Mekong River Commission

Status of the Mekong *Pangasianodon hypophthalmus* resources, with special reference to the stock shared between Cambodia and Viet Nam

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P.O. Box 1112, 364 M.V. Preah Monivong Boulevard
Phnom Penh, Cambodia
Telephone: (855-23) 720-979 Fax: (855-23) 720-972
E-mail: mrcs@mrcmekong.org
Website: www.mrcmekong.org

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Background of the Working Group on Mekong Giant Fish Species
The Technical Advisory Body on Fisheries Management (TAB) of the Mekong River Commission (MRC) was established in June 2000. The TAB gives advice to the MRC Fisheries Programme on technical issues relating to basin-wide fisheries management. During the first meeting, five main issues were identified. Among these was the following:

Management of *Pangasius* (River catfish)

The Meeting considered under this item in particular, Pangasianodon hypophthalmus. *The size of fish caught has been declining, pointing to overexploitation. A fry fishery for aquaculture purposes, while illegal in some countries, may still be taking place. Fry of other species are also being caught as unwanted by-catch. The TAB is concerned about this situation.*

It was agreed that the MRC Fisheries Programme (Cambodian Capture Fisheries Component, Assessment of Mekong Fisheries Component and Aquaculture Extension Component) shall produce two "status reports" on Pangasianodon hypophthalmus*, summarising what is presently known on spawning and feeding habits, migrations of fry and adult fish, fishing efforts and possible management interventions, as well as the use of the species for aquaculture, the status of artificial breeding, and an assessment of whether increased availability of artificially-produced fry might eliminate the collection of wild fry. The report will be submitted to the TAB.*

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Summary

Most of the information available on the state of fishery exploitation of the *Pangasianodon hypophthalmus* population in Cambodia and Viet Nam has been examined. The limited evidence suggests that the wild stock has greatly declined. However, this may be partly the result of a paucity of studies that have addressed stock assessment issues in the past. Present exploitation appears to be intense from the fry stage onward to spawning. Therefore, management interventions for the protection of the species are considered to be necessary and have been recommended. In addition, it is imperative to study the nature and extent of the larval and juvenile migrations, as well as the effect that fry fisheries have on survival rates.

- The northern and southern stocks are likely to be independent from each other and should be managed separately. The southern stock is of especially-great economic importance in Cambodia and Viet Nam, being the provider of important quantities of highly-valued food fish and of seed that is essential for catfish cultivation in Cambodia and (now to a lesser degree) in Viet Nam.

- The southern stock utilises the floodplains around the Tonle Sap, as well as south of Phnom Penh and in the Vietnamese delta. Although overall, this stock seems to be in decline, the catch rates in the Tonle Sap area appear to be stable, possibly because the habitats of the Great Lake floodplains are still largely intact.

- *P. hypophthalmus* are late-in-life spawners. Sexual maturation takes more than three years. Egg production increases dramatically from some 30,000 eggs for a fish of 5 kg to over 1,000,000 for a fish of 10 kg. Due to the intensifying middle and small-scale fisheries targeting migratory fish, only a small percentage of fish survive to reach maturity.

- Spawning takes place in the stretch of the Mekong River between Kratie town and the Khone Falls on the Cambodian/Lao border. The habitat consists of rapids and sandbanks, interspersed with deep rocky channels and pools. Catfish concentrate in these deep areas during the dry season, when the river is very low. Spawning takes place during the monsoon season between May and August. Apparently, exposed root systems, such as those of the rheophilic tree species *Gimenila asiatica,* serve as a substrate for egg deposition.

- The use of explosives in the deep pools in the spawning areas from Kratie to the Cambodian/Lao border has a decimating effect on the reproduction success of the species. It is recommended to increase awareness of the negative effects of the use of explosives among Cambodian provincial authorities and the military, and to strengthen NGO involvement with fisher communities along the Mekong in Kratie and Stung Treng to achieve a responsible conduct in fishing activities.

- Larvae and fry drift down with the Mekong current to the floodplains of central Cambodia and the delta, and enter newly-inundated areas for feeding. At the end of the rainy season, juvenile catfish tend to move to deeper areas, such as the Tonle Sap Great Lake and river, and the Mekong. Adult fish, however, migrate upstream to the spawning areas. After spawning, adult fish move back to the floodplains.

- Despite being officially banned, the fishery for fry is continuing, and it appears not to have decreased in Cambodia since the introduction of the ban in 1994. Given that natural mortality of this species is very high, it is not clear if this fishery has significantly contributed to the decline of the species. It is more likely that the expansion of other fisheries, in particular the middle-scale fisheries, as a result of the growing population, is causing fishing pressure to increase, leaving few adult fish alive for spawning.

- Aquaculture. Even though hatchery production in Viet Nam is reported to exceed demand, wild fry collection in Cambodia is still very large. Cage and pond culture is still expanding both in Viet Nam and Cambodia. This suggests that Vietnamese hatcheries are not yet producing enough seed of good quality (including for *Pangasius bocourti*). Wild seed is still regarded as more vigorous and fetches higher prices. Availability of hatchery produced fry is limited in Cambodia. It is recommended to increase hatchery production of *P. hypophthalmus* fry/fingerlings, especially in Cambodia, and possibly that of *Pangasius bocourti* in Viet Nam, as well as to produce better-quality seed.

- Little biological information is available on the wild *P. hypophthalmus* stocks, as well as on other Pangasiids. It is most crucial to improve our understanding of the larval drift and fry migrations, as these are particularly vulnerable to the effects of waterworks, such as dams (especially on the Mekong main stream), flood protection and irrigation schemes.

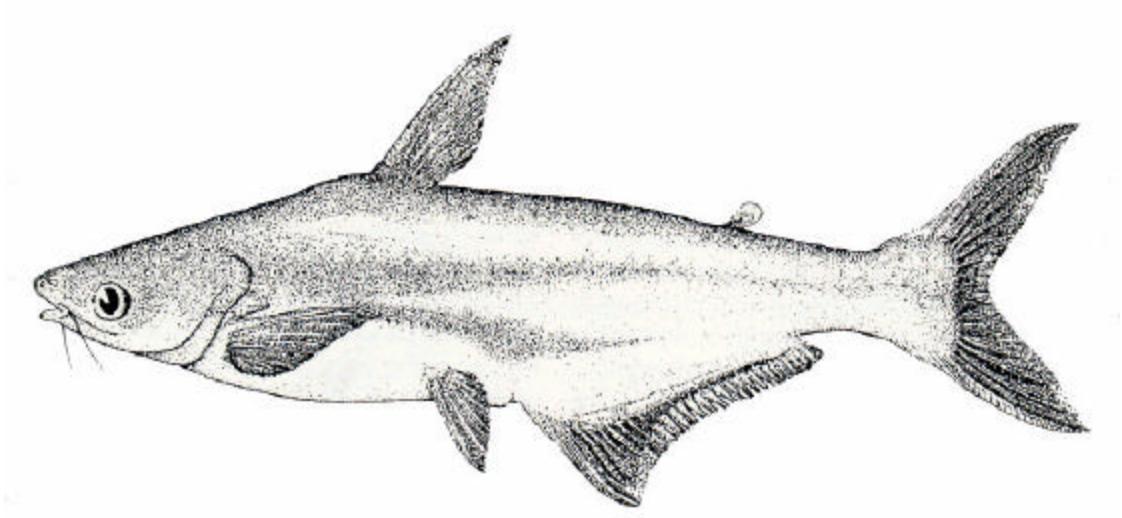
Identification, stock delimitation and distribution

1

We follow Rainboth (1996) in using the scientific name *Pangasianodon hypophthalmus*, although Roberts and Vidthayanon (1991) placed the species in the genus *Pangasius*. An invalid name is *Pangasius sutchi*. The Khmer name is *pra*. In Lao it is *souay kheo*, in Thai, *swai* and in Vietnamese, *cha*.

A terminal mouth and 8–9 pelvic fin rays separate the genus *Pangasianodon* from the genus *Pangasius*. *Pangasianodon gigas* has seven dorsal fin rays and no gill rakers, while *Pangasianodon hypophthalmus* has six dorsal fin rays and well-developed gill rakers. A drawing is shown in Figure 1 and a photograph in Figure 2.

Figure 1 *Pangasianodon hypophthalmus* drawing by Chavalit Vidthayanon.



Source: Roberts and Chavalit 1991.

The natural range of *P. hypophthalmus* is limited to the Mekong, Chao Praya and possibly the Mekong basins in Cambodia, the Lao People's Democratic Republic (Lao PDR), Thailand and Viet Nam (Roberts and Vidthayanon 1991). Aquaculture introductions have taken place elsewhere.

Poulsen and Valbo-Jørgensen (2001) conclude that *P. hypophthalmus* stocks in the Mekong in Cambodia and Viet Nam belong to one population (southern stock) and that the stocks above the Khone falls in Lao PDR and Thailand may form a separate population (northern stock). There may be some limited connection between the two populations, as *P. hypophthalmus* has been recorded in small numbers in the Khone falls wing-trap fishery in two out of the four years that were monitored (Baird *et al.* 2000). A very recently begun investigation into *P. hypophthalmus* genetics may reveal the distinctness of these two populations (So Nam, Department of Fisheries and F. Volckaert, University of Leuven, Belgium, 2001, personal communication).

A map of the Mekong River system and floodplains is shown in Figure 4.

Figure 2 *Pangasianodon hypophthalmus*, Tonle Sap *dai* fishery, November 2000

Life cycle of *Pangasianodon hypophthalmus* (southern population) 2

2.1 Reproduction

2.1.1 Spawning areas and habitats

Spawning takes place in the stretch of the Mekong River between Kratie town and the Khone Falls on the Cambodian/Lao border, but is concentrated from Prek Kampi near Kratie to the north end of Koh Rongiev near the Kratie/Stung Treng provincial border (Touch 2000). There are few settlements along this part of the river and the shore is largely forested.

The habitat consists of rapids and sandbanks interspersed with deep rocky channels and pools. Catfish concentrate in these deep areas during the dry season, when the river is very low. Also other fish species shelter there. Apparently, exposed root systems, such as those of the rheophilic tree species *Gimenila asiatica* (see Figure 3), serve as a substrate for egg deposition (Touch 2000).

Figure 3 Root systems of *Gimenila* trees along the Mekong River, February 2001

It is not clear to what extent deep pool areas in the Sekong, Sesan and Srepok Rivers are utilised by this Pangasiid species. Apparently deep areas in other parts of the Mekong are not used for spawning by the southern population. This means that all *P. hypophthalmus* captured in Viet Nam originate in Cambodia. The spawning grounds of the northern population have not been identified yet (Poulsen and Valbo Jørgensen 2001).

Figure 4 Map of the Mekong River system and floodplains

2.1.2 Fecundity

Sexual maturation takes more than three years, at least in captivity (Cacot 1999). In nature it may well be the same. It is not clear at what size the species reaches sexual maturity. Touch (2000) mentions a minimum weight of 3–4 kg, which corresponded with a total length of 54 cm. The consequence of attaining sexual maturity (relatively) late in life is that relatively few individuals survive long enough to participate in spawning. Survival is determined by the levels of natural mortality and the mortality caused by fishing. Natural mortality of the larvae, fry and fingerlings is likely to be very high.

Definition of development stages for the purpose of this document

Larva: Development stage after hatching from the egg, where the yolk sack is still visible and the only source of nutrition.

Fry: Next development stage where the young fish is not fully developed yet and largely drifts with the current.

Fingerling: Fully developed young fish capable of limited independent swimming action (size up to approximately 15 cm)

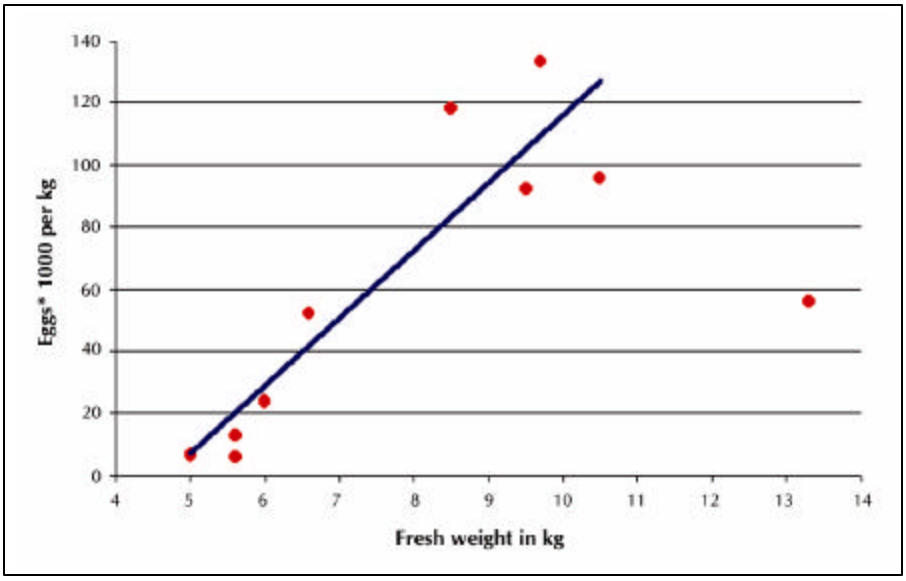
Sub-adult: immature fish. Different sizes depending on age.

Adult: able to spawn. 3+ and older, minimum weight 4 kg?

P. hypophthalmus is a prolific spawner. Egg production per kilo of fresh weight increases dramatically with increasing size until a weight of around 10 kg has been reached (see Figure 5 and Table 1). Apparently some fish are capable of spawning twice in a year. In the Vietnamese cage culture, less than a third of the female fish could be induced to spawn a second time, 6 to 17 weeks after the first spawning (Cacot 1999).

The eggs are sticky and are apparently deposited on roots of trees that become flooded early in the wet season (Touch 2000). The eggs hatch within 24 hours. It is not clear where the larvae go after hatching. After two or three days, they start feeding and by the time the larvae have developed into fry and fingerlings, they are pelagic and capable of independent movement.

Figure 5 Fecundity: Egg production per kilo of fresh weight for *P. hypophthalmus*, as a result of induced maturation mainly in floating cages in Viet Nam



Source: Cacot 1999.

Table 1 Some fecundity or egg production values for *P. hypophthalmus*, as a result of induced maturation, primarily in floating cages in Viet Nam

Fresh weight (kg)	Fork length (cm)	Total number of eggs	Number of eggs per kg	First or second spawning
5.0	68.0	33,100	6,620	1st
5.6	73.0	33,100	5,911	1st
5.6	73.0	71,900	12,839	1st
6.0	75.0	143,700	23,950	1st
6.6	76.0	344,900	52,258	2nd
8.5	83.0	1,005,900	118,341	1st
9.5	84.0	876,600	92,274	1st
9.7	83.5	1,293,300	133,330	2nd
10.5	84.0	1,005,900	95,800	1st
13.3	92.0	742,900	55,857	1st

.

Source: Cacot 1999.

2.2 Migrations

2.2.1 Time of spawning and downstream migration of *P. hypophthalmus* fry

Poulsen and Valbo-Jørgensen (2001) report that fish with eggs are found in the Mekong from Stung Treng to Kandal between May and August, and particularly in June-July.

In May, fish with mature or nearly mature gonads were caught upstream of Kratie (Touch 2000). The onset of the monsoon leads to a rapid rise in Mekong water levels. This apparently triggers the actual spawning, usually in June. Subsequent sudden rises may induce spawning again. Up to three peaks have been recorded between May and August (Touch 2000). The July peaks are usually the most important. Water current speeds are fast in this period. The water mass from Kratie can potentially reach Phnom Penh in about three days and the delta in four days. However, the travelling time for fry and fingerlings is likely to be longer, as they seek out slower currents along the banks of the river (Ngor 1999).

According to Ngor (1999), the specialised *dai* (bagnet) fishery for catfish fry and fingerlings in the Cambodian Mekong started in the first week of June in 1997 and 1998, and ended in 1997 in the last week of July, and in 1998, one month later. The major peak in fry availability was in the first week of July in both years. Similar *dais* in the Mekong delta of Viet Nam were monitored in 1999 by Tung *et al.* (2000; 2001a). They found a peak in *P. hypophthalmus* abundance in the last two weeks of June and a much smaller peak a month later. This suggests that each year spawning takes place from late May to August, with massive spawning probably happening only in the first part of June, depending on the start of the rains.

Tung *et al.* (2000; 2001a) suggest there is a lunar effect underlying the peaks in the occurrence of the larvae, as they coincide with a waxing moon. This could of course be the result of a lunar influence on the preceding spawning process. There also seemed to be a somewhat weak correlation with the start of rises in water level.

From July to September, a fishery for Pangasiid fingerlings (species composition undetermined) takes place with dipnets and special arrangements of baited hooks (*santouch kontrey pra*) along the banks of the Mekong and other rivers both in Cambodia and Viet Nam. Healthy specimens are sold for culture purposes, as happens with the catfish fry caught in *dais*. The fingerlings are found close to the riverbanks and are probably seeking ways to enter the inundated floodplains behind the banks. Once they have succeeded in this, an abundance of food is available and rapid growth follows.

P. hypophthalmus feeds on algae, higher plants, zooplankton, insects and, at larger sizes, on fruits, crustaceans and fish (FishBase Website March 2001). According to Blache (1951), phyto- and zooplankton reach peak abundance in the Mekong during the dry season from February to May. In the Tonle Sap, the highest plankton densities occur when the current starts flowing to the Great Lake, especially in June, and again when the flow reverses in October-November. *P. gigas* and *P. hypophthalmus* follow the current to make use of the plankton abundance, and the *dais* take these species mainly in October and November (see Figure 6).

2.2.2 Migration of adults and sub-adults

Once spawning is over, the adult fish move back down river for feeding in the floodplains that are being submerged by the rising floods. They are followed by the fingerlings that have survived the downstream drift.

The adult fish are the first to leave the floodplains and Great Lake. Some depart in September, even before the floodwaters start to recede (Srun and Ngor 2000). Most leave in October–December, which is well before the big fishing lot operations in the Great Lake start. However, some are caught in the Tonle Sap River by the barrages of Kampong Chhnang and the *dai* fishery (see Figure 6), which start in mid-October. Adult fish apparently prefer to stay in the deeper sections of the Mekong River and move gradually upstream as the spawning time approaches.

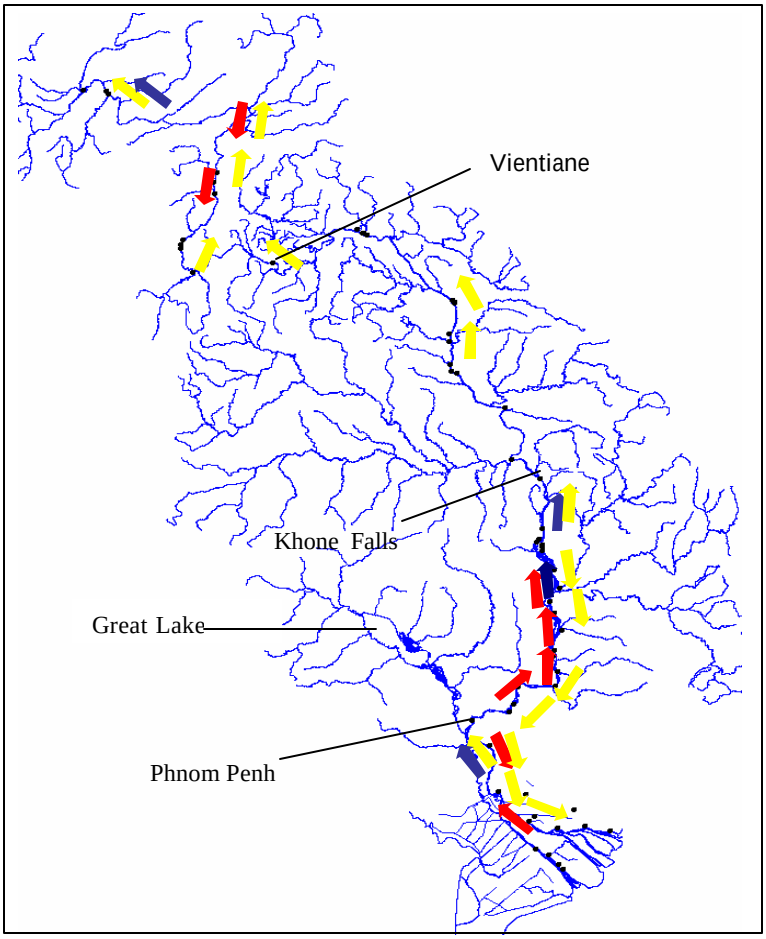
Figure 6 Aerial view of a bagnet (*dai*) fishery in the Tonle Sap River. The mouths of the nets are on the right-hand side of the photo. The nets channel fish down to the processing pontoons, approximately 150 m downstream.

Certain barrages and *dais* capture much larger quantities than others. This is probably related to the specific geographic position of those fishing gears. Phnom Penh *dai* rows 1 and 2 are located at the end of a relatively deep stretch of water in a narrow section of the river, which causes the fish to be swept into the large mouths of the *dais*. As far as we know, these are also the only *dais* where the giant Mekong catfish, *Pangasianodon gigas*, is caught annually from October to December. These *dais* caught four in 1999, 11 in 2000 and seven in 2001.

Poulsen and Valbo-Jørgensen (2001) carried out a survey along the Mekong in Cambodia and Viet Nam to record local fisher's knowledge of migrations. This confirmed that there is an upstream migration from October to May and a downstream migration from May to September (see Figure 7). Srun and Ngor (2000) came to a similar conclusion, having analysed daily fish market landings in six locations along the Mekong and Tonle Sap Rivers.

The young of the year and other sub-adult fish tend to stay longer in the floodplains and are caught everywhere throughout the season. Srun and Ngor (2000) reported a peak catch of small catfish in the *dai* fishery in December 1998. Touch (2000) mentions a Great Lake catch in March 1982, exclusively consisting of immature fish ranging from 0.8–3.7 kg in weight. It is not clear whether these fish also move to the Mekong and upstream or not. Possibly they remain widely dispersed over the deeper parts of the river system till the next flood season.

Figure 7 *P. hypophthalmus* adult migrations. Note: Red, Oct –Feb; Yellow, May–Sept; Blue, March–May.



Source: Poulsen and Valbo-Jørgensen 2001.

3 Status of fishery exploitation of the *Pangasianodon hypophthalmus* stock

The reason behind the request for the present report is the general belief that, in particular, the southern *P. hypophthalmus* stock has declined greatly over the past ten years or so. In the following section, we will look at what data are available and weigh the evidence.

3.1 The Pangasiid fry fisheries

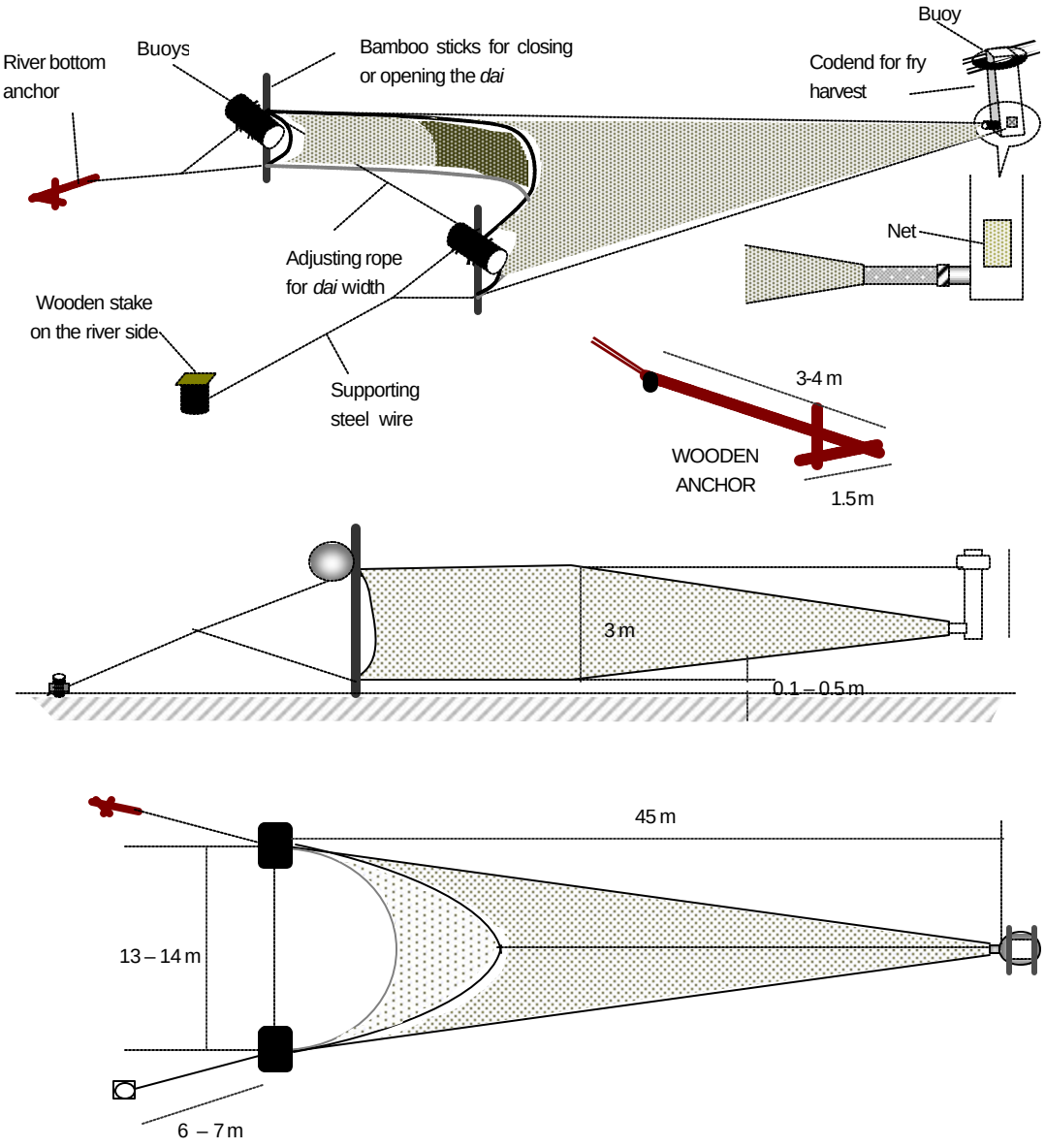
The small bagnet or *dai* fishery for Pangasiid fry takes place in the Cambodian part of the Mekong in Kampong Cham, Prey Veng and Kandal provinces. Apparently, fishing for fry is not feasible in Kratie, as the fry are too small (Touch 2000). Only a little fry fishing occurs in the Bassac. In Viet Nam, a *dai* fishery is carried out in both the Mekong and Bassac Rivers in An Giang and Dong Thap provinces. This fishery has been banned in Cambodia since 1994, and in Viet Nam since March 2000. However, we have received reports that the fishery in both countries continues unabated.

Ngor (1999) and Tung *et al*. (2000) have described the small *dai* gear used (See Figure 8). This fishery generally operates from the end of May till the end of August. It tends to catch smaller sizes than the *santouch kontrey pra* fishery, which targets Pangasiid fingerlings (especially *P. bocourti*) from July to September (see Figure 9 for a drawing of the gear).

As detailed in Section 2 on migrations, the availability of the fingerlings varies markedly over time. Usually two to three peaks in abundance occur per season.

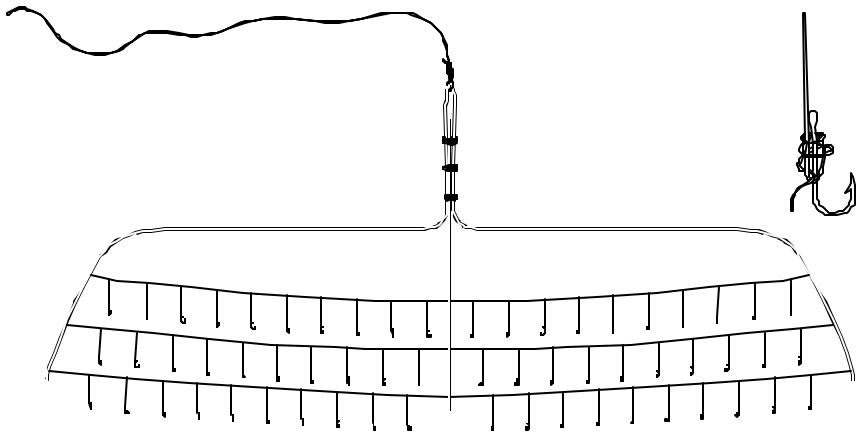
The purpose of these fisheries is to provide "seed" for the cage and pond culture practices in Viet Nam, and to a much-lesser degree in Cambodia. We have some rough estimates of the numbers of *P. hypophthalmus* fry caught in the *dai* fishery. In addition to *P. hypophthalmus*, other Pangasiids and several Cyprinid species are also caught. Only the Pangasiids are kept alive and the rest are thrown away or used for food. Ngor (1999) estimated the Pangasiid share of the catch in Cambodia to be 25 percent. In Viet Nam, the majority of the fry caught are Cyprinids (over 90 percent), about 3 percent is *P. hypophthalmus* and the remainder a variety of other species, among which *Pangasius bocourti* is an important species (Tung *et al.* 2000). In Viet Nam, the Pangasiid component in the *dai* catch is much lower than in Cambodia, because many have been caught already, have entered the floodplains or have simply died of natural causes. The average size of the fry is larger in Viet Nam.

Figure 8 Bagnet or *dai* for catching Pangasiid fry, as used in Cambodia and Viet Nam.



Source: Tung *et al.* 2000.

Figure 9 Pangasiid fingerling catching gear, *santouch kontrey pra*. The hooks are not barbed and are baited with red ant eggs, pieces of worm, etc.



Ngor (1999), Touch (2000) and the An Giang Fisheries and Agriculture Department statistics of 1977 (quoted in Khanh 1996), provide an approximate indication of the numbers that might be involved (Tables 2a and 2b). In Cambodia, the number of fry bagnet units was 650 in 1981. However, despite the government ban in 1994, this increased to 948 units in 1998. All captured fry and fingerlings are transported by boat to Viet Nam.

Table 2a Estimated numbers of *P. hypophthalmus* fry caught in the *dai* fishery in Cambodia.

Year	Number of fry caught	Number of *dai* units	References
1981	108 –165 billion	650	Touch 2000
1991	5.0 –12.0 billion	1050	Touch 2000
1997	2.0 – 4.0 billion	1050	Touch 2000
1998	0.9 – 2.1 billion	948	Ngor 1999

The data provided by Touch (2000) suggest that a strong decline occurred in the numbers caught, despite the significant increase in effort. However, the origin of the data is of an anecdotal nature.

Table 2b Estimated numbers of *P. hypophthalmus* fry caught in the *dai* fishery in Viet Nam, An Giang province.

Year	Number of fry caught	Hatchery fry production	References
1977	200 –800 million	-	Khanh, 1996
1994	62 million	-	Tung *et al.* 2001b
1995	60 million	-	"
1996	56 million	-	"
1997	48 million	6.8 million	"
1998	36 million	25.6 million	"
1999	27 million	90.0 million	"
2000	0.4 million	99.7 million	"

The Vietnamese data suggest a strong decline in the numbers of fry caught between 1977 and 1994. Thereafter, the decrease in numbers caught in the wild seems to be mainly related to the increasing availability of hatchery-produced fry on the market. Consequently, there may not have been a significant decline in the abundance of wild fry in the last decade.

To produce three billion eggs, as few as 3,000 large female fish are actually needed to spawn. Srun and Ngor (2000) report a catch of 58,440 catfish landed in Kratie from October 1998 to September 1999. Kratie is located at the southern end of the main spawning area. Over 90 percent of this catch consisted of small catfish, with an average weight of 309 g, while over 7 percent (4,180 head) weighed on average 5.7 kg. This suggests that the actual number of fish involved in spawning might be quite small.

P. hypophthalmus is a prolific spawner. Under normal circumstances, we expect natural mortality of this species to be very high as the result of a life-cycle involving extensive larval drift and migrations. Therefore, the mortality caused by the fisheries for Pangasiid fry is probably only a small part of the total mortality, and by itself, would probably not cause a decline in the stock. However, as we will show below, the fishery is not the only threat to their survival.

3.2 The bagnet (*dai*) fishery in the Tonle Sap River

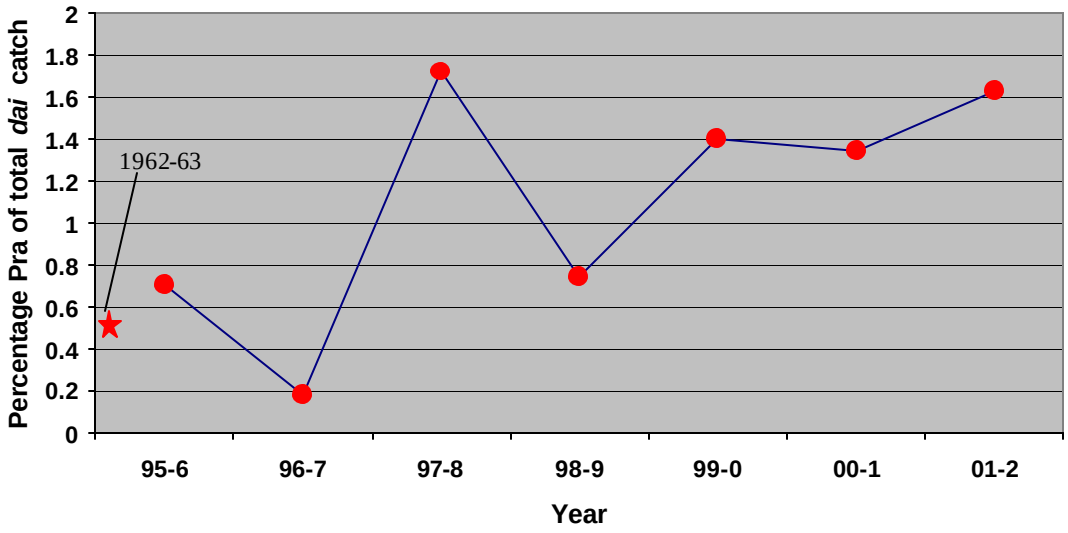
This fishery, like the barrages in Kampong Chhnang, targets fish migrating from the floodplains around the Great Lake to the Mekong River, via the Tonle Sap River. Photos of the *dai* fishery are shown in Figures 6 and 10. A description is given by Lieng *et al.* (1995).

Figure 10 Catch of approximately 500 kg taken by one bagnet (*dai*) after 15 minutes fishing in the Tonle Sap River. This photo was taken during the peak migration in January 1996

P. hypophthalmus sub-adults and adults form a small proportion of the total catch. Catches have been monitored annually since 1995, and the sampling result for *P. hypophthalmus* is given in Figure 11 and Table 3.

The only data from the past are for 1962-63 (Fily and d'Aubenton 1965). They indicate that recent catches are not particularly low. The 1995–2001 data do not show a very clear trend, except that there does not seem to have been a major decline since the 1960s, at least for the part of the population that visits the Great Lake. Data are lacking for the part of the population using the more degraded flood plains south of Phnom Penh and in the delta.

Figure 11 Percentage of the *pra* (mainly *P. hypophthalmus*) catch as part of the total bagnet (*dai*) fishery catch taken in the Tonle Sap River during the October to March seasons, from 1995 to 2002.



Source: Cambodian Capture Fisheries Project data for the years 1995 to 2002

Table 3 Catch of *pra* (mainly *P. hypophthalmus*) in the bagnet (*dai*) fishery in the Tonle Sap River during the October–March seasons of 1962-63 and 1995 to 2002.

Year	Catch in tonnes	Percentage of total *dai* catch	Reference
1962-63	9	0.40	Fily & d'Aubenton, 1965
1995-96	95	0.70	CCF project data *
1996-97	28	0.18	"
1997-98	157	1.72	"
1998-99	66	0.74	"
1999-00	162	1.40	"
2000-01	201	1.34	"
2001-02	223	1.63	"

Note: * Cambodia Capture Fisheries Project

Touch (2000) gives monthly catch data and average weight of *P. hypophthalmus* for two *dai* units (8A and 9A) fishing in the Tonle Sap River in 1981/82 and 1982/83. The data suggest that larger-sized fish move out of the Tonle Sap system earlier than smaller fish. The average fish weight was reported to be 4.85 kg (longer than 60 cm). However, the sampling was probably biased, as fish selected by middlemen were used. In 1999-2000 and 2000-2001, average fish length was only 18.3 and 26.5 cm, respectively (see Figure 12). All fish over 50 cm were caught between October and December.

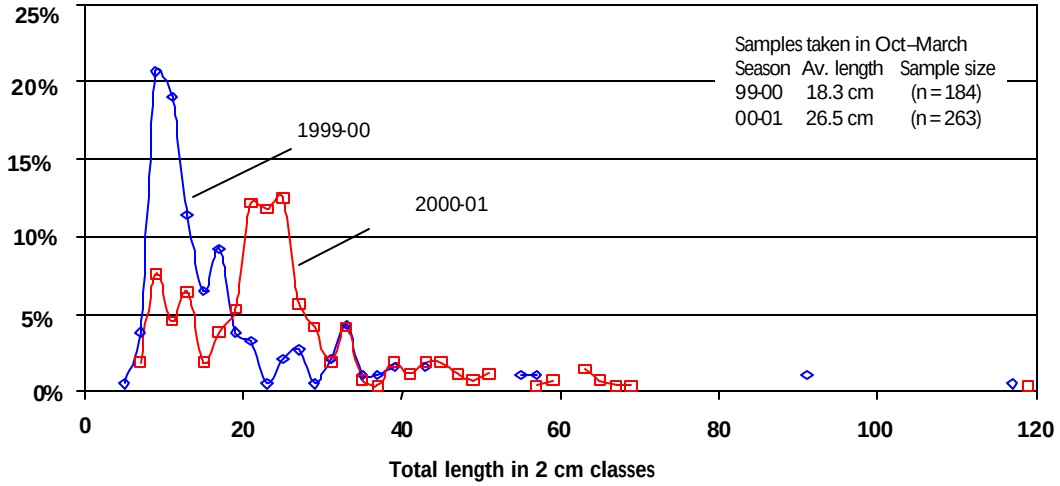
The length composition of fish sampled over six months in the Tonle Sap *dai* fishery clearly shows that the vast majority are sub-adults (probably all fish below 50 cm) (Figure 12). However, some of the bigger fish may have already departed in September before the fishery started.

In the *dai* rows 1 and 2 near Phnom Penh, 13 large *P. hypophthalmus* were caught and released in the last three months of the year 2000. These 13 fish averaged 14.8 kg in weight (ranging from 8.5 to 20 kg) and 111 cm in total length (ranging from 0.94 – 122 cm). Each female fish in this size range is capable of producing between one and two million eggs. Interestingly, a 17-kg fish tagged and released in November 2001 was recaptured on the border of Kratie and Stung Treng Provinces 68 days later. It had traveled a distance of about 310 km (Hogan 2002).

3.3 Other fisheries for *Pangasianodon hypophthalmus*

P. hypophthalmus is taken by a wide variety of fishing gears. Gillnets, hooks and lines, seines and trawls are the most common ones. It is also caught in the fishing lots and the big arrow-shaped traps in the Great Lake. Some assessments of quantities are available, but regular monitoring, as in the Tonle Sap *dai* fishery, has not been possible. Table 4 gives an overview, but it must be borne in mind that due to imprecise identification, other catfish species may have been included.

Figure 12 Length frequency of *pra* (mainly *P. hypophthalmus*), sampled from the Tonle Sap *dai* catch in 1999-00 and 2000-01.



Source: Cambodian Capture Fisheries Project.

Table 4 Catch of *pra* (mainly *P. hypophthalmus*) in a variety of Cambodian fisheries.

Year	*pra* catch in tonnes	% of total gear catch	Type of fishery	References
1994-97	1367	5.5	Mainly Great Lake fishing lots	Deap *et al.* 1998
1997-98	1276	5.0	Mainly Great Lake fishing lots	Thor *et al.* 1999
1994-97	330	1.3	Gillnets, seines, etc. Great Lake	Deap *et al.* 1998
1997-98	366	1.6	Gillnets, seines, etc. Great Lake	Thor *et al.* 1999
1997-98	109	6.6	Great Lake arrow-shaped traps	Troeung and Phem 1999

Blanc (1959) reported that in the past, *pra* made up 30 percent of the catch from the Tonle Sap, but had become relatively rare in 1959 and sizes were, on average, half of what they had been previously (no date was mentioned). Blanc suggested this was a consequence of illegal fishing practices, of the doubling of the human population between 1921 and 1958, and the associated intensification of small- and middle-scale fisheries.

The mostly middle-scale fisheries in the Mekong River itself are also very intensive. Srun and Ngor (2000) analysed daily fish market landings in six locations along the Mekong and Tonle Sap Rivers. Except in Stung Treng, the average weight of the fish was below one kilogram. In Kampong Cham, they reported landings of 423,000 fish. Here fingerlings (average weight 47 g) formed the bulk of this catch (86.7 percent). This clearly shows how intense the middle-scale fisheries are, leaving comparatively few fish alive for spawning.

Thus, in an average year, more than 2000 tonnes of *P. hypophthalmus* catfish are caught in Cambodia. This figure is surely incomplete, and could easily be three times higher, as our information on fish catches is quite limited. Also capture data from Viet Nam are missing.

3.4 Fishing with explosives

Fishing with explosives is obviously illegal and damaging to the fishery. Unfortunately, the practice is widespread, as explosives are readily available and cheap. The main perpetrators seem to be personnel associated with military or police agencies. Fishermen are also lured into using explosives by the prospect of easy bounty, especially when fishing in the deep channels during the dry season, when numerous fish in spawning condition are concentrated there. This of course reduces spawning success and the recruitment of the next generation. In addition, explosives kill indiscriminately and destroy the surrounding habitat. They are often harmful to the user too (see Figure 13).

In the Mekong stretch from Kratie town to the Cambodian-Lao border, presently two non-governmental organisations are working with the fisher communities along the river. They are trying to set up community rules to regulate gear use. There are signs that the use of explosives is decreasing among these fishers.

Figure 13 Fishing with explosives cost this Stung Treng fisher the lower part of his right arm

The utilisation of *P. hypophthalmus* in aquaculture and its impact on the wild stock

4

River catfish have been cultured for centuries in ponds in the Mekong delta of Viet Nam (Peignen 1993, cited by Cacot 1999), and today are an important culture species. Production in 2000 was estimated to be 39,500 tonnes from ponds, and 52,000 tonnes from cages (mixed *P. hypophthalmus* and *Pangasius bocourti).* This is sufficient to meet the demand from domestic markets (Tung 2001 b). In addition, Viet Nam exports whole fish on ice to Thailand and frozen fillets (mainly *P. bocourti)* to countries with large Vietnamese populations, such as the United States, Australia and France. Thus, aquaculture production by far exceeds the catch from wild stock.

P. hypophthalmus have air-breathing organs and are obligate air breathers (Browman and Kramer 1985, cited by Cacot 1999). This enables the fish to tolerate poor water quality, including high organic matter or low dissolved oxygen levels, and they can therefore be stocked at high densities. Catfish are omnivorous and will accept trash fish, pellets, home-made feed formulated from agro- and fishery by-products, water plants and even animal and human wastes when cultured in ponds and cages. In Viet Nam catfish are commonly stocked in ponds with over-hung latrines. Traditionally, catfish culture systems in Viet Nam relied entirely on wild-caught fry, with 200-800 million fry being caught annually (Department of Freshwater Fisheries 1977; Department of Agriculture of An Giang 1977, cited by Khanh 1996).

Research on artificial propagation of catfish in Viet Nam was undertaken by various institutions, beginning in 1978. Sexual maturation of *P. hypophthalmus* takes more than three years. The development of the technique to remove oocytes by intra-ovarian canulation and diameter measurement, using a binocular microscope to assess readiness of females for spawning, was vital for successful induction of spawning in Pangasiids, and especially for *P. hypophthalmus* and *P. bocourti* (Cacot 1999). Fry survival rates are now 60–70 percent. Seed production by artificial propagation has become routine. In 1999, more than 270 million fry and fingerlings were produced by a number of state and private hatcheries. In 2000, there was an over-supply and the government banned the fishery for wild catfish fry (Trong *et al.* 2001).

However, despite the claimed over-supply in Viet Nam, the illegal fry fishery in Cambodia, which exports mainly to Viet Nam, as well as the fishery in Viet Nam itself, are still flourishing. It is claimed in Viet Nam that only some 8–10 million *P. bocourti* are bought annually from Cambodia for use in cage culture. Hatcheries are still not producing sufficient *P. bocourti* seed, and thus the price is high. But perhaps more importantly, many grow-out farmers believe wild fish fry are of superior quality, and are willing to pay a higher price for them.

In Cambodia, Pangasiid production from cage and pond culture systems has apparently increased from some 6000 tonnes (Csavas 1994) to 10,000 tonnes (So Nam 2000). It is almost entirely based on wild caught fry.

Given that in 1998, an estimated 1-2 billion fry/fingerlings were caught, real demand may still be considerably larger than maximum seed output by the hatcheries.

Conclusions and recommendations 5

Conclusion 1

The northern and southern stocks are likely to be independent of each other and should be managed separately.

The southern stock is of great economic importance in Cambodia and Viet Nam. It is the provider of highly-valued food fish and of seed that is essential for catfish cultivation in Cambodia and in Viet Nam (although now to a lesser extent in Viet Nam).

Conclusion 2

The southern stock utilises the floodplains around the Tonle Sap, as well as south of Phnom Penh and in the Vietnamese delta. Although overall this stock seems to be in decline, the catch rates in the Tonle Sap area appear to be stable, possibly because the habitats of the Great Lake floodplains are still largely intact.

Recommendations

Protect the natural floodplain habitats where they still exist.

Conclusion 3

P. hypophthalmus are late-in-life spawners. Due to the intensifying middle- and small-scale fisheries targeting migratory fish, only a small percentage of the fish survive till maturity.

Recommendations

Permanently close row 1 of the dai fishery in the Tonle Sap near Phnom Penh. Keep two of the four units of row 2 open for monitoring purposes. Determine the quantities of catfish caught in rows 3 and 4.

Study how many catfish fry are caught by the santouch kontrey pra fishery, which targets Pangasiid fingerlings.

Study the catches of the barrages in Kampong Chhnang in detail, with the purpose of closing some if they are found to catch important quantities of brood stock.

Determine which middle and small-scale fisheries capture most catfish and at what sizes.

Conclusion 4

The use of explosives in the deep pools in the spawning areas from Kratie to the Cambodian/Lao border has a decimating effect on the reproductive success of the species.

Recommendations

Increase awareness of the negative effects of the use of explosives among Cambodian provincial authorities and the military.

Strengthen NGO involvement with fisher communities along the Mekong in Kratie and Stung Treng in order to achieve responsible conduct in fishing activities.

Conclusion 5

Despite being banned, the catfish fry fishery in Cambodia is continuing and appears not have decreased since the introduction of the ban.

Recommendations

Increase awareness of the fisheries regulations among Cambodian provincial authorities and the military.

Hold Cambodia–Viet Nam consultations on transportation of fry by boat from Cambodia to Viet Nam in order to find ways to efficiently protect and manage the Pangasiid catfish stocks.

Conclusion 6

Even though hatchery production in Viet Nam is reported to exceed demand, wild fry collection in Cambodia is still very large. Cage and pond culture is expanding both in Viet Nam and Cambodia. This suggests that Vietnamese hatcheries are not yet producing enough seed of good quality (at least of P. bocourti). Wild seed continues to be regarded as more vigorous and fetches higher prices. Availability of hatchery-produced fry is limited in Cambodia.

Recommendations

Increase hatchery production of P. hypophthalmus fry/fingerlings, especially in Cambodia, and possibly that of P. bocourti in Viet Nam.

To produce stronger seed, continue to raise fingerlings for a longer period, as apparently people are willing to pay higher prices for better quality.

Conclusion 7

Little biological information is available on the wild P. hypophthalmus stocks, as well as those of other Pangasiids. It is most crucial to improve our understanding of the larval drift and fry migrations, as these are particularly vulnerable to the effects of waterworks such as dams, flood protection and irrigation schemes.

Recommendations

Study and report on larval drift and fry migrations.

Determine the locations and physical characteristics of the spawning grounds of both the northern and southern populations. A better understanding of the spawning process and its natural conditions will contribute much to efficient protection.

Gather information on all biological parameters, such as age-at-first-maturity, length-weight and age relationships, as well as indicators of the mortality caused by different fishing gears and the effects of the fry fishery.

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