruitment compensation:

- If fishing continues at a moderate, ‘traditional’ level and reproduction is not compromised, the population is most likely to fluctuate around the current abundance for the next 20 years but increase slowly thereafter. If the degree of density-dependence in recruitment is very high, the population may recover to its historical abundance more quickly.
- If fishing ceases completely and reproduction is not compromised, then the population will recover more quickly and to a higher level of abundance, but a significant increase is unlikely to be noticeable before 2030.

- If reproduction had failed (e.g due to habitat degradation or Allee effects) since 1990, the population would decline below the level expected for moderate fishing without reproductive failure by about 2020.

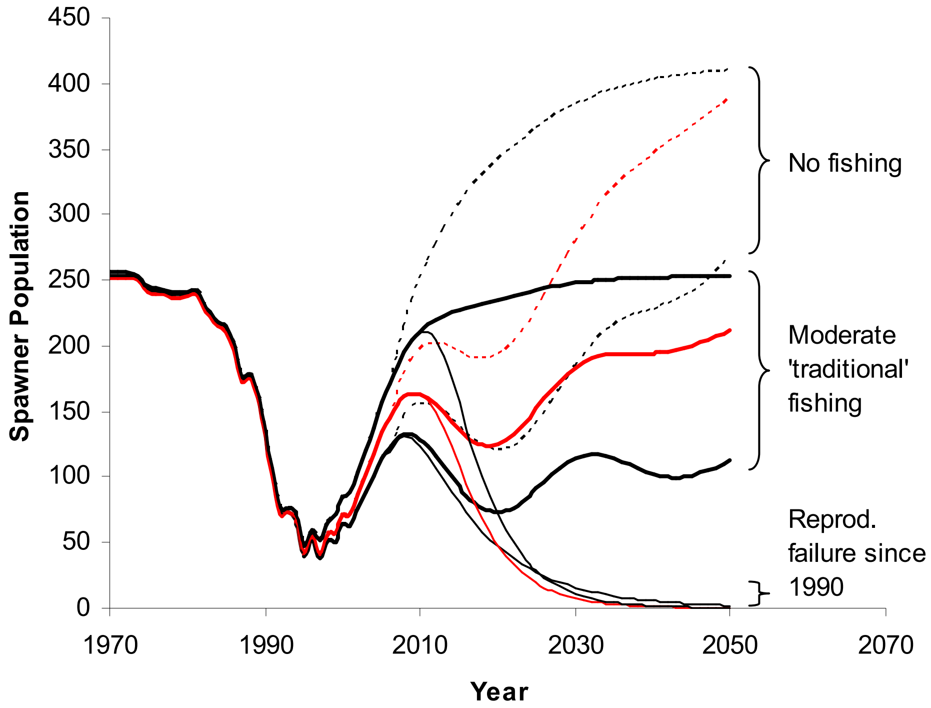

Figure 5. Predicted spawner population abundance assuming normal recruitment with a 'traditional' (pre-1983) level of fishing or no fishing, or complete reproductive failure since 1990 with 'traditional' fishing. For all three scenarios, predictions are given for recruitment compensation values of K=2, 5, and 100. Predictions are shown for a natural mortality rate of mature fish of 0.12 per year only.

2.3.2 Wild population genetic diversity

The genetic diversity of the giant catfish population is slightly lower than that of other large Pangasiids in the Mekong and Chao Phraya basin. This suggests that the population has been relatively small for a prolonged period, but there is no indication at the present time that population viability and evolutionary potential have been significantly compromised. Molecular genetic studies indicate that the effective population size of the wild population is between 55 and 137 animals. This is about 10% of the census size estimated from the population assessment (defined as the number of mature individuals recruiting to the population over one generation).

Intensive fishing between 1980 and 2000 (motivated partly by the establishment of the captive broodstock) has removed over 900 wild fish maturing over this 20 year period (approximately one generation). This is equivalent to about 50% of the census population. Hence the captive breeding programme has sampled a large proportion of the wild population.

2.3.3 Captive population status

There is now a large captive population of MGC comprising some 20,000 individuals in 20 age groups, most of these first generation offspring of wild parents. Although genetic management of the captive population requires further attention, the current population is large, diverse and as yet only moderately domesticated. Loss of genetic variation in the captive stocks is a common phenomenon. The consequences include loss of rare alleles accompanying by the occasional reduction of heterozygosity. However, a molecular genetic study has shown that levels of genetic variation in the captive stock of MGC are commensurate with those of the wild stock based on the same sets of microsatellite loci. This may be due to a large number of founders and a brief captive history. Therefore the captive stock represents the genetic diversity in the wild stock of Mekong giant catfish, and provides an effective means of conserving the species in captivity and for possible re-introduction.

2.3.4 Red list status

The MGC is currently listed as critically endangered on the IUCN Red List. The quantitative analysis suggests that this classification was fully warranted in the 1990s, based on criterion D (population numbers fewer than 50 mature individuals) alone. The population is likely to have recovered somewhat since, though conclusive empirical evidence of recovery can only be obtained through monitoring over an extended period.

Given the information summarized above, the species has moved towards the 'borderline' between the endangered (E) and critically endangered (CE) categories, but should still be considered critically endangered. A brief outline assessment is given here against the red list criteria.

A. Reduction in population size

The population has declined by about 80% in three generations. The cause of decline (unsustainable fishing) is understood and has largely ceased due to both reduced economic incentive for fishing and conservation action. However, there is sustained and possibly, resurgent fishing pressure on the MGC population. Hence the cause of decline has not fully been addressed. There is also a substantial risk that the population will decline by 80% over the next three generations due to current and projected decline in the quality of habitat (CE).

B. Geographic range

The species occurs over a geographical range > 100 km^2 and does not qualify for E or CE under this criterion.

C. Small population size and decline

The population size currently numbers fewer than 250 mature individuals, a moderate decline over the next generation is likely, and over 90% of mature individuals are likely to be in one sub-population (CE).

D. Very small population size

The population is estimated to have numbered fewer than 50 mature individuals throughout much of the 1990s. It is likely that the population has now recovered to about 145 mature individuals, but conclusive empirical evidence of a recovery of this magnitude is not available. It is also likely that the population will decline again temporarily as a result of low recruitment during the 1990s when spawner population size was very low. (Has been CE, now likely E)

E. Quantitative analysis

No quantitative assessment of extinction probability has been carried out.

3 Factors affecting the Mekong giant catfish population

3.1 Fishing

Fishing was the main factor driving past population decline, and remains a potentially significant threat. Incidental catches of giant catfish are rare, and targeted fishing is currently practised only at very low intensity. However, targeted fishing has not ceased and could rebound once the population has recovered to a level that makes fishing more profitable again, or if greater demand for the species or the activity itself (e.g. through tourism) was created. It is thus important to set quantitative biological limits to exploitation that should not be exceeded.

To assess the potential for sustainable exploitation of the giant catfish, the equilibrium (=sustainable) catch and the corresponding spawner abundance have been calculated for different levels of natural mortality and and recruitment compensation. The maximum sustainable catch has been estimated at 20-40 fish per year, depending of the values of the uncertain parameters. It is not possible, due to the uncertainties in biological parameters, to assess with confidence whether or not the traditional level of fishing prior to the Chiang Khong 'boom' overexploited the population. This may seem unfortunate, but it does not present a major problem for management in the short-to-medium term because the population is currently depleted and will not rebound to levels at which the maximum sustainable catch could be taken for at least 2-3 decades.

Predictions of fishing impacts on short-to-medium term population abundance are given for a 'traditional' level of fishing mortality, and for a scenario where all fishing for MGC is stopped from 2007. The 'traditional' fishing scenario is deemed most likely in the medium term, though closure of the Chiang Khon/Huay Xay and decommissioning of the Dai net responsible for the bulk of MGC catches in the Tonle Sap river would lead to the 'no fishing' scenario. The MGC population is expected to recover under both scenarios (Fig. 6), but recovery would be faster and to a higher level of abundance if fishing were discontinued. For recruitment compensation K=5, the population would recover to pre-1983 abundance around 2025 in the absence of fishing, but would still be below pre-1983 abundance in 2050 if fishing continued at the 'traditional' level.

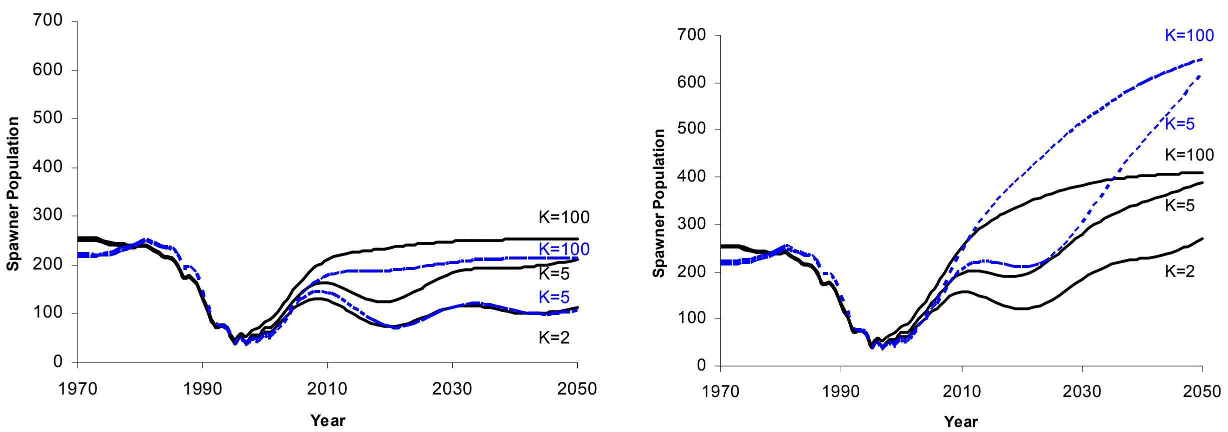

Figure 6. Predicted spawner population change given 'traditional' levels of fishing mortality (left) or no fishing (right). Predictions for natural mortality rates of M_r = 0.12 year^{-1} (black solid lines) and M_r = 0.12 year^{-1} (blue dotted lines).

Predictions of spawner population abundance in 2030 for different levels of annual catch (numbers of mature fish caught) between 2007 and 2030 are given in Fig. 7. Predictions for the most likely level of recruitment compensation (K=5) are similar for the two assumed levels of natural mortality. Only if harvesting is restricted to less than five mature fish per year will the spawner population rebuild to 'pre-boom' level of abundance of 250 fish by 2030. Harvesting 10-15 fish per year would stabilize the population at the current, very low level of about 145 spawners. Harvesting more than 15 fish would lead to further population decline. The analysis shows clearly that, if population rebuilding is to be achieved at all, harvests should be limited to a basinwide maximum of 10 mature fish per year. Lower harvest levels are desirable to achieve faster rebuilding.

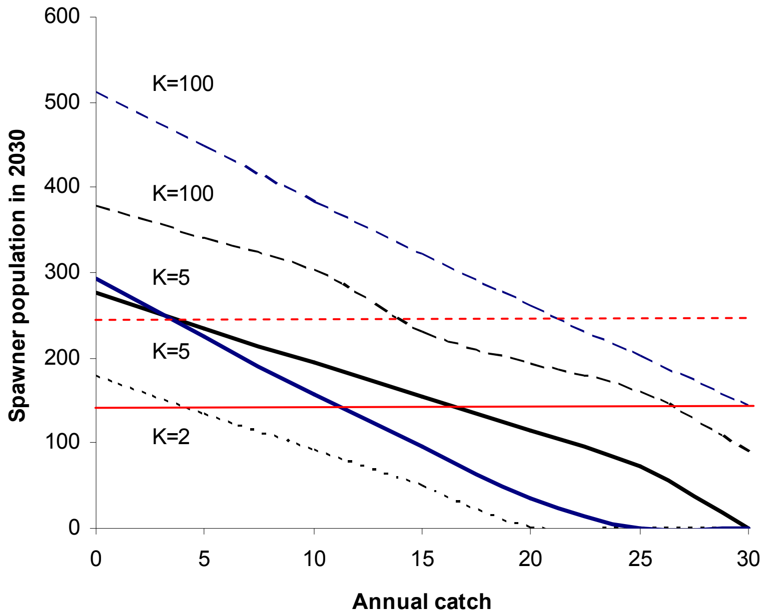

Figure 7. Predicted spawner population in 2030 for different levels of annual catch (number of mature fish caught) between 2007 to 2030. Red horizontal lines show the abundance in 2006 (solid line) and prior to the Chiang Khong fishing boom. Predictions for natural mortality rates of M_r = 0.12 year^{-1} (black solid lines) and M_r = 0.12 year^{-1} (blue dotted lines).

3.2 Habitat

Mekong aquatic habitats have remained largely intact until very recently, but are now being modified substantially and rapidly. Key changes include:

- Catchment land use change, in particular in floodplain habitat that is likely to act as the main nursery habitat. For example, forest clearing around the Tonle Sap Lake and the Mekong delta.
- River corridor engineering including dam construction. Dams reduce sediment and nutrient load, alter river flow, modify water temperature, and block fish migration. Dams may impact the spawning migration of giant catfish in Thailand and Lao PDR, because spawning behavior may be triggered by water quality or flow/timing of seasonal flooding.
- Waterway modification - Removal of rapids, canalization of the river bank, and dredging alter river habitat and may negatively impact Mekong giant catfish. The stretch of river between Chiang Khong and Chiang Saen, Thailand is almost certainly the key spawning habitat for giant catfish, but a second spawning area may exist near Stung Treng in Cambodia. Potentially harmful river modifications in the area include port construction (Chiang Saen) and rapid blasting (as part of the Mekong Navigation Improvement Project). Increased boat traffic may in itself cause noise pollution and erosion/sedimentation issues.
- Bridge construction in sensitive habitats: a third Mekong bridge is planned for Chiang Khong/Huay Xai, near the likely spawning grounds of giant catfish.

It is not possible at present to gauge quantitatively the likely impact of such habitat changes on the giant catfish population. Changes in localized, critical habitats such as the spawning ground(s) are likely to be most detrimental and possibly, catastrophic. Changes in the availability of other habitats are likely to have a more moderate, proportional effect on population carrying capacity.

3.3 Captive/supportive breeding

A captive/supportive breeding programme has been operational for MGC since 1983. Broodstock capture for the programme was an important factor in the intensification of fishing at Chiang Khong and thus, the depletion of the wild population. There have been some releases, mostly of small captive-bred fish, into the Mekong but the fate of these animals is unknown. Only some of the animals were marked and it is possible that the current wild population includes some animals that were spawned in the hatchery from wild-caught parents. There is no indication however that captive releases have had any significant impact on population abundance or structure. The importance of the captive population lies in the fact that it provides a vital 'insurance' for species conservation and will allow supplementation or re-introduction of the wild population should the latter fail to recover naturally.

3.4 Interactions with other species

There is no indication that biological interactions with other species are major conservation concerns at present.

'Technical' interactions, such as the incidental harvesting of juvenile Mekong giant catfish in the river catfish (*P. hypophthalmus*) fishery, and failure to identify and report any giant catfish caught in this way may affect population status and also the estimate of 'unexploited' population size of the species. There is no indication, however, that such incidental catches are common.

3.5 Interactions with cultured fish

Increasingly, however, interactions between captive-bred or commercially cultured MGC and the wild population may become an important threat. Lack of genetic resource management, intentional hybridization between MGC and other pangasiid catfish, and possible transfer of diseases are key risks.

4 Specific conservation goals

Specific conservation goals have been formulated as follows:

1) Maintain a viable and resilient population in the wild
   - a) Prevent further population decline or extinction in the short-to-medium term
   - b) Rebuild population abundance at least to the pre-1980 level (about 250 spawners)
   - b) Maintain genetic diversity and evolutionary potential

2) Maintain habitats and processes critical to the achievement of (1)
   - a) Geomorphological habitat (e.g. rapids likely to serve as spawning grounds)
   - b) Hydrology
   - c) Water and environmental quality

3) Maintain a viable and genetically representative captive population for possible re-introduction into the wild if necessary.

4) Maintain the social, economic and cultural importance of the species and its role as an indicator and flagship species for conservation

5 Conservation strategy

Key conservation measures are identified in the areas of fishing regulations, habitat protection, and maintenance of a representative captive population for possible re-introduction. Such measures may be supported by awareness building, the development of a regional cooperation framework, and thorough and transparent environmental impact assessment of infrastructure projects.

5.1 Limiting fishing

Fishing has been, and potentially remains a significant threat to the population of Mekong giant catfish. At the same time, fishing captures are the only occasions where the animal is “seen” in the wild and targeted fisheries with ceremonial elements (such as the one at Chiang Khong in Northern Thailand) contribute to public awareness. It is unlikely, and perhaps undesirable for giant catfish fishing to cease entirely, but catches must be limited to very low numbers in order to prevent extinction of the species in the wild. Population analysis suggests that in order to allow population recovery, no more than 10 adult giant catfish (individuals that are mature or nearly mature) should be taken basin wide per year for the next ten to 20 years. To achieve this, (1) targeted harvesting should be strictly limited through legal or community-based measures and (2) continued efforts should be made to minimize incidental capture and mortality of giant catfish in the Cambodian Dai fishery.

At present, Cambodian law forbids harvest of Mekong giant catfish without exception, while Thai law allows the issuing of special permits. There is no legal protection of the species from harvesting in Laos. It is thus important for biological limits to be taken into account in the determination of permits in Thailand, and for legal or community-based measures to be developed that would allow the same limits to be set and enforced in Laos. It should be noted that in recent years, catches have remained within the limits suggested here.

All targeted and known incidental fishing for the species should be carefully monitored for both, research/population assessment and enforcement of regulations where these are in place. Fisheries monitoring should be coordinated at basin (or lower basin) level. Regional cooperation in reporting, information exchange, and the setting of biological limits to fishing should be maintained and strengthened.

<u>High priority measures:</u>

- Strictly limit basinwide catches to a maximum of 10 adult fish/year for the next ten years
- Further legal protection in some areas (see 5.5.1) and improved basinwide cooperation on setting of biological limits to fishing and exchange of information on catches

5.2 Protecting critical habitat

Habitat and ecosystem conservation are key to safeguarding the species’ long-term future in the wild. As a long-distance migrant, the species likely relies on the integrity of, and access to a variety of habitats throughout the lower Mekong basin. Adult fish appear to inhabit the main channels of the Mekong River and its tributaries, while juveniles are likely to utilise floodplain wetlands. However little is known about the species’ specific habitat use and migrations, and it is not possible to identify critical habitat other than the fairly well-defined spawning area in Northern Thailand and Laos. A further spawning area such may exist in the north of Cambodia but has not been confirmed.

The spawning area(s) should be protected from geomorphological alterations (e.g. rapid blasting) and hydrological change (preserving in particular water levels and flows during the spawning season). It may also become increasingly necessary to protect the areas (at least temporarily) from other sources of environmental degradation, such as disturbance by boat traffic or oil or chemical spills.

Conservation of the wider Mekong river-floodplain ecosystem from catchment land use change, river corridor engineering including dam construction, and pollution will be important to the maintenance of a wild giant catfish population. It is thus crucial for MGC conservation efforts link with and influence wider policy processes in Mekong environmental management and conservation. The MGC itself can serve as a flagship species for such conservation efforts.

High priority:

- Conserve spawning area(s) from 'rapid blasting' and from changes in hydrology
- Consider possible impact on Mekong giant catfish and other long-distance migratory fish species in impact assessments for infrastructure development

5.3 Captive/supportive breeding

The captive population is large, relatively diverse and as yet only moderately domesticated. It is thus a key resource for species conservation, ensuring species persistence and enabling supplementation or re-introduction of the wild population. The captive population should be maintained, and managed primarily as a conservation resource until the wild population has demonstrably recovered to substantially higher levels of abundance and is no longer deemed to be critically Endangered or Endangered according to IUCN Red List criteria. Given the predicted development of the MGC population (3.2), this is unlikely to be the case for at least 2-3 decades.

In order to avoid risks associated with unexpected catastrophes that may lead to loss of MGC broodstock, the population should be maintained at more than one facility. The four Fisheries Stations/Hatcheries Ayudthaya, Phayao, Chiangmai and Pitsanulok maintain the greatest share of genetic diversity in the captive population (relatively higher numbers of mtDNA haplotypes compared to other facilities), hence these facilities should be considered to maintain the MGC captive gene pools. A specific mating plan has been designed based on molecular genetic analysis (Na-Nakorn et al. 2008). The plan provides a basis for broodstock management for about the next five years, and should be implemented in order to maintain the greatest possible genetic diversity in the next generation of captive bred MGC.

It is important that maturation of male and female of each breeding pair according to mating plan need to be synchronized. Therefore, broodstock rearing conditions (e.g. feed, controlled environments) and enhancement of gamete development by chronic application of hormone (e.g. implantation of gonadotropin releasing hormone) should be investigated to ensure that males are ready when females could spawn. Also, cryopreservation techniques for male gametes of MGC should be refined and applied to all hatcheries. Male gametes should be cryopreserved, possibly at a central unit or share amongst hatcheries for all males in MP5. Once females are ready to spawn then cryopreserved milt of appropriate males could be used. This will reduce the risks and costs associated with transporting fish from long distance.

No further capture of wild broodfish is recommended at present, given that the captive population is diverse and is being carefully managed to maintain this diversity, and that the wild population remains in a very depleted state.

For the time being, captive-bred fish should not be released into the Mekong or its tributaries, for two reasons: (a) The wild population is likely to recover naturally, unless there have been recent and as yet unknown negative effects on recruitment. Releases would have only limited net benefit, but may partially replace wild fish through ecological interactions. (b) Despite of good hatchery management developmental and genetic responses to the culture environment are likely to result in the captive-bred fish being less fit than their wild counterparts, and reproductive interactions between the wild and captive-bred population segments may reduce spawning success or the survival of offspring. It should be noted that, because the wild population carrying capacity appears to be quite low, releases of even low numbers of captive-bred fish can have significant impacts on the wild population.

A programme of releases of captive-bred fish for re-introduction or supplementation should commence if and only if the wild population fails to recover as predicted. This assessment can be made, at the earliest, around 2025.

High priority:

- Improve broodstock management by implementing the mating plan and associated measures.
- Develop/improve cryoprservation procedures.
- No captive fish releases should be carried out in the Mekong unless the wild population fails to recover naturally.

5.4 Minimizing interactions with escapees from aquaculture

Aquaculture of MGC is currently carried out only on very limited scale and does not pose a threat to the wild population. However, escapes of farmed MGC could become an important threat should the industry expand substantially in the Mekong basin. The current analysis suggests that even moderate escapes of a few tens or hundreds of large/mature animals can lead to significant replacement of wild with captive/cultured types, provided that the latter survive well in the wild and are reproductively competent. Results of MGC stocking in reservoirs suggest that cultured fish can survive well in semi-natural environments.

High priority:

- Monitor expansion of the MGC farming industry and develop measures to improve containment should substantial expansion take place in the Mekong basin.

5.5 Institutional issues

5.5.1 National legislation

National legislation in Cambodia and Thailand provides frameworks for protection of MGC against unsustainable harvesting. Relevant legal instruments in the Lao PDR should be improved in order to allow greater control of harvesting of MGC and potentially, other large migratory species.

5.5.2 Community and co-management

Community and co-management arrangements could aid the management of the remaining, targeted fishery for giant catfish in Northern Thailand and Laos (Chiang Khong/Huay Xai). Legal support for such arrangements should be considered where appropriate. Current efforts directed at cooperation between Lao and Thai provincial governments are a positive step.

6 Monitoring, research and adaptive management

6.1 Monitoring

Monitoring should encompass factors affecting the wild population, the status of the wild population, and the status of the captive population. Monitoring of factors affecting the population is particularly important because it will allow identifying and alleviating risks well before population impacts would become measurable. Monitoring of the population itself is possible only on the basis of fisheries data from traditional targeted and incidental fisheries (principally in Chiang Khong and the Tonle Sap River, respectively). There is thus a tradeoff between minimising harvest and maximising monitoring information, but maintenance of a low level of traditional harvesting is deemed not to pose a great risk to the population.

6.1.1 Monitoring threats

Due to the difficulties of monitoring population status and the long delay between any problems affecting reproduction and their manifestation in fisheries data, monitoring of known or likely threats is an important precautionary measure.

Table 1 Indicators of changes in threats that should be monitored regularly

Threat category	Indicators
Habitat	• Changes affecting geomorphology of likely spawning and nursing habitat • Changes in hydrology of likely spawning and nursing habitat and migration channels • habitat
Exploitation	• Change in targeted fishing effort for giant catfish • Change in catch from targeted fishing • Change in level of incidental catch • Indicator based on incidental culture of MGC in fish ponds (indicator of reproduction in wild)
Aquaculture	• Expansion of commercial aquaculture of giant catfish • Escapes of giant catfish from ponds or reservoirs with the Mekong watershed • Increasing promotion of hybrid catfish • Genetic changes in aquaculture stocks

6.1.2 Monitoring wild population status

Monitoring of wild population status is currently possible only on the basis of fisheries catch and effort data. Such data are best interpreted using modelling tools such as the length-based stock reduction analysis employed in the status assessment.

The Chiang Khong fishery is a particularly valuable source of population monitoring data due to its long time series. A moderate level of traditional fishing in Chiang Khong may be allowed to continue in order to provide such information, but harvest must be strictly limited to sustainable levels. This must take into account incidental catches (mainly in Cambodia).

CPUE monitoring data from Chiang Khong may be compared with predicted CPUE as shown in Figure 9. It should be noted that, given overlap in predictions and variability in CPUE observations, it is unlikely that even very different population trajectories can be distinguished before about 2025.

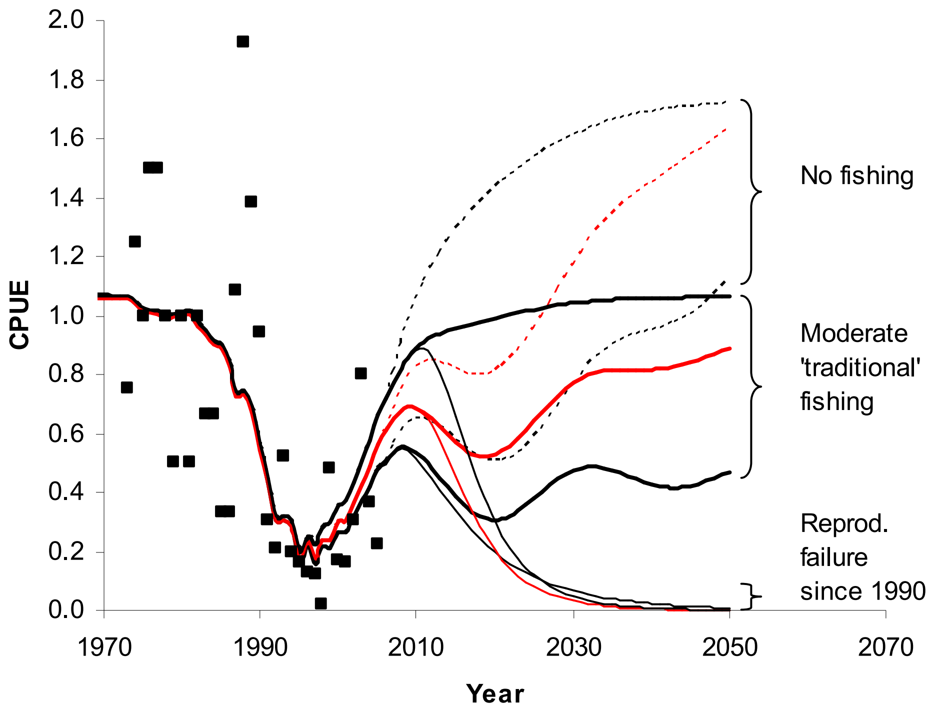

Figure 9 Historical and predicted future CPUE in the Chiang Khong fishery for alternative development scenarios. Given overlap in predictions and variability in CPUE observations, it is unlikely that trajectories can be distinguished before about 2025.

6.1.3 Monitoring the captive population

Monitoring of the captive population should cover its demography and breeding practice in relation to the genetic management plan. Further molecular genetic analysis will be required approximately every 5 years in order to extend the breeding plan to newly maturing fish. Monitoring procedures in the captive breeding programme are considered adequate.

6.2 Research

Further research is indicated in a number of areas relevant to MGC conservation, including:

- Continued development of wild population quantitative assessment in the light of new data and methodological developments.
- Assessment of habitat use and movement of wild or released captive-bred fish.
- Identification of MGC larvae and sampling of larval stages for population assessment.

6.3 Adaptive management

Given the critical status of the wild population, there is little scope for active adaptive (experimental) management of the population. Adaptive management will thus be primarily passive, responding to new information as it arises from the threat and population monitoring programmes, e.g.:

- Adapting the regulation of fisheries if either the level of fishing or catches change in a way that suggest an increasing threat from harvesting
- Undertaking habitat protection activities where new threats emerge
- Initiating a supplementation or re-introduction stocking programme should the population decline to a very low level (based on population monitoring)
- Developing management measures to reduce risk of escape from commercial giant catfish farms should the industry expand

7 Implementation

7.1 Strategy coordination and review

The strategy will be implemented by multiple institutions. The MRC Technical Advisory Body for Fisheries (MRC-TAB) will assume a coordinating function and conduct annual reviews and assessments of monitoring information.

7.2 Specific tasks

The Fisheries Administration (Govt. of Cambodia) will continue to implement the fishery law and to minimise incidental capture of MGC.

The Lao Department of Livestock and Fisheries will strive to increase protection of the MGC and other large migratory fish species from unsustainable harvesting. This may involve legal and/or community-based measures.

The Royal Thai Department of Fisheries will maintain its captive population of giant catfish and apply improved breeding protocols based on molecular genetic analysis. It will also continue to regulate the harvest of giant catfish with a view to conserving the wild population while also providing population monitoring data and maintaining the indicator value of the species. Any requests for permits to harvest the protected species will be determined with due consideration of population status and quantitative biological limits to exploitation.

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