

A Communal Fishery for the Migratory Catfish *Pangasius macronema* in the Mekong River

I. BAIRD¹, Z. HOGAN², B. PHYLAIVANH¹, and P. MOYLE²

¹ Environmental Protection and Community
Development in Siphandone Wetland Project
P.O. Box 860
Pakse, Lao PDR

² Department of Wildlife, Fish, and Conservation Biology
University of California, Davis
One Shields Avenue, Davis
California, U.S.A. 95616

Abstract

The seasonal migration of the catfish *Pangasius macronema* is the basis of an economically and culturally important household-oriented fishery in the Hou Sahong channel, Khone Falls, southern Lao PDR. Three communities capture *P. macronema* as the fish move upstream through Hou Sahong channel in April and May. These communities have developed several fishing systems with traditionally established user rights over particular areas of water. Current plans to develop hydropower in Hou Sahong channel threaten the fishery for *P. macronema*. The dam will flood fishing sites and negatively impact fish migrations.

Introduction

Pangasius macronema (Bleeker 1851) is a small migratory catfish found in large rivers throughout Southeast Asia. Common in the Mekong River, the fish has been recorded recently in Vietnam, Cambodia, Lao People's Democratic Republic (Lao PDR or Laos), and Thailand (Roberts and Vidthayanon 1991, Lieng et al. 1995, Roberts and Baird 1995, Lenormand 1996, Rainboth 1996, Singhanouvong et al. 1996). According to Rainboth (1996), *P. macronema* occurs throughout Southeast Asia from Thailand to

Borneo and Java. Rainboth reported a similar species *Pangasius siamensis* (Steindacher 1879) in the Mekong and Chao Phraya basins.

However, Roberts and Vidthayanon (1991) group *P. macronema* and *P. siamensis* as one species distributed throughout the Mekong and Chao Phraya basins, Java, and southern Borneo. We have only found *P. macronema* in the Mekong River basin, and we believe that *P. siamensis* is probably a synonym for the first species. Recent work seems to confirm that *P. macronema* and *P. siamensis* are the same species (Vidthayanon, pers. comm). Therefore, we call this species *P. macronema* from Roberts and Vidthayanon (1991).

In Lao PDR, *P. macronema* supports socioeconomically and culturally important household-oriented fisheries in the Hou Sahong channel of the

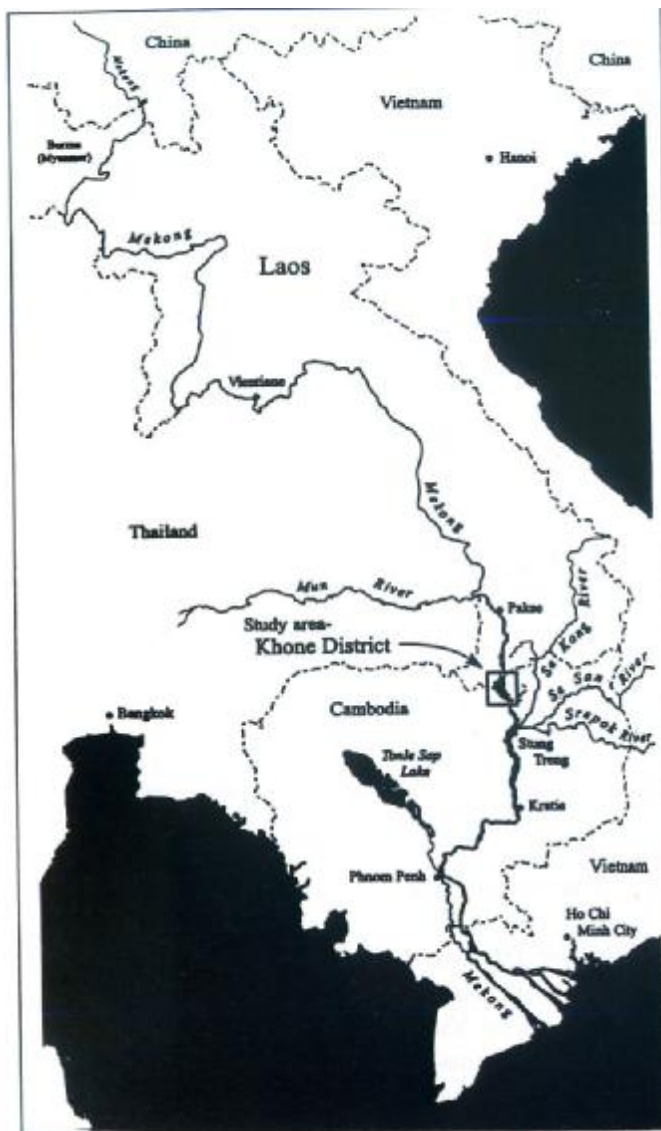


Fig. 1. The Mekong River basin.

Khone Falls. Hou Sahong channel is located near the Lao-Cambodian border in southern Lao PDR (Fig. 1). Hou Sahong channel lies between the islands of Don Sadam to the east and Don Sahong to the west (Fig. 2). The approximately seven km long channel is the only route in the Khone Falls area that fish can easily migrate up in the low-water season. Hou Sahong is the most important channel for migrating fish moving through the Khone Falls area all year round (Roberts and Baird 1995, Baird 1996, Baird et al. 2000 a and b).

P. macronema migrates upstream from Cambodia through Hou Sahong beginning in mid to late April each year. This is the most important fish migration

describe social aspects of the communal fishery for *P. macronema* in Hang Sadam Village and 5) to discuss the potential impacts of hydropower development in Hou Sahong.

Materials and Methods

The Environmental Protection and Community Development in Siphandone Wetland Project (EPCDSWP) maintains field offices near Hou Sahong in the villages of Hang Sadam and Hang Khone. The project is well known in the area. In 1997, the EPCDSWP took over the work of the Lao Community Fisheries and Dolphin Protection Project (LCFDPP). The LCFDPP began systematically monitoring fisheries in the Khone Falls area in 1993.

In conjunction with the EPCDSWP, we collected the information for this paper between 15 April and 15 June 1999. The descriptions of fishing gears and management techniques come from a large body of knowledge collected by our project since 1993.

We collected information about the weight of fish caught per day, individual fish length, individual fish weight, the timing of the migration, price, fishing gears, and management. We collected the weight of fish caught per day by recording the number of fish “*te*” made by the villagers each day. The “*te*” is a traditional form of grouping fish so that they can be smoked. We found that each “*te*” of fish weighed an average 600 g ($n = 32$). In addition, we recorded the weights and lengths of approximately 100 fish per day during the peak of the migration. Lengths were recorded to the closest 0.1 cm. Fish were weighed on a 1 kg scale with 5 g increments. To increase the precision of weight measurements, small fish were weighed in groups. The fish were collected at random from the catches of villagers from Hang Sadam village.

Information about fish ecology, fishery importance, and management was collected through semi-structured interviews with families in Hang Sadam village. We collected fish catch data from each household in the community every day between 23 April and 15 May 1999.

Results

Fish size, timing, price and total catch

In 1998, we estimate that fishers from Hang Sadam village caught a total of 4,000 kg of *P. macronema* from Hou Sahong. Between 23 April and 15 May 1999, fishers at Hang Sadam caught a total of 5,572 kg of *P. macronema* from Hou Sahong. In 1999, apart from *P. macronema*, 21 other species of fish were recorded in catches, although catches of all other species combined represented only a very small proportion of the total catch, which was heavily dominated by *P. macronema* (Table 1). Three other *Pangasiidae*

catfish, *P. pleurotaenia*, *P. conchophilus* and *H. waandersii* were the next most abundant species after *P. macronema*. No large fish were caught.

In 1999, the mean standard length of *P. macronema* was 10.6 cm (std=1.84). The largest fish measured 16.3 cm, the smallest 7.4 cm. Size distribution by standard length is given in figure 3. Mean weight per fish was 13.6 grams (Table 2).

P. macronema migrates through Hou Sahong from April to June. In 1998, the migration began on 15 April. In 1999, the migration began on 23 April (Fig. 4). In 1999, the peak migration of *P. macronema* occurred between 23 April and 30 April 1999. In Hang Sadam village, the highest catch for one day was 1,641 kg on 25 April 1999.

The Champasak Province Division of Communications and Transport maintains a gauge to measure water flow at Hang Sadam Village. The gauge is a metal post situated in cement at a spot near Hang Sadam village and approximately 100 m downstream of Tat Pho. We measured the water level at this gauge between 23 April and 15 May 1999. In 1999, *P. macronema* migrated after an extended period of continuously rising water

Table 1. List of species recorded from Ban Hang Sadam Hou Sahong fisheries, April 23-May 15, 1999.

Species name	Total number of fish
<i>Pangasius macronema</i>	409,700 (approx.)
<i>Pangasius pleurotaenia</i>	1,611
<i>Pangasius conchophilus</i>	525
<i>Helicophagus waandersii</i>	326
<i>Hemibagrus nemurus</i>	234
<i>Puntioplites falcifer</i>	150
<i>Belodontichthys dinema</i>	70
<i>Hypsibarbus malcolmi</i>	62
<i>Micronema micronema</i>	56
<i>Notopterus notopterus</i>	34
<i>Mystus sp.</i>	27
<i>Kryptopterus spp.</i>	12
<i>Tenualosa thibaudaeui</i>	12
<i>Coius undecimradiatus</i>	6
<i>Toxotes microlepis</i>	4
<i>Gyrinocheilus pennocki</i>	2
<i>Hemibagrus wyckiioides</i>	2
<i>Barbodes altus</i>	1
<i>Probarbus jullieni</i>	1
<i>Pangasius larnaudii</i>	1
<i>Henicorhynchus lobatus</i>	*
<i>Henicorhynchus siamensis</i>	*

*Three kilograms of *H. lobatus* and *H. siamensis* were collected on May 12.

Table 2. Measurements of *P. macronema* collected at Ban Hang Sadam, 24 April to 26 April 1999.

Date	Standard length (cm)		Range SL (cm)	Mean weight (grams)	Sample size
4/24/99	10.3	std = 1.82	8.1 - 15.6	13.5	107
4/25/99	10.8	std = 1.71	7.5 - 14.8	13.6	168
4/26/99	10.6	std = 2.07	7.4 - 16.2	13.7	81

levels. The peak occurred when the gauge measured a water depth of approximately four meters.

We began keeping records of prices in 1997 (Table 3). The approximate price of one “te” of *P. macronema* at Hang Sadam village in 1999 was 2,500 Lao Kip, or US\$ 0.40.

Community fisheries data

Every year, fishers catch *P. macronema* as they migrate up Hou Sahong. Most are captured from Hou Sahong at Tat Pho. The area adjacent to Tat Pho, on the Don Sahong side of the channel, is called Tat Dieu (Fig. 2). Fishers from three villages fish for *P. macronema* in Hou Sahong; Hang

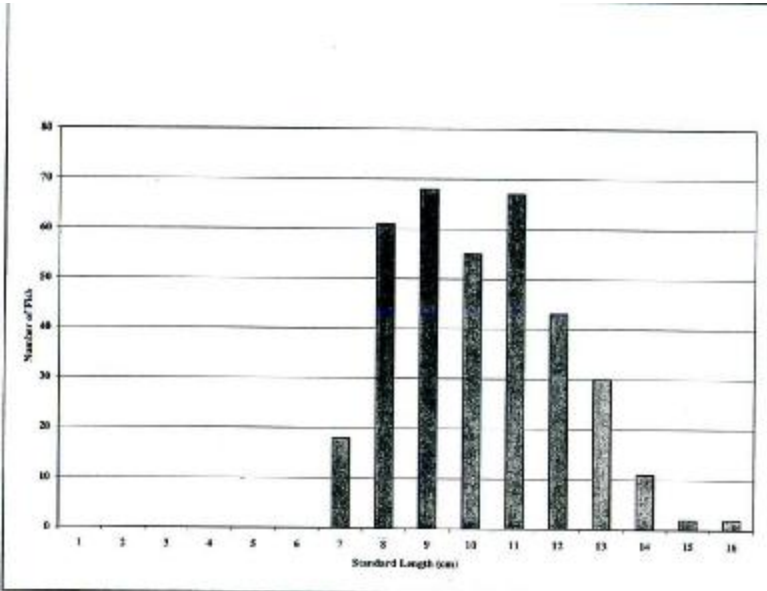


Fig. 3. Size distribution of *P. macronema* Hang Sadam Village, 1999.

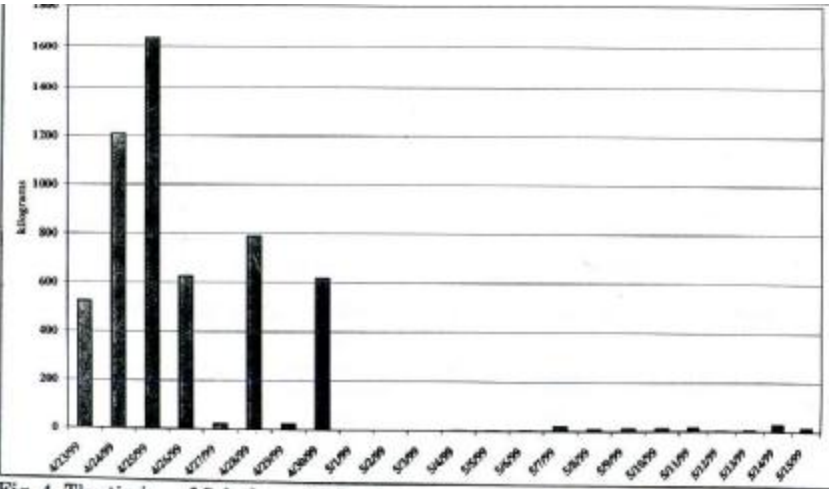


Fig. 4. The timing of fish through Hou Sahong: Total catch of *P. macronema*, Hang Sadam Village, 1999.

Sadam, Houa Sadam and Don Sahong. Villagers from Hang Sadam village fish in Hou Sahong at Tat Pho. Villagers from Don Sahong fish on the opposite side of the channel at Tat Dieu. Villagers from Houa Sadam fish farther up Hou Sahong at a site called Tat Louang. Tat Pho and Tat Louang are the main rapid areas, and thus fishing areas, in the channel. Apparently no other villages are extensively involved in fishing for *P. macronema* in Hou Sahong, although many participate irregularly in the fishery.

Table 4 provides a brief description of the fisheries in each of the three villages near Hou Sahong. The data came from interviews with fishers in Hang Sadam village.

Table 3. The price of one "Te" of Fish, 1997 to 1999.

Year	Village Price (Kip)	Village Price (USD)
1997	300	.28
1998	500-600	.25
1999	2500	.40

Table 4. Community fisheries data.

Village	No of families	<i>Ou</i> Traps	<i>Li</i> and <i>Chip</i> Traps	Scoop Nets	Total Catch
Hang Sadam	87	70 families from the village have 25 <i>ou</i> traps at Tat Pho.	Villagers operate nine <i>li</i> traps and three <i>chip</i> traps near Tat Pho.	Other villagers scoop net for <i>P. macronema</i> (number unclear but probably few families).	The total catch for all methods for all families is estimated to be 5,400 - 6,000 kg for the season.
Don Sahong	53	The village has no <i>ou</i> traps like Hang Sadam Village - no suitable geographical conditions to do so.	8 families operate one <i>li</i> at Tat Lieu, and a few villagers own <i>chip</i> traps.	About thirty families scoop net in the area.	The total catch for the village using all methods is about 1,800 kg for the season.
Houa Sadam	92	About fifteen families from village have four <i>ou</i> traps at Tat Louang, a rapids area in Hou Sahong north of Tat Pho. Also six families from Houa Sadam operate one <i>ou</i> trap together at Tat Pho.	There is one <i>chip</i> in operation near Tat Pho owned by Houa Sadam villagers.	Villagers scoop net for <i>P. macronema</i> at Tat Louang (number unclear but probably many families), also about ten families scoop-net near Tat Pho.	The total catch for all methods and families is estimated to be about 2,400 kg for the season.

The importance of Hou Sahong for community fisheries

Hou Sahong is a very important channel for *P. macronema* and other species. Fishers report that greater numbers of *P. macronema* are captured in Hou Sahong than in other channels.

P. macronema supports an economically important fishery in the villages of Hang Sadam, Don Sahong, and Houa Sadam. In Hang Sadam village, the fishery for *P. macronema* is probably the third most important fishery based on fish migrations through Hou Sahong. As already mentioned, the two other important migrations are the dry season movement of small cyprinids (*Henicorhynchus* spp. and *Paraluabuca typus*, among others) and the early rainy season migrations of *P. conchophilus* (and other catfish) (Baird et al. 2000 a & b). We believe that the fishery for *P. macronema* is more important than the fishery for *Cirrhinus microlepis* in March and early April (Roberts and Baird 1995, Baird 1996, Baird 2000).

Villagers from Hang Sadam catch the more *P. macronema* than fishers from other villages because they have well established fishing rights at Tat Pho, the best fishing site in Hou Sahong channel. Villagers from Don Sahong and Houa Sadam catch less *P. macronema* from Hou Sahong channel than Hang Sadam villagers. Individual families from other villages in the Khone Falls area also sometimes catch significant amounts of *P. macronema*, with wide variations in catches from year to year, depending on the migration routes that the species tries to follow in particular years.

Apparently, only the Hou Sahong fishery for the species is certain to occur each year, because the fish must pass this channel before moving past the falls (Roberts and Baird 1995, Baird 1996).

Villagers themselves eat few *P. macronema*, although they consider it to be a good food fish. Most fish are sold to consumers outside the villages. Traders buy fish in the villages and then resell them in commercial centers such as Pakse and Ubon Ratchathani, Thailand. The sale of *P. macronema* provides a significant amount of income for the villagers of Hang Sadam. Hang Sadam village probably sells more *P. macronema* than any other village in the Khone Falls area.

Villagers estimate that approximately eighty to ninety percent of their cash income comes from fishing. The income derived from selling *P. macronema* is significant both in terms of the amount earned and the time of year it is generated. If the migration comes before the Lao New Year, fishing may generate extra spending money for the biggest holiday of the year. Most importantly, since many families in Hang Sadam village have no rice paddy farmland, or only a small amount of land, the fish they sell provides them with money to buy rice, thus fulfilling an important food security function. Hang Sadam villagers believe that *P. macronema* stocks have been greatly reduced in recent decades.

Data from the seasonal bagnet fishery in the Tonle Sap River of Cambodia support the beliefs of the villagers (Lieng et al. 1995). In 1995, *P. macronema* accounted for 0.31% of this catch, while the species made up 1.5% of the catch in 1962 to 1963. In 1938 to 1939, *P. macronema* was

among the most abundant fish (Lieng et al. 1995). Information provided in Bardach (1959) and Singhanouvong et al. (1996) also suggests that *P. macronema* was more abundant and larger in individual size in the past. This may indicate that stocks have decreased significantly over the last 60 or so years, at least in Cambodia.

Fishing systems developed by communities near Hou Sahong

The choice of fishing gear depends on season, species, and site-specific environmental parameters (Ahmed et al. 1996, Claridge et al. 1997, Baird 2000). Over twenty different techniques have been recorded from the area around Hou Sahong (Roberts and Baird 1995). The five primary gears used to catch *P. macronema* in Hou Sahong are described in table 5.

The *ou* filter trap fishery for targeting *P. macronema* at Tat Pho in the Hou Sahong is unique to the area. User rights are village-based rather than family-based (Roberts and Baird 1995). Every family in Hang Sadam has the right to participate in the fishery. This system has been in existence as long as anybody can remember, and certainly predated the arrival of communism to Laos in 1975. One group of fishers agreed that the villagers of Hang Sadam have been making *ou* traps for the past 80 years. The *ou* fish traps at Tat Pho have apparently been set in virtually the same place for decades, and are essentially arranged to take advantage of natural rock configurations that determine the path that fish migrate up, and are swept down into the traps.

In 1999, there were 25 *ou* traps at Tat Pho, all of which were owned and operated by villagers from Hang Sadam, or people from Houa Sadam with close kinship ties with people from Hang Sadam. Each trap is built and maintained by two to eight families, depending on the efficiency of the trap. Basically the better traps have more owners. The arrangement of users of traps changes from year to year depending on immigration and emigration of families in Hang Sadam village. Individual families do not have long-term ownership or usage rights over particular traps.

During the *P. macronema* fishing season in Hou Sahong, every family representative from the village that goes out to the traps at Tat Pho is guaranteed a share of the catch. The take for each family varies somewhat based on which traps catch fish and who is responsible for particular traps. However, it is not unusual to see 20 people walking back together from picking up their catches of *P. macronema* from Tat Pho, each with an equal-sized basket of fish.

These same villagers are also obliged to help maintain the traps on a daily basis, as required. Some people make the approximately 2 km journey from the village to Tat Pho every day, while other villagers build small huts near Tat Pho and sleep there for many nights in a row during the peak fishing *P. macronema* season. Moreover, some villagers take their share of the communal catch every day, while others only send family members out to get their share on certain days, depending on family conditions.

The ownership of *li* trap sites is restricted to those with traditionally established user rights over particular areas of water. Individual families, or groups or two or more families, have established claims over the particular

spots where they annually set their gears. Villagers believe that they own these particular trap sites, just as they own their rice field farmland or houses (Roberts and Baird 1995, Baird et al. 2000 a and b). These sites can

Table 5. Fishing gears used in Hou Sahong.

Trap Name	Trap Style	Description
Ou	Filter	The <i>ou</i> trap is a fence filter trap. Rocks and bamboo are used to direct fish into a series of baskets placed in a row perpendicular to the direction of the flowing water. The fish are then collected from the baskets periodically throughout the day. The <i>ou</i> traps at Tat Pho (Dtat Po in Roberts and Baird 1995) are made specifically to target <i>P. macronema</i> . By the time the water rises and other pangasiid catfishes begin to migrate upstream, these traps are covered by water and are no longer functioning.
Li	Wing	Wing traps are bamboo structures that guide migrating fish onto grates that separate the fish from the water. <i>Li</i> traps are often constructed in March and April before the water begins to rise. From May to July, <i>li</i> traps are used to catch migrating fish, especially pangasiid catfish (Claridge et al. 1997). <i>Li</i> traps are not constructed specifically to catch <i>P. macronema</i> , but rather to catch <i>P. conchophilus</i> , <i>P. bocourti</i> , <i>P. lar-naudii</i> , <i>P. krempfi</i> , and other species in May and June (Baird et al. 2000 b). <i>P. macronema</i> is a “by-catch” for these traps, although in some cases this by-catch can be significant.
Sone	Scoop net	The main scoop-net fishery for <i>P. macronema</i> is basically open access fishing in the Hou Sahong channel. This fishery tends to take place in mid to late April, around the same time as the main <i>P. macronema ou</i> trap fishery in the Hou Sahong is at its peak. Villagers individually, or in small groups, spread themselves along the Hou Sahong (especially the lower sections) and periodically scoop up small amounts of <i>P. macronema</i> as they move up the channel.
Chip	Cylindrical current	Cylindrical current traps are used widely in the Khone Falls area to target migrating fish. Cylindrical traps are used to target migrating and nonmigrating fish in channels at the end of the rainy season. They are also used for targeting small, migratory cyprinids in the dry season, and for catching migrating pangasiid catfishes at the beginning of the rainy season. <i>Chip</i> traps have been introduced to the area over the last few decades.
Mong	Stationary	2.5 and 2.8 cm meshed mono-filament nylon gill nets target <i>P. macronema</i> which congregate in deep water pools at daytime, either before migrating up the Hou Sahong channel or other channels, or after retreating to a deep water pool from an unsuccessful attempt to migrate up one of the channels in the Khone Falls area. Some fishermen believe that these fish rest in the pools and then try to migrate up the same channel or another one the next night, or a few nights later, depending on hydrological conditions. One deep-water area where <i>P. macronema</i> is commonly targeted with gill nets is called <i>Hin Ta Moun</i> . This area is located between the southern tip of Don Sahong Island and the middle of Don Khone Gnouak Island. During the height of the <i>P. macronema</i> migration season, large numbers of the species are caught there when villagers from Ban Hang Khone set gill nets right at the bottom of the 10 to 20 m deep pool. There are no individual fishing restrictions for this kind of fishery, probably because gill nets are a relatively new fishing tool in the area, having only been widely used for the last twenty years or so.

be inherited and passed on through family lines, which often results in matriarchal inheritance in which the youngest daughter inherits the family fishing site.

The traditional property rights of villagers over *li* and *chip* sites are well respected in the Khone Falls area. Few challenge the system or try to break the established rules. Social taboos are strong. In fact, the system is so strong that villagers occasionally sell good sites for considerable amounts of money (Roberts and Baird 1995). Moreover, when a family decides to not build a *li* trap at their traditional site, they may choose to rent out the right for another family to put up a trap there. But after the season when the site is rented out is over, the site reverts back to its original owner.

There are also traditional restrictions on establishing new sites that may interfere with use of older already established sites. Owners can also reclaim traditional sites not used for many years, even if this action reduces the effectiveness of more newly established sites used every year (Roberts and Baird 1995, Baird et al. 2000 a and b)

Discussion

The migration of P. macronema through Hou Sahong

The migration of *P. macronema* at the beginning of the rainy season is well documented (Bardach 1959, Roberts and Baird 1995, Rainboth 1996, Singhanouvong et al. 1996). Nevertheless, questions remain as to whether *P. macronema* migrate long distances or rather exist as isolated populations performing local migrations (Pantalu 1971). Bardach (1959) reported that fish move upstream from the Great Lake of Cambodia and probably spawn in northeast Cambodia in April. Rainboth (1996) stated that *P. macronema* move from the mainstream Mekong into smaller streams and tributaries at the beginning of the rainy season (April-June). Singhanouvong et al. (1996) reported that *P. macronema* migrate upstream from Cambodia past the Khone Falls. Similarly, Roberts and Baird (1995) reported that the species moves through the Khone Falls area in April, May, and June. We found that *P. macronema* moves through Khone Falls, and specifically upstream through Hou Sahong channel, in April and May.

While there are small numbers of *P. macronema* in catches until June, their peak migratory period is in April, and only small numbers of individuals are seen mixed with other species in May. *P. macronema* move before other species of catfish begin migrating in large numbers.

In April, the river is often still quite low, and for this reason *P. macronema* may move through the Khone Falls area differently than other species of catfish. Most fish apparently migrate at night, as this is when the majority of the fish are captured. However, fishermen sometimes catch fish during the day. No downstream migrations of this species are known.

There is considerable uncertainty as to what triggers *P. macronema* migrations. Singhanouvong et al. (1996) believe that threshold river volumes

trigger the migrations. Additional rain or changes in water depth may induce additional migratory activity. Furthermore, sudden increases in flow may stimulate migratory behavior, especially during rainy weather (Singhanouvong et al. 1996). Others have suggested that temperatures, rainfall, water turbidity, or lunar cycles may influence the timing of migration (Bardach 1959, Mekong Secretariat 1992).

We think that the evidence suggests that changes in water levels and possibly associated changes in water turbidity are likely to be the primary determinants of the timing of migrations up Hou Sahong channel. Lieng et al. (1995) recorded *P. macronema* moving out of the Great Lake, Cambodia as the water receded in January and February.

During the low-water months of March and April, fishers report large numbers of *P. macronema* congregating in deep pools in the Mekong River below Khone Falls. Fishers report that the fish then wait below the Khone Falls until water levels rise. They are then able to move upstream though Hou Sahong and past the Khone Falls. The gauge at Tat Pho showed that migrations occurred once the water depth exceeded four meters. Water level needs to be recorded at his gauge in subsequent years to determine if this measurement can be used to predict the timing of migrations.

The reasons for the migration of *P. macronema* are unclear (Roberts and Baird 1995, Singhanouvong et al. 1996). Roberts and Baird (1995) report that many catfish species are in reproductive condition in May and June. However, Singhanouvong et al. (1996) found no evidence of spawning *P. macronema* in the Khone Falls area. They hypothesize that *P. macronema* spawn upstream of the Khone Falls and that fish reach spawning condition at the spawning ground. Singhanouvong et al. (1996) suggest that *P. macronema* may spawn upstream of Khone Falls during the rainy season so that fry are transported downstream by the floods to rearing grounds in Cambodia. However, we did not observe fry moving downstream in the water column in April or May.

This suggests that *P. macronema* may spawn later (along the Thai-Lao border). During April and May, we observed no *P. macronema* in spawning condition at Hou Sahong channel. Moreover the small size of the fish from just over seven centimeters to sixteen centimeters, suggests that some of these fish may be too small to spawn. We believe that these fish were less than a year old. These young *P. macronema* may be moving upstream in search of food or in search of areas where they will spawn once they mature.

There are three possible scenarios that could explain the migratory behavior of *P. macronema*. First, the migrations may be local upstream movements for spawning or feeding purposes. Under this scenario, groups of *P. macronema* throughout the basin are discrete populations that spawn at multiple sites along the river. Second, *P. macronema* may spawn in at least two locations: 1) along the Thai-Lao border and 2) in northeast Cambodia.

According to this second scenario, *P. macronema* may move long distances but at least two spawning grounds exist and populations may form distinct regional groups (e.g. Vietnam spawners, Cambodia spawners, and

Thai-Lao spawners). Third, *P. macronema* may migrate from Cambodia to spawn in the Mekong or tributaries in Laos and/or Thailand. Under this third scenario, groups of *P. macronema* may form distinct populations in the spawning season but mix in Cambodia during the floods.

Unfortunately, we have no direct evidence to help determine which of these scenarios (if any) is correct. The second author observed small (2.0 to 4.0 cm) *P. macronema* along the Thai-Lao border in June 1997, but the presence of very young fish along the Thai-Lao border is consistent with each of the three scenarios. In a general sense, the information presented in this paper is most consistent with the assertion that *P. macronema* migrate from Cambodia and move upstream past the Khone Falls.

Therefore, we suggest that the third scenario is most likely. The migratory behavior of this species is not yet well understood and requires further study.

The impacts of damming Hou Sahong

In 1994, the Compagnie Nationale du Rhone, Acres International Limited, and the Mekong Secretariat Study team proposed damming Hou Sahong (Mekong Secretariat 1994). The proposal described plans for Don Sahong dam, an approximately 240 MW capacity hydroelectric project with a 70 to 72 m operating level (Mekong Secretariat 1994). Don Sahong dam would span 1,264 m in length and cost an estimated USD 530,000,000. The Secretariat recommended that a prefeasibility study be carried out at Hou Sahong, because the Hou Sahong barrage is one of four "first category projects". This dam is apparently a top priority for further development.

The authors of the Mekong Mainstream Run-of-River report suggest that the environmental and social impacts of the Don Sahong Dam would be very low, and that fish probably do not migrate up the channel. According to the report, no land would be inundated and no people would be displaced.

The report emphasizes that more research is necessary to understand the potential fisheries impacts of hydropower development in the Hou Sahong. Specifically, the report concludes that data "are insufficient to describe important fish stocks and migrating patterns, locations and characteristics of spawning and rearing habitats; and that the (hydropower) projects cannot be safely designed or mitigated without first establishing a sound and reliable database. The social impact on seasonal fishery communities must be considered as well" (Mekong Secretariat 1994).

As has been stated in this paper, as well as in others (Roberts and Baird 1995, Baird 1996, Baird 2000, Baird et al. 2000 a and b) the Hou Sahong channel is the most important channel for migratory fish in the Khone Falls area. Villagers and local government officials regard Hou Sahong as a special pathway for migratory fish; not only for *P. macronema*, but for a large number of species of great importance to local fisheries (Baird 1996, Baird 2000).

The information provided in this paper, as well as in Roberts and Baird (1995), Baird (1996) and Baird (2000) suggest that, of all the channels in the

Khone Falls area where a dam could possibly be built, the one that would cause the most severe impact would be the Hou Sahong. The dam would flood the entire Hou Sahong channel, including the important fishing sites Tat Pho, Tat Lieu, and Tat Louang. Fish migrations up Hou Sahong would be blocked.

Damming Hou Sahong channel and blocking the migrations of *P. macronema* and other fish species would have a negative impact on the villages of Hang Sadam, Don Sahong, and Houa Sadam as well as other communities in the Khone Falls area. The dam would destroy many fisheries, including the *P. macronema* fishery, a communal fishery that has helped sustain the people living near Hou Sahong for at least the past 80 years. Moreover, many characteristics of the fishery (e.g. trap site, ownership regime, fishing gear) are specific to the geology and hydrology of Hou Sahong channel.

The fishery (and other important fisheries for migratory species) could not exist if the channel was flooded. Without these wild-capture fisheries, the villagers in the area around Hou Sahong would have no means for feeding themselves or earning money.

Flooding habitat or blocking access to spawning areas can lead to the extinction of distinct fish species and populations (Barthem et al. 1991, Hill and Hill 1994, Borghetti et al. 1994, Allendorf and Waples 1996, Araujo-Lima and Goulding 1997, Barthem and Goulding 1997). The extinction of populations of *P. macronema* would most likely disrupt seasonal wild-capture fisheries along the migration and dispersal routes of the migratory species. Therefore, damming Hou Sahong would probably impact wild-capture fisheries for *P. macronema* in Cambodia and Thailand, if *P. macronema* from southern Laos migrate to and from those areas. The same goes for many other fish species that migrate through the Hou Sahong area each year (Baird 1996, 2000).

It is likely that the construction of the Pak Mun dam at the mouth of the Mun River, a large tributary of the Mekong River in Ubon Ratchathani province in northeast Thailand, has had some impact on *P. macronema* populations in the Mekong basin. However, adequate baseline fisheries studies in the Mun River were not conducted prior to the construction of the dam, so we may never know the impact of the Pak Mun dam on migratory fish.

What is presently known about the species habits indicates that *P. macronema* probably migrated up the Mun River from the Mekong River in Laos before the dam was constructed, and that the dam has now blocked *P. macronema* movements. Because of the migratory nature of *P. macronema* the construction of any dams on the Mekong River in Thailand, Laos, or Cambodia would certainly be a major threat to the species. Dams block migration routes, alter riverine habitat, change river hydrological patterns and disrupt the free flow of eggs or larvae (Hill and Hill 1994, Rothert 1995).

In the case of *P. macronema*, the Hou Sahong dam would probably impact fish moving between Laos, Thailand, and Cambodia.

Conclusion

The migratory fish of the Mekong River basin support many important community-based fisheries (Roberts 1993, Ahmed et al. 1996). We studied one such fishery: the capture fishery for the migratory catfish *P. macronema* in Hou Sahong channel in southern Lao PDR. Although little is known about the origin or destination migrating *P. macronema*, we found that significant numbers of *P. macronema* migrate from Cambodia upstream through Hou Sahong channel and past Khone Falls each year at the height of the low-water season.

Hou Sahong channel is an important migratory corridor for *P. macronema* and many other species. Three communities located near Hou Sahong channel capture *P. macronema* as the fish migrate upstream, although the fish are undoubtedly important to a lesser extent to large numbers of villages situated along the Mekong River and large tributaries. The catch from Hou Sahong is significant both in terms of food security and the economic well being of the three communities. A dam planned for Hou Sahong threatens the fishery for *P. macronema* in Hou Sahong as well as many other important fisheries in the mainstream Mekong River. The dam will flood fishing sites and negatively impact fish migrations and populations. The dam may also impact populations of *P. macronema* and other important fish in other areas of the Mekong River basin, because the species and some others apparently migrates long distances and move across international borders.

We suggest that species that migrate long distances and “straddle” international borders warrant special attention, because a high level of knowledge and cooperation between countries is needed to manage such shared-stock fisheries (Speer 1996). More quantitative information about migratory fish species is needed.

In order to determine the potential impact of the Don Sahong dam, the following information is essential:

- Documentation of the importance of fisheries for migratory species

- Identification of the rearing and spawning grounds of migratory species

- Gathering of basic data on the life history requirements of migratory species, including the environmental cues that trigger migrations

- Detailed economic and social analyses of the effects of dams on fishery dependent villages

We agree with Hill and Hill (1994) who recommend tracking tagged fish and sampling for eggs and larval fish. We also believe that a genetic study of the population structure of migratory fish species could be an effective way of understanding migrations and differentiating between fish stocks (Avisé 1994). Researchers should recognize the limitations of collecting data using traditional gears. For example, some gears (e.g. gill nets) may not provide a random sample from fish populations. In the case of migratory species, local ecological knowledge (LEK) held by local fishers may be able to provide important information about fish biology and ecology, but LEK from single areas cannot provide a complete picture of migration routes, because fishers generally only have information about limited geographic areas.

Therefore, a combination of LEK from different places, fish sampling, and more complex research methods such as genetic analysis, tagging, or experimentation are necessary to help answer the unresolved questions about the ecology of Mekong fishes. Scientific and local ecological knowledge can complement each other just as qualitative and quantitative methods can. Combining research methods will aid in the sustainable management of the natural resources of the Mekong River basin.

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