

## STATUS AND CONSERVATION OF TWO ENDANGERED FISH SPECIES, THE MEKONG GIANT CATFISH *PANGASIANODON GIGAS* AND THE GIANT CARP *CATLOCARPIO SIAMENSIS*, IN CAMBODIA'S TONLE SAP RIVER

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### ABSTRACT

The Mekong giant catfish *Pangasianodon gigas* and the giant carp *Catlocarpio siamensis* are two of the largest freshwater fish in the world, attaining 3 m and 300 kg. These two species are incidental catches of the Tonle Sap River bagnet fishery in Cambodia. A buy and release project was established in 2000 to help conserve *P. gigas* and *C. siamensis*. These species were purchased from bagnet operators and returned alive into the Tonle Sap River. In addition, two giant catfish were marked with external plastic tags prior to release. In the short term, the purchase and subsequent release of captured wild fish may decrease the probability of the extinction of *P. gigas* and *C. siamensis*. The tagging of *P. gigas* may provide information about the migratory behavior of this species.

Key words: Catch and release project, tagging, endangered species, fisheries management, transboundary stocks

### INTRODUCTION

The giant Mekong catfish *Pangasianodon gigas* (CHEVEY, 1930) is a Mekong endemic (RAINBOTH, 1996). *P. gigas* is one of the world's largest freshwater fish, measuring up to three meters in length and weighing in excess of 300 kilograms (SMITH 1945, ROBERTS & VIDTHAYANON, 1991). Historically, *P. gigas* was distributed throughout the Mekong River Basin from the coast of Vietnam to southern Yunnan Province in China (SMITH, 1945, ROBERTS & VIDTHAYANON, 1991).

In the Tonle Sap River of Cambodia, adult giant catfish are caught from October to December. At this time, the fish are moving out of the Tonle Sap Lake and into the mainstem of the Mekong River. Based on catch information provided by ROBERTS (1993) and others, we believe that *P. gigas* may migrate from Cambodia upstream into Laos, Thailand, or China to spawn. Spawning fish were reported in northern Thailand about twenty kilometers upstream of Chiang Khong (POOKASWAN, 1983), but the authors do not have recent evidence of spawning activity in this area.

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*P. gigas* presently appears to be limited to the Mekong River and its tributaries in Thailand, Laos, and Cambodia. The species has been stocked in various reservoirs in the Mekong and other basins in Thailand but invariably such introductions have failed to result in established populations (Tyson R. Roberts, personal communication, 2 November 2001). *P. gigas* is now very rare in Northeast Thailand, southern Laos, and Vietnam (see Table 1).

Table 1. The status of the Mekong giant catfish *Pangasianodon gigas* in the Mekong River Basin. Based on catch data, the abundance of *P. gigas* appears to be declining throughout the basin. The range of *P. gigas* is also shrinking. Fish have disappeared from sites where they were once caught. For example, fishermen in Vietnam, Northeast Thailand, and Southern Laos no longer report the species.

Location	Status (based on catch data)	Source
Chiang Khong, Northern Thailand	The catch has declined from a peak of 69 fish in 1990 to just 7 fish in 1997. This year (2001) no fish were caught in Chiang Khong.	SRETTACHEUA, 1995, HOGAN, 1998
Luang Prabang, Lao PDR	The catch declined from about 12 fish per year to just 3 fish in 1968. No fish were caught in 1972, 1973, or 1974. Since that time, no significant catch of <i>P. gigas</i> has been reported for the Luang Prabang area.	DAVIDSON, 1975
Nong Khai Province, Northeast Thailand	In the early 1900's, 40–50 fish were caught per year. Since that time, however, the number of fish has declined. In 1967, fishermen captured 11 fish in the Nong Khai area. By 1970, <i>P. gigas</i> occurred only rarely as by-catch of beach seine fisheries. Today, very few <i>P. gigas</i> are reported from Nong Khai Province.	PHOLPRASITH & TAVARUTMANEEGUL, 1998 POOKASWAN, 1969
Khone Falls, Southern Lao PDR	A few fish were reported by fishermen each year prior to 1993, almost all caught in the first half of the year. No fish were reported in 1993. The status of <i>P. gigas</i> in the Khone Falls area has not been assessed since 1993.	BAIRD (personal communication)
Tonle Sap River, Cambodia	Four fish were captured in the bagnet (dai) fishery in 1999 and eleven fish reported in 2000. Fishermen report that they catch a few <i>P. gigas</i> each year.	PENGBUN <i>ET AL.</i> , 2001. HOGAN <i>ET AL.</i> (this article)
Mekong Delta, Vietnam	Once abundant in the delta, <i>P. gigas</i> is now very rare. No significant fishery for this species exists in Vietnam.	LENORMAND, 1996

The giant carp, *Catlocarpio siamensis* (BOULENGER, 1898), is one of the largest cyprinids in the world. SMITH (1945) reports *C. siamensis* grows to three meters in length and a maximum of 300 kilograms. Once found through the Chao Phraya River Basin and the Mekong River Basin, spawning populations of the giant carp now appear restricted to the Mekong River, mainly below the Mun River in Eastern Thailand (HUMPHREY & BAIN, 1990). A population of *C. siamensis* supposedly is present in the Chao Phaya but it is unclear whether this population is naturally occurring or the result of artificially bred stock that has become successfully established (Tyson R. Roberts, personal communication, 24 Sept. 2001)

In Cambodia, *P. gigas* and *C. siamensis* are incidental catches of the Tonle Sap bagnet fishery. In 1999, four giant catfish were caught in bagnet row #2 just outside of Phnom Penh. Row #2 traditionally catches most *P. gigas* and *C. siamensis*. The river is deeper and narrower at this site, causing the current to flow swiftly. The fast current sweeps fish into the bagnet and makes it difficult for them to escape. Although Cambodian law forbids the capture, sale, or transport of the endangered species *P. gigas* and *C. siamensis*, bagnet owners catch both of these species every year. These fish are usually sold quietly in the market or to fish processing factories.

The Tonle Sap River is one of the last places where giant catfish and giant carp are caught in appreciable numbers, but the population status of these species is unclear. Although *P. gigas* has been slowly disappearing from Thailand, Laos, and Vietnam, little information exists about the health of *P. gigas* populations in Cambodia. In fact, as recently as 2000 *P. gigas* was listed as extinct in Cambodia (FRIEDERICH, 2000). Nonetheless, adult fish of both *P. gigas* and *C. siamensis* occur in the Tonle Sap River. Furthermore, a relatively young *P. gigas* (15 kg, 1.0 m TL) has been reported recently from fishing lot number five in the Tonle Sap Lake (So Nam, personal communication, 30 May 2001). Likewise, young *C. siamensis* also occur in the Tonle Sap Lake in Prey Veng, especially near the Tonle Tauch River. The presence of young fish (and adult fish) supports the idea that self-sustaining populations of *P. gigas* and *C. siamensis* exist in Cambodia, and so presumably, these species may spawn somewhere in the lower Mekong River.

The two objectives of this study were: (1) to establish a buy and release scheme for adults of the endangered species *P. gigas* and *C. siamensis*, and (2) to tag adult Mekong giant catfish to study migratory behavior.

## PROJECT RATIONALE

**Buy and release.**—Several recent studies suggest that, for long-lived organisms, the survival of adults is the most important factor contributing to stock abundance (CROUSE ET AL., 1987, HEPPEL, 1997, BOREMAN, 1997). Large-bodied adults have few natural predators, and no mechanism exists to cope with high adult mortality (BOREMAN, 1997).

In the Mekong River Basin, the three largest species of pangasiid catfishes, *Pangasianodon gigas*, *Pangasius sanitsongsei*, and *Pangasianodon hypophthalmus*, are all rare. These species were more abundant before the introduction of highly efficient fishing gears in the 1960s and 1970s (ROBERTS, 1993). Hydropower development and habitat modification may also negatively impact fish abundance (HILL & HILL, 1994). Today, managers are looking for techniques to restore these depleted fish populations (MEKONG

RIVER COMMISSION, 1992). Several strategies have been suggested or implemented, including a closed fishing season for adults, a moratorium on fishing of fry and fingerlings, the supplementation of existing stocks using hatchery reared fry, and the establishment of small, community based no-fishing zones.

For this project, we applied a different approach. We purchased and released live large-bodied, endangered species for release into the wild. The buy and release approach provides a low cost, short-term solution to fishing mortality of endangered species. The buy-and-release scheme does not harm the fisher's livelihood and provides an opportunity for additional research (e.g. tissue sampling for genetics studies). Moreover, the purchase and release of charismatic species generates a wider appreciation for the conservation of the aquatic biodiversity of the Mekong River Basin.

**Tagging.**—Tag and recapture projects are common in fisheries research. Normally, large numbers of fish are tagged and released. Information about recaptured fish is used to generate population estimates, calculate growth curves, or track fish movements. The focus of this project, however, was the study of the migratory behavior of *P. gigas*. We focused on the Mekong giant catfish and only a small number of fish were tagged. Giant catfish were tagged in the hope that they would be recaptured in Thailand in April or May. Although the chance of recapturing a tagged giant catfish is small, the rarity and notoriety of the species increase the likelihood of detecting a recapture. Only two established fisheries exist for the Mekong giant catfish, one in northern Thailand and the other in the Tonle Sap River of Cambodia. The Cambodian Department of Fisheries, in cooperation with the Project for Management of Cambodian Freshwater Capture Fisheries Project, monitors the Tonle Sap fishery. The Thai Department of Fisheries monitors the Thai fishery. The Freshwater Fisheries Project and the Thai Department of Fisheries have agreed to contact each other in the event that a tagged fish is caught in either location.

In the case of *P. gigas*, the problem is to determine whether Cambodian fish and Thai fish represent distinct stocks or one population. If a fish tagged in Cambodia is recaptured while spawning in Thailand, this implies that the Thai fish and Cambodian fish represent one stock and should be managed accordingly. On the other hand, the existence of multiple spawning sites and multiple reports of young fish (distributed throughout the basin) implies that the Thai fish and Cambodian fish represent different stocks.

The situation is further complicated by the operations of the Thai Department of Fisheries captive breeding program for *P. gigas*. The Department of Fisheries has been releasing young *P. gigas* into the Mekong since 1984. Although catches of *P. gigas* in the Thai portion of the Mekong River have continued to decline since the establishment of the Thai breeding program, the impact of the program on the abundance and population structure of *P. gigas* in Cambodia have not been assessed. Genetic studies are underway to determine the population structure of wild *P. gigas* and probable population genetic impacts of the Thai breeding program on wild *P. gigas* populations (Hogan, unpublished).

## STUDY SITE

The Tonle Sap River connects the Tonle Sap Lake with the Mekong and Bassac Rivers in central Cambodia. From October through March, the river and its associated waterways and flooded areas support several types of small and medium size fisheries. The bagnet

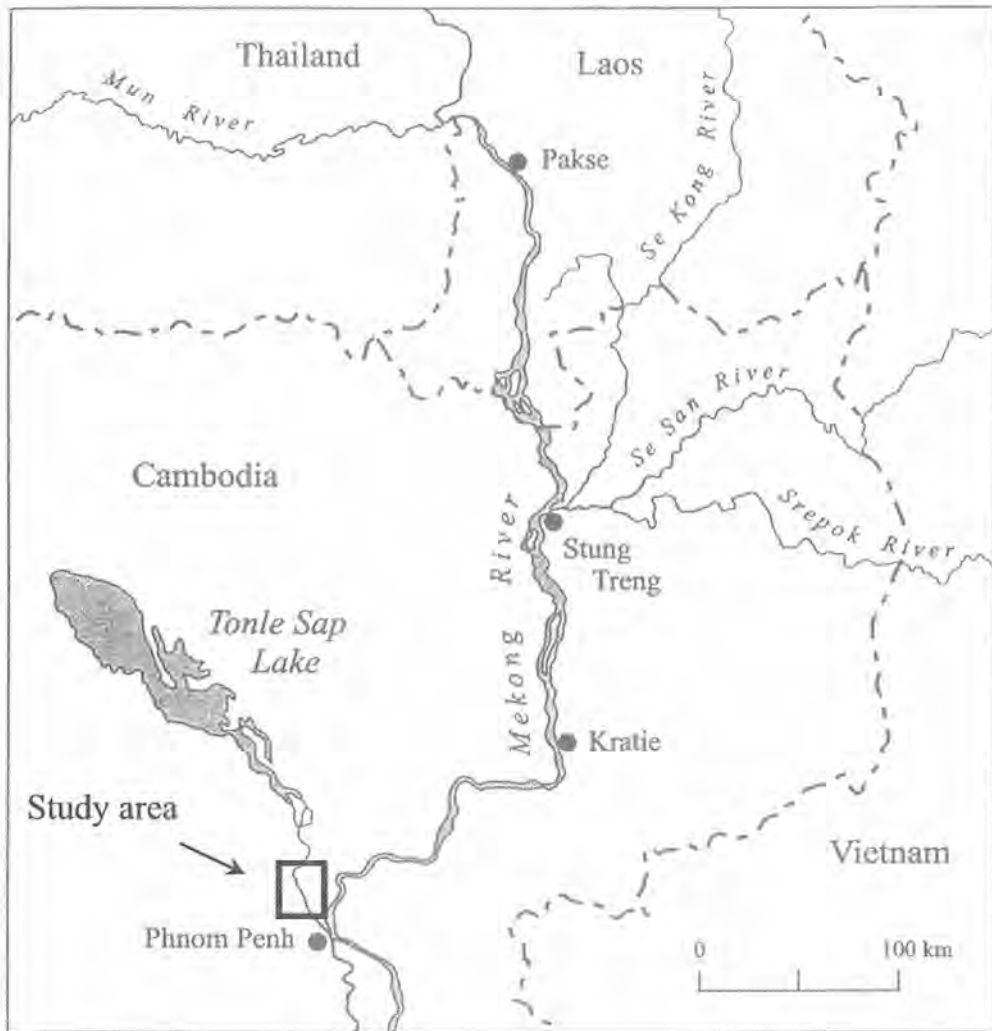


Figure 1. Map of the study area.

(*dai*) fishery is located in the lower part of the Tonle Sap River between 4 and 35 km outside of Phnom Penh (Fig. 1). There are 15 rows and 63 individual nets (also called units) in the fishery. Thus, one "*dai* unit" refers to a single bagnet 120 m long and 25 m in diameter at the mouth. The first row of nets is located near Phnom Penh city while the 15th row is located 35 km north of Phnom Penh. The bagnets, like many other fisheries in the Tonle Sap River, operate from October to March, the period when water flows out of the Great Lake down the Tonle Sap and into the Mekong and Bassac Rivers. A description of the fishery is given by LIENG *ET AL.*, 1995.

Before 1989, the *dai* units were owned communally by the state. Several families worked together to operate the *dai*. Part of the catch was given to the government as tax and the families were free to sell the remainder of the catch. Since 1989, rights to participate

in the dai fishery have been sold at public auction. During the 2000 fishing season, the highest price paid for the right to operate one dai unit was US \$7,923 and the lowest price was US \$103 (mean of 63 dais = \$1798). The main catch of the dais are cyprinid species such as *Henicorhynchus siamensis* that are caught on their migration from the floodplains via the Tonle Sap River to the Mekong River. The migration is lunar phase dependent and at peak times, especially in January, catch rates may exceed 1 ton per hour per dai unit.

## METHODS

The project was initiated through cooperation between the University of California, Davis, the Cambodian Department of Fisheries, the MRC/DoF/Danida Project for Management of Freshwater Capture Fisheries of Cambodia, and the Phnom Penh Fisheries Office.

Rather than monitor the nets ourselves, we relied on cooperation from the bagnet owners to collect *P. gigas* and *C. siamensis*. We spoke with each bagnet owner individually to explain our objectives. We informed the bagnet owners of our intent to purchase, tag, and release all *P. gigas* or *C. siamensis* caught in the bagnet fishery. All of the bagnet owners agreed to cooperate with our project. We asked them to contact us immediately, 24 hours a day, when they captured a fish. Once we were contacted, we went by car to the river and then the bagnet owner would usually arrange a boat for us to get to the nets. The fish were usually kept in nets underneath a floating house located near the owner's bagnet. These floating houses serve as holding areas for fish caught in the bagnet and also as landing sites where fish are brought from the bagnet for sale. The bagnet owners were reimbursed for the fish according to the market price. Fish in poor condition were not purchased.

We measured, weighed, photographed and tagged each fish. Fish total length was recorded to the nearest centimeter using a standard measuring tape either placed flat on the ground beside the fish or held level over the body of the fish. Weight was recorded on a standard market grade scale with one-kilogram increments. The fish were tagged with a Floy FH-69 stainless steel dart tag with #13 vinyl tubing and 200 lb. Test nylon monofilament with Shrink-Lock (Floy Tag Inc., Seattle U.S.A.). The tags were placed in the dorsal musculature of the fish just behind and to the side of the dorsal fin. After tagging, the fish were returned to the water for a period of five minutes to ten minutes, then released downstream of the bagnet fisheries.

## RESULTS

In 2000, 11 giant catfish were caught (Table 2). The largest giant catfish weighed 268 kg and measured 2.64 m in total length. Eleven giant carp were also captured in the bagnet fishery (Table 3). The largest giant carp weighed 120 kg. The average cost of *P. gigas* was 1,600–2,000 riel (US \$0.40–0.50) per kg. The cost of *C. siamensis* ranged from 4,500 to 6,000 riel (\$1.10–1.50) per kg, depending on the size of the fish. Prices are listed as dollars per kilogram in instances where the fish was not purchased by our project. These fish were sold to fish retailers at the price indicated in the table (i.e. wholesale market price).

Table 2. Mekong giant catfish, *Pangasianodon gigas*, caught in the bagnet fishery October–December, 2000

Date	Bagnet unit	Weight (kg)	Total length (m)	Price (USD)	Status
24-Oct-00	2B	171	2.18	0.58/kg	
25-Oct-00	4A	180		0.44/kg	
28-Oct-00	1B	135		0.40/kg	
28-Oct-00	1B	185		0.40/kg	
31-Oct-00	2D	270			Released
05-Nov-00	2C	170			Released
09-Nov-00	4A	200		0.40/kg	
10-Nov-00	1D	160	2.10	100	Released
11-Nov-00	2C	260	2.35	133	Released
26-Nov-00	2D	210			Released
06-Nov-00	1C	268	2.64	137	Released

Table 3. Mekong giant carp, *Catlocarpio siamensis*, caught in the bagnet fishery October–December 2000

Date	Dai unit	Weight (kg)	Total length (m)	Price (USD)	Status
07-Nov-00	4D	40		1.50/kg	
08-Nov-00	5C	42		1.40/kg	
08-Nov-00	6D	28		1.15/kg	
19-Nov-00	2C	8	0.74	10	Released
19-Nov-00	2D	50	1.34	76	Released
20-Nov-00	2C	56	1.36	86	Released
20-Nov-00	Boat Seine	55	1.25	84	Released
21-Nov-00	2D	85	1.62	127	Released
23-Nov-00	2D	40			
28-Nov-00	Boat Seine	120			
03-Dec-00	4C	116			



Figure 2. A Mekong giant catfish captured October 24, 2000 in bagnet unit 2B. This fish weighed 171 kg and measured 1.71 m total length.



Figure 3. One of the largest Mekong giant catfish caught in Cambodia in 2000. This fish weighed 268 kg and measured 2.64 m total length. Here, the fish is being returned to the Tonle Sap River after tagging.





Figure 4. An 85-kg giant carp from bagnet unit 2D. This fish was caught on November 21, 2000, and measured 1.62 m total length. This fish was successfully re-released into the Tonle Sap River.



Figure 5. Three fishermen lift a bagnet to clear it of fish. A medium-size *Pangasius larnaudei* can be seen inside the net.



Figure 6. Fishermen preparing to empty the bagnet basket into a boat for transport to the landing site. This basket is attached to the bagnet at the far downstream end of the funnel-shaped net.



Figure 7. The Tonle Sap River. The floating houses of the bagnet owners can be seen along the river bank. These floating houses serve as holding areas for fish caught in the bagnet and also as landing sites where fish are sorted, stored, and then later sold.

## DISCUSSION

### Population Status

Wild giant catfish may become extinct in the near future. Until more is known about the capture rates, migration patterns, and basinwide distribution patterns of the species, it is difficult to determine the status of the population(s). Despite this uncertainty, fishing and habitat degradation continue. In the short term, the purchase and subsequent release of captured wild fish afford the giant Mekong catfish and the giant carp the greatest chance of survival, because the survival of adult fish is critical to the persistence of populations of rare species. The tagging of *P. gigas* may resolve questions about the population structure and migratory behavior of the species. Information about migratory behavior is needed to partition populations of *P. gigas* into appropriate management units (i.e. demographically independent populations).

While fishing has undoubtedly had negative impacts on populations of *P. gigas* and other rare species (and continues to do so) habitat degradation should not be over-looked as a cause for population decline. In rare species such as *P. gigas*, any decrease in survivorship as a result of habitat loss can result in a chronic long-term decline of the population (MARSH *ET AL.*, 1999). Declines in recruitment due to loss of habitat or habitat modification can be especially acute in highly fecund species such as *P. gigas* and *C. siamensis* (assuming recruitment is correlated with habitat quality). DOHERTY & FOWLER (1991) suggest that for such species, large numbers of young combined with declining recruitment can lead to huge declines in future adult stock abundance. Habitat degradation (due to increasing siltation of the Mekong mainstem) became a critical problem for *P. gigas* and *C. siamensis*, especially in the upper stretches of the river, when the Chinese engaged in large-scale deforestation of Yunnan in the early 1960s (Tyson R. Roberts, personal communication, 24 Sept. 2001). Current threats to *P. gigas* include the planned destruction of rapids in the stretch of the Mekong River in the northern Lao PDR and southern China. This area is thought to be spawning habitat for *P. gigas*.

### Fishery Management

This project would not have been possible were it not for several aspects of the fishery itself. First, the dai fishery is located near Phnom Penh, making the fishery easy to monitor from the capital city. The Cambodian Department of fisheries and the Phnom Penh Fisheries Office are both headquartered in Phnom Penh. Second, the giant catfish and the giant carp are caught illegally, as by-catch, and sold for relatively small sums of money (i.e. US \$100), making the purchase of fish economically feasible. Moreover, both species are rare and so we were able to purchase every fish. Had a targeted fishery for Mekong giant catfish or giant carp existed, we would not have wanted to encourage the capture of the fish by paying for it. However, we did not encourage the capture of the fish because these species are caught incidentally as by-catch and are not targeted by the dai fishery.

In the future, fishing for Mekong giant catfish and giant carp should be closely regulated. These relatively long-lived species are endangered and cannot support intensive fishing pressure (VAN ZALINGE *ET AL.*, 2000). Unfortunately, the effective monitoring of the dai units is not possible at this time. And little specific information exists on *P. gigas* or

*C. siamensis* catches in other fisheries. Therefore, we do not know which fisheries are the main culprits for the demise of the species. The high monetary value of these species virtually guarantees that the fish will not be released voluntarily.

Given this situation, there are few options available to fisheries managers wishing to limit the catch of giant catfish and giant carp. One option is the closure of selected dai units from October to December, the period of capture of the giant catfish. The advantage of the dai unit closure is the ease of monitoring such a moratorium. The disadvantages include the lost tax revenue from the auction of the rights to operate the dai and the negative consequences of the moratorium on dai operators. The lost revenue (both to the government and the dai operators) could be substantial. A second option is to continue to purchase and release the giant catfish and the giant barb. Such a buy and release scheme does not harm the dai operators' livelihood, allows for further research on the species, and generates public interest for a wider conservation effort of the species. However, an annual fund of approximately US \$5,000 would be necessary to cover the costs of a buy-and-release scheme. A second disadvantage of the buy and release scheme is the risk of injury to the fish. The nets sometimes injure fish.

In terms of the maintenance of brood stocks of *P. gigas* and *C. siamensis*, we had hoped that this buy and release project would lead the Cambodian Department of Fisheries to rethink its fishing policy for bagnet row #2. We believed that a three month suspension of fishing operations at bagnet row #2 would decrease the chance of capture of endangered fish species. In fact, the Cambodian Department of Fisheries has already closed bagnet row #1 and is considering suspending fishing at bagnet row #2. However, the conservation of the giant catfish and giant barb is made more difficult by the discovery that these species are captured in more bagnet rows and during a longer period of time than previously believed. So while the suspension of fishing at bagnet row #2 during the months of October to December will reduce fishing pressure on giant catfish and giant barb, some fish will likely be caught in other bagnet rows. The closure of bagnet row #2 would also compromise current research of the genetics and migrations of *P. gigas*.

### Recommendations

In the short-term, we recommend continued monitoring of the bagnet fishery. Endangered species should be released if captured, either through monitoring and enforcement of existing fisheries laws or through a buy and release program similar to the project described in this paper. Furthermore, we recommend surveys of the Kampong Chhnang barrages from October to February and the Great Lake fishing lots in March - May to determine the status of *P. gigas* in the Tonle Sap River and Great Lake. The presence of young *P. gigas* in the Tonle Sap Lake supports the hypothesis that naturally occurring *P. gigas* still spawn in the Mekong River. We also recommend that a group of fisheries experts draft a basinwide conservation status report, including information from relevant Thai, Khmer, Vietnamese, and Lao literature. Once completed, the conservation status report can serve as the basis for a conservation action plan (i.e. a species survival plan) including detailed recommendations regarding the steps necessary to protect the species. Finally, we recommend genetic and tagging studies to determine the population structure and migratory pathways of *P. gigas*, and also to improve the current breeding program of the Thai Department of Fisheries. These studies are necessary to accurately

determine the status of *P. gigas* in Cambodia and also to safeguard wild populations of *P. gigas* from introgression with genetically homogenous cultured stock.

In the long term, the Cambodian Department of Fisheries would do well to develop methods to manage and protect endangered, migratory species and their habitat. The giant catfish and giant carp represent flagship species that highlight the need for broad efforts to protect endangered species and limit habitat loss. And, because the Mekong giant catfish is captured in Cambodia, Laos, and Thailand, the protection of giant catfish in Cambodia must be coupled with similar conservation efforts in all countries within the Mekong River Basin. Regional cooperation is important, not only to protect the Mekong giant catfish, but also to successfully manage and sustain fisheries for all migratory, transboundary stocks.

The Mekong River Commission (MRC) Project for the Management of Freshwater Capture Fisheries of Cambodia and the Assessment of Mekong Fisheries Component Project in Lao PDR are well positioned to facilitate coordination between fisheries departments in Thailand, Lao PDR, and Cambodia. Together, these groups can coordinate a basin-wide approach to the management and conservation of the Mekong giant catfish. The MRC Technical Advisory Body for Fisheries Management is another possible forum for discussion of international conservation issues.

## CONCLUSIONS

*P. gigas* is one of the most vulnerable species in the Mekong River Basin and it occurs naturally nowhere else. Its large size and migratory behavior place *P. gigas* at risk from fishing and habitat modification. Populations of other vulnerable species are also declining. The endangered giant carp, *Catlocarpio siamensis*, is disappearing from the wild.

The Mekong giant catfish and giant carp are biologically important and charismatic species (KOTTELAT & WHITTEN, 1996). As flagship species, the giant catfish and giant carp symbolize the ecological integrity of the Mekong River and other freshwater ecosystems in Asia. Thus, the successful recovery of these species is an important part in the sustainable management of the Mekong River Basin.

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