MIGRATORY PATTERNS, HABITAT UTILIZATION AND BEHAVIOURAL ECOLOGY

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Mekong giant catfish tracking project (MCTP): preliminary results in 2002

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Abstract

The Mekong giant catfish (*Pangasianodon gigas* Chevey, 1931), or the pla buk in Thai, is one of the largest freshwater catfish in the world. It is endemic to the Mekong River basin. The biggest fish recorded was about 300 kg with a total length of about 3 m. Although it is listed as a highly endangered species in the IUCN Red List, little is known of its ecology or feeding habits. The Mekong giant catfish tracking project (MCTP) was initiated to investigate the migration behaviour of the catfish using ultrasonic biotelemetry, at the request of the Department of Fisheries, Ministry of Agriculture and Cooperatives of the Government of Thailand in 2001. This request included the following issues: to develop a methodology for tracking the Mekong giant catfish; to clarify the migration behaviour of the mature catfish after spawning and their habitat; to evaluate the resource enhancement achieved by releasing fingerlings into the Mekong River; and to conserve this resource in Thailand. We began by developing the methodology in the Mekong River. In 2002, ten Mekong giant catfish were released into the Mekong River with coded ultrasonic transmitters implanted inside their body cavities. They were monitored by five ultrasonic receivers covering a range of about 110 km. Five of ten catfish were tracked successfully for 10 days after release, four of which went upstream for about 60 km and the other went downstream for about 50 km.

Introduction

The Mekong River is the largest river in Southeast Asia. It flows through six countries including China, Myanmar, Thailand, the Lao People's Democratic Republic (Lao PDR), Cambodia, and Viet Nam from its source in the Tibetan Himalayas, and covers a distance of more than 4,400 km before reaching the South China Sea. The river basin covers an area of nearly 800,000 km. An estimated 1,700 species of fish are believed to inhabit the Mekong River and its basin, including the Mekong giant catfish (Bao *et al*., 2001).

The Mekong giant catfish (*Pangasianodon gigas*), or pla buk in Thai, is endemic to the Mekong River. As its vernacular and English names indicate ("buk" means colossal or strong), pla buk is known for its huge size, attaining a length of 3 m and a weight of more than 300 kg in adults (Akagi *et al*., 1996). It is classified as an endangered species on the 2000 International Union for the Conservation of Nature (IUCN) Red List and also listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Therefore, the fishing of catfish is strictly regulated in Thailand. The only fishery cooperative permitted to catch the Mekong giant catfish in Thailand is located in the Chiang Khong District in the northern part of Thailand. The fishermen in the cooperative use gill nets with a height of 3 m and a mesh width of 40 cm. The fishing season starts in April and finishes by the end of the dry season at the end of May. Recently, the number of fish in these catches has decreased dramatically.

An artificial insemination project, using captive pla buk males and females, was begun in 1981 as a conservation strategy by the Department of Fisheries, Ministry of Agriculture and Cooperatives of the Government of Thailand. Its first success was achieved in 1983. A demonstration of the release of captured pla buk was conducted in 1996 (Akagi *et al*., 1996). However, little is known of the ecology or feeding habits of wild or artificially released pla buk. In particular, the migration behaviour of the Mekong giant catfish is cloaked in mystery because very few mature fish have been caught in the limited area described above.

The Mekong giant catfish tracking project (MCTP) was initiated in 2001 to investigate the migration behaviour of the catfish, using ultrasonic biotelemetry, at the request of the Department of Fisheries, Ministry of Agriculture and Cooperatives of the Government of Thailand. The request included the following issues: to develop a methodology for tracking the Mekong giant catfish in the Mekong River; to clarify the migration behaviour of the mature catfish after spawning and their habitat; to evaluate the effectiveness of the resource enhancement achieved by releasing fingerlings; and to conserve this resource not only in the Mekong River but also in reservoirs in Thailand. At the outset of the cooperative project, we began to develop a methodology to track the Mekong giant catfish in the Mekong River. Our preliminary results are introduced in this paper.

Materials and methods

Study site and experimental fish

The study was conducted in 2002 in the middle reaches of the Mekong River, covering around 110 km within the Nakhon Phanom Province (Fig. 1). We studied ten Mekong giant catfish in 2002. These experimental catfish were artificially inseminated in the Chiang Rai Inland Fisheries Research and Development Center and reared at the Nakhon Phanom Inland Fisheries Station (Table 1).

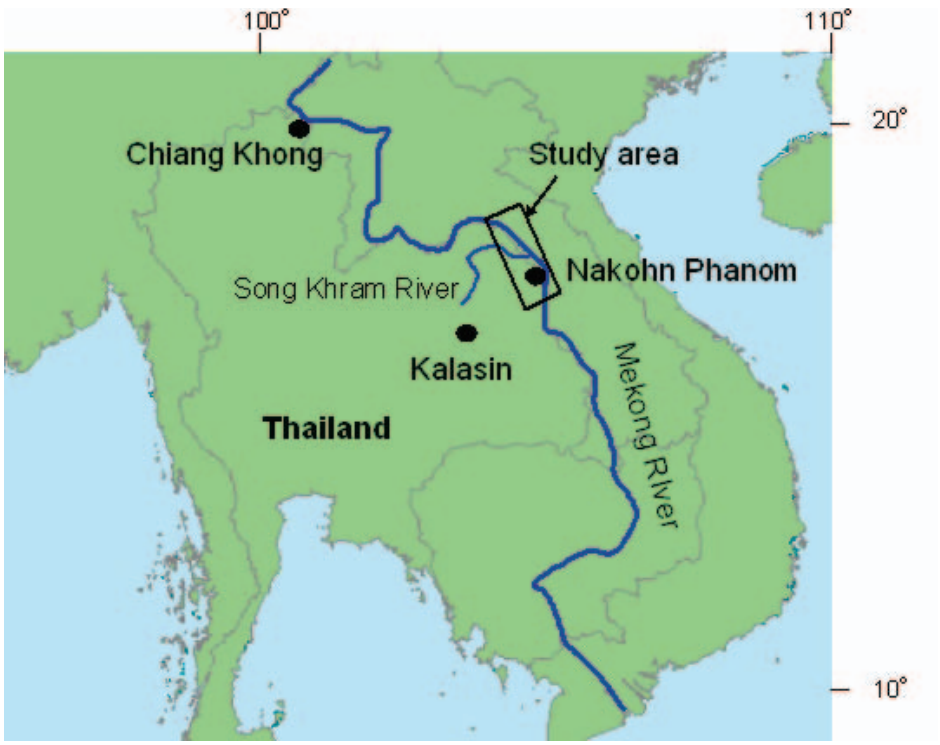

Fig. 1 – Location of the study area of the Mekong giant catfish tracking project (MCTP) in 2002.

Table 1 – Characteristics of the Mekong giant catfish used in this study. The fish were tagged with coded ultrasonic transmitters placed inside their body cavities on June 25, 2002 at the Nakhon Phanom Inland Fisheries Station. The fish were released at the mouth of the Song Khram River on June 27, 2002, at the noted release times.

ID	Fork length (cm)	Body weight (kg)	Release time (June 27, 2002)
1	103.5	15.0	17.00
2	86.5	9.0	12.07
3	105.0	17.2	16.58
4	91.0	12.0	17.02
5	103.5	15.0	12.11
6	67.5	4.2	17.01
7	67.0	4.7	17.03
8	72.0	5.2	9.06
9	69.0	5.4	8.58
10	70.5	5.4	16.59
Average	83.6	9.3	-
s.d.	15.4	4.8	-

Transmitters

We used coded ultrasonic V16-4H transmitters (Vemco Co., Ltd., Canada). They are 16 mm in diameter, 65 mm long, and weigh ca. 10 g in water. The frequency of the transmitters was 69 kHz. The power of the acoustic signals was 153 dB and the interval of transmission was about 45 seconds, on average. The battery lasted over two years. The transmitters transmit complex codes consisting of six pulses per transmission. If the receiver picks up all the six pulses of a transmitter perfectly, it can identify and record the ID number of that transmitter. If the receiver cannot identify the ID number, it records only the number of pulses. Two hundred and fifty-six different fish have been identified on the same frequency using this transmitter (Voegeli *et al*., 1998 & http://www.vemco.com/).

Experimental deployment

Before the main experiment, we carried out preliminary tests to determine the effects of external and surgical transmitter attachments on the fish in the Kalasin Inland Fisheries Research and Development Center using dummy transmitters, from May 3 to June 19, 2002. No external attachment transmitters remained after the experiment. Therefore, all the transmitters were implanted surgically into the abdominal cavities of the catfish under anaesthesia, using our previously described method (Mitamura *et al*., 2002). We implanted the transmitters at the Nakhon Phanom Inland Fisheries Station on June 25, 2002. After surgery, the fish were kept in indoor tanks for at least 24 hours, so that their physical condition could be observed before the release experiments.

The sample catfish were released on June 27, 2002, at the mouth of the Song Khram River, which is one of the branches of the Mekong River (Table 1, Fig. 1).

Tracking system

We used VR1 receivers (Vemco Co., Ltd., Canada) to track the catfish carrying the coded ultrasonic transmitters. The VR1 receivers were installed in water of medium depth to record the presence of the catfish carrying the transmitters. The dimensions of the VR1 receiver are 60 mm in diameter and 205 mm in length, and it is powered by a lithium battery that lasts for 180 days. It has flush-memories inside to record the data. Information, including the ID number and the time, were recorded when the tagged fish

passed within the detection range of the receiver. According to a test of the detection range, the receiver was able to detect signals from transmitters within about 300 m in the main stream of the Mekong River. Therefore, the receivers were unable to completely cover the area up to the opposite side of the river (i.e. the Lao PDR side) in the flood season because the width of the river expands to about 500–600 m.

Tracking periods and placement of fixed stations

We installed five VR1 receivers, No. 1–5, in the Mekong River. Two (No. 3 and 4) of the five receivers were set up near the release point. One (No. 5) receiver was set up in the Song Khram River, which is a branch of the Mekong River. Another (No. 1) receiver was set up at a place about 60 km upstream from the release point, in the Bannakhae district of the Nakhon Phanom Province. The fifth receiver (No. 2) was set up about 50 km downstream from the release point in front of the River View Hotel in the downtown sector of Nakhon Phanom. The data from the five VR1 systems were downloaded on August 18, 2002. After downloading, the locations of two VR1 receivers were changed to cover further areas 100 km upstream (Fig. 2). The second downloading was conducted on November 23, 2002.

Results

All the VR1 receivers worked well and detected signals from the coded ultrasonic transmitters in the sample catfish. Figure 3 shows a summary of the results of the tracking study. The No. 3 receiver, nearest to the release point, recorded data for all the sample fish on July 27, 2002, when the fish had been released. This indicates that all the transmitters were working well inside the catfish.

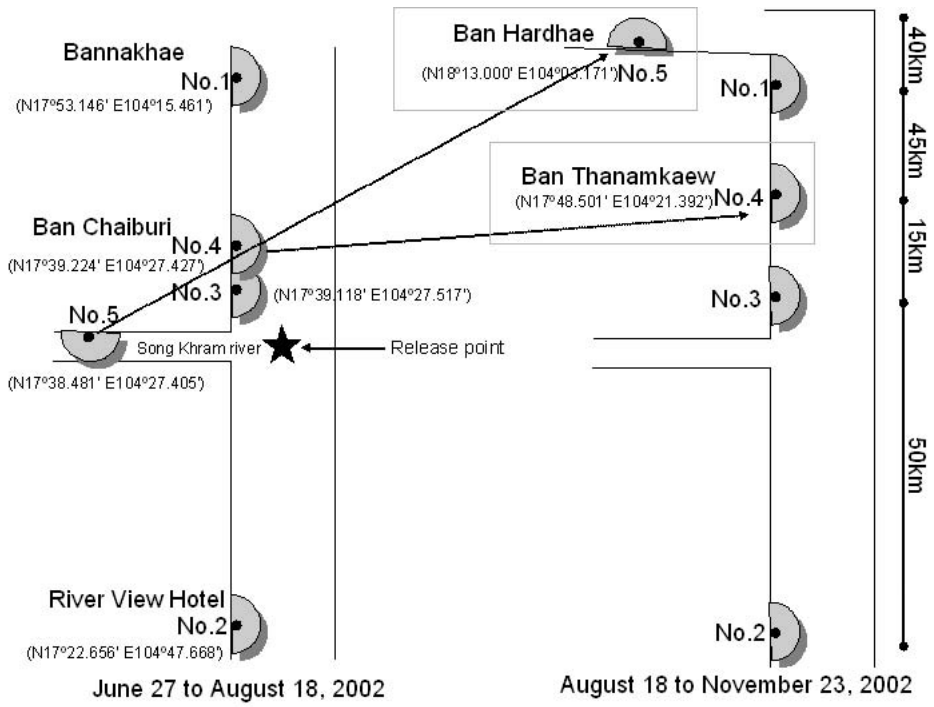

Fig. 2 – Distribution of the VR1 receivers between June 27 and August 18 and between August 18 and November 23, 2002.

We describe in detail the attendance of each fish at the receivers as follows: ID 1 went out of range of receiver No. 3 just after its release at 17:00 hours on June 27, 2002. Then it returned to the release point and stayed between receivers No. 3 and 4 from June 27 to July 1, 2002. At 20:58 hours on July 1, it went out of range of receivers No. 3 and 4. It appeared again 60 km upstream from receiver No. 1 at 11:00 hours on July 4 and stayed around receiver No. 1 for 01.02 hours.

ID 2 was released at 12:07 hours and stayed for 10.34 hours around the release point, then disappeared.

ID 3 was released at 16:58 hours and stayed there for two hours. It was also detected in the branch stream, at receiver No. 5, soon after. It disappeared between June 28 and July 3, and then returned to receiver No. 4. It went upstream again at 06:55 hours on July 4 and arrived at receiver No. 1 at 11:00 hours on June 6.

ID 4 moved out from the release point just after release and never returned.

ID 5 was released at 12:11 hours and stayed around the release point for five days. On June 29 and 30, 1,367 and 1,555 signals from its transmitter were detected by receiver No. 3, respectively.

ID 6 was released at 17:01 hours and moved into the branch stream, around receiver No. 5, on June 28 and stayed there for three days. On June 28, 29, and 30, 1670, 2110, and 1753 signals from the transmitter were detected by receiver No. 5, respectively. The fish then moved into the main stream at 09:33 hours on July 1, 2002 and swam 60 km upstream and passing the No. 1 receiver at 0:42 hours on July 3.

ID 7 was released at 17:03 hours and stayed at the site for two hours. It then moved away from the release point and appeared around the mouth of the branch stream on July 3, 2002. ID 8 was released at 09:06 hours, stayed for 5.16 hours, and then disappeared. After six days, it appeared about 500 m upstream from the release point. It then moved upstream at 14:50 hours on July 4 and arrived at receiver No. 1 at 11:28 hours on July 6.

ID 9 was released at 08:58 hours and moved out from the release point. It appeared again 50 km downstream on July 4 and passed receiver No. 2. The signals were recorded between 09:58 and 10:53 hours by receiver No. 2.

ID 10 was released at 16:59 hours, disappeared immediately, and never returned to the vicinity of any receiver.

We downloaded the data from all the receivers on November 23, 2002. We found that no IDs were recorded on all the receivers, although there were many pulses recorded, as shown in Table 2.

Discussion

All the VR1 receivers successfully recorded the ID numbers of the sample Mekong giant catfish in a wide area ranging along about 110 km of the river. However, the detection range of the VR1 receivers was limited to within a radius of about 300 m, so that it was impossible to detect signals when the catfish moved to the opposite side of the river, i.e., the Lao PDR side. Disappearance of IDs 2, 4, and 10 just after release indicates that they moved out of the detection range. In future, receivers should also be installed on the Lao PDR side of the river to track the catfish completely.

The V16 coded transmitters sent ultrasonic signals every 45 seconds on average. The signal interval varied randomly ranging from 20 to 90 seconds, in order to avoid crosstalk. Therefore, the number of detection events should be less than around 1920 per day on average. ID 5 was detected on June 29 (1367 times) and on June 30 (1555 times) at the No. 3 receiver, and ID 6 was detected on June 28, 29, and 30 (1670, 2110, and 1753 times, respectively) at receiver No. 5, indicating that these fish were continuously within a 300 m radius of the respective VR1 receiver. Moreover, it is clear that ID 6 entered the Song Khram River on June 28 and stayed there until June 30 (Fig. 3).

The data from the VR1 receivers show us the times at which fish were present in an area with a 300 m radius. This constitutes an attendance book for the fish. We can infer the fish's movements using two attendance books. ID 1 moved away from receiver No. 4 at 20:58 hours on July 1 and was detected at receiver No. 1 at 11:00 hours on July 4. It took 38 hours and two minutes to move from receiver No. 4

ID	July 2002										Moving direction
	27	28	29	30	1	2	3	4	5	6	
1	Release point (RP)*							60 km up***			UP
2	RP										-
3	RP							RP		60 km up	UP
4	RP										-
5	RP		RP								-
6	RP	Branch**			RP		60 km up				UP
7	RP						RP				-
8	RP							RP		60 km up	UP
9	RP							50 km down****			Down
10	RP										-

* Release point included data of Nos. 3 and 4 VR1 receivers

** Branch was No. 5 VR1 receiver data

*** 60 km-up was No.1 VR1 receiver data

**** 50 km-down was No. 2 VR1 receiver data

Fig. 3 – Summary of the results of the Mekong giant catfish tracking project using coded ultrasonic transmitters and VR1 receivers in the Mekong River in 2002.

Table 2 – Number of pulses recorded by the VR1 receivers between August 18 and November 23, 2002.

VR1 location	Number of pulses
No. 1	344
No. 2	67
No. 3	1688
No. 4	7089
No. 5	364

to receiver No. 1. In the same way, IDs 3, 6, and 8 took 52 hours and 8 minutes, 55 hours and 49 minutes, and 44 hours and 38 minutes, respectively, to move between these points. They swam about 60 km from receiver No. 4 to receiver No. 1 in 49 hours and 39 minutes, on average. If the catfish swam 12 hours a day, the average swimming speed was 178 cms^{-1}, taking into consideration the velocity of the river current, which was about 2 kmh^{-1} (measured by a global positioning system [GPS] on the boat). The average body length (BL) of the fish (l) was 87 ± 20 cm, so that 178 cms^{-1} can be converted to two body lengths per second (2 BLs^{-1}). This is a reasonable value according to previous studies (Bainbridge, 1958; Wardle, 1975).

Only ID 9 appeared at receiver No. 2, 50 km downstream from the release point, on July 4, 2002. We should interpret downstream movement with caution because dead fish will also drift downstream with the current. If the fish were dead, it would move across the 600 m diameter of the detection range of receiver No. 2 in 18 minutes, if the velocity of the river were 2 kmh^{-1}. Therefore, because the signals for catfish ID 9 were recorded for 55 minutes, from 09:58 to 10:53 hours, on July 4 by receiver No. 2, it appears to have been alive, although there is no other evidence to support this inference.

The second downloading on November 23, 2002, gave us no ID number at all. However, fractions of ultrasonically coded signals were recorded by all the VR1 receivers, as shown in Table 2. The No. 4 receiver, located 15 km from the release point, stored 7089 pulses for 97 days, from August 18, 2002 to November 23, 2002. This indicates that

some experimental catfish occupied an area near receiver No. 4, but slightly outside the detection range of the neighbouring VR1s or inhabited areas on the opposite side of the river, i.e. on the Lao PDR side of the Mekong River.

In this study, we used artificially reared Mekong giant catfish instead of wild fish to circumvent the difficulties in preparing wild catfish that result from the serious decrease in recent catfish catches. Therefore, we should interpret the results of this analysis of catfish behaviour with caution. However, the results will provide useful information for understanding the resource enhancement achieved by releasing catfish fingerlings in the future, as has been requested by the Government of Thailand. We are also preparing tracking experiments using wild catfish in accordance with the recommendations of the Government of Thailand but it may be too late to proceed with this because there has been no catch for some years. Against this background, we have started another tracking experiment in an artificial reservoir, the Mae-puem Reservoir in Phayao Province. The Mae-puem Reservoir has an area of about 816 km^2, and was completed in 1982 for irrigation water. The Government of Thailand has undertaken to create new catfish resources in reservoirs. Therefore, we are attempting to clarify the behaviour of reared Mekong giant catfish in order to conserve them in the reservoirs of Thailand.

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