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Fisheries in the Mun River: A One-Year Trial of Opening the Sluice Gates of the Pak Mun Dam, Thailand

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ABSTRACT

The changes in fisheries during the trial on the opening of sluice-gates of Pak Mun Dam (July 2001 to June 2002) were investigated. There were 184 fish species from 44 families found, with some species recognized to extirpate from the Mun River. Shannon's diversity index ranged from 1.92 to 3.14. Catch per unit of fishing effort ranged from 0.38 to 1.70 and 0.61 to 2.71 kg set^{-1} $night^{-1}$ in down- and up-stream, respectively. Fish upstream migrations during the rainy season were observed. Incomes from fishing activities were 16,366 Thai Baht yr^{-1} per household. Traditional activities, especially related to fisheries, returned and income from fishing also increased during the study period.

Key words: Pak Mun Dam, fishes and fisheries

INTRODUCTION

Fisheries in the Mun River, the largest Mekong River tributary in Thailand, have been an issue of interest since the construction of Pak Mun Dam in 1990. The dam is about 22 m high (with the operating head of 17 m) and 300 m wide. The length of the reservoir outflow from the dam to the Mekong River is 4.5 km and at the full storage level, water flowing into the dam is backed up 35-km upstream (Roberts, 2001). The dam was inaugurated to impound in 1994. After the 1994 impoundment, there were major concerns on the potamodromous behavior of many antipodal species, the transformation from rheophilic- to the limnophilic- environment, as well as changes and lost in fishing activities (Roberts, 1994).

The Mun River is the longest river in the north-east of Thailand, 641 km from its origin to the Mekong confluence, with a 117,000-km^2 catchment area (Duangswasdi and Chookajorn, 1991). Schouten *et al.* (2000) reported 265 fish species recorded in the Mun watershed before 1994 and about 10 were introduced species. Fish are the cheapest source of animal protein and source of income for the local people, who live in the vicinity to inland water bodies in Asia (De Silva, 2001) and the migratory fishes of the Mekong River Basin support many important community-based artisanal fisheries (Roberts, 1993; Ahmed *et al.*, 1996). Warren and Mattson (2000) stated that most of Mekong fishes were migratory species, albeit to different degrees, for reproductive, trophic or dispersal purposes. Poulsen and Jørgensen (2000) also reported that many Mekong indigenous species have to move to the Mekong tributaries such as the Mun River in Thailand for their reproductive purpose. However, since the construction of the Pak Mun Dam, it is likely to be a bio-geographic barrier and has a major impact

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for the upstream movement of migratory fishes from the Mekong River to the Mun River (Roberts, 2001). Schouten *et al.* (2000) reported that after the completion of the Pak Mun Dam, fishes and fisheries was haphazard and performance of the fish ladder, pool and weir type, had never been properly evaluated.

In June 2001, The Royal Thai Government tried to solve these controversies and ordered the Electric Generation Authority of Thailand (EGAT) to open all the sluice gates to monitor the changes during the one-year trial (from July 2001 to June 2002) and to investigate the methods for rehabilitation of fishes and fisheries. The objective of the study was get the information of changes in fish species and fisheries in the Mun River for a compromised management.

MATERIALS AND METHODS

Sampling sites

The sampling sites were divided into two main areas, a downstream site (from Mun confluence to dam) and an upstream site (from dam to Pibun Mungsaharn District), by using the dam as the barrier. Many rapids, slightly sharp curves and narrower width were found in the downstream site, while the bottom was flatter and wider at the upstream site. The downstream and upstream sites were subdivided into 11 and 17 stations, respectively (Figure 1).

Data collection and analysis

Each station had its own data collector. The study period was from July 2001 to June 2002 since the Thai Government had allowed opening of sluice gates for only one year. Fishers were free to decide when they went to fish as well as what fishing gear(s) should be used in their given areas while the sampling dates were set by the project. Two field-staff members meet with the data collectors fortnightly, to check on data collected and brought the samples back. Fish samples were packed in 10% formalin and were taken to the Faculty of Agriculture, Ubon Ratchathani University (70 km from the Pak Mun Dam). Samples were weighed, measured and taxonomically classified.

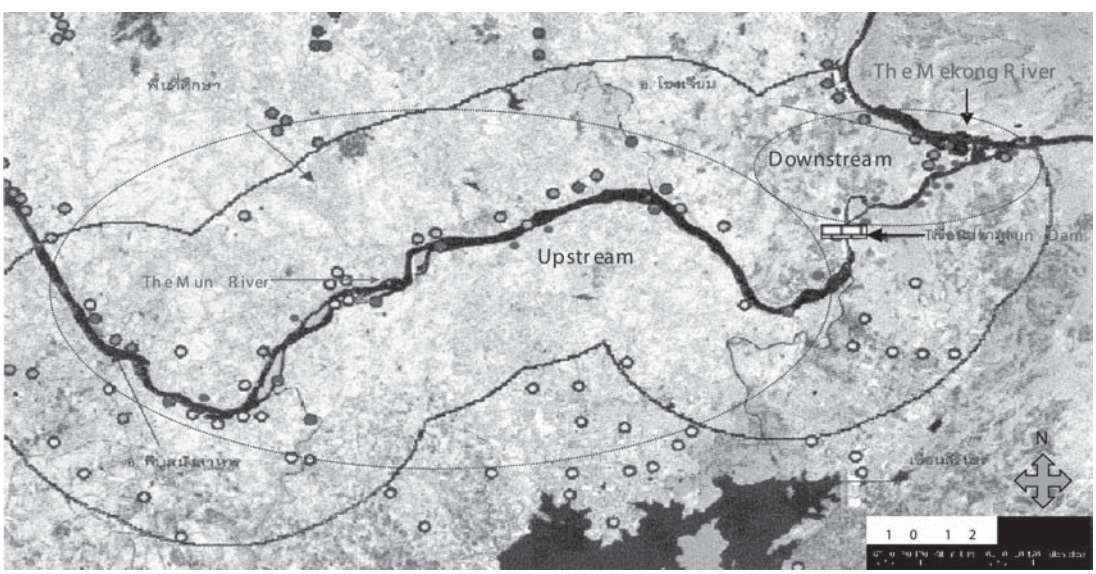


Figure 1 Map of the sampling area and stations.
Note ● Sampling stations

Species diversity was calculated by using Shannon's diversity index (H') and the relative evenness (J');

$$H' = \hat{A} P_i \ln P_i \text{ ---------- (1)}$$

and

$$J' = H'/H_{max} \text{ ---------- (2)}$$

where, P_i was the relative abundance, i.e. the number of individuals for each species divided by the total number of individuals for all species (S) in each sample and H_{max} was the natural logarithm of S (Begon *et al.*, 1990).

Non-parametric chi-square (c^2) was used for comparing catch per unit of fishing effort (CPUE; kg set^{-1} $night^{-1}$) between the main sampling sites. Analysis of variance (ANOVA) and the least-significant different (LSD) were used as tools for analyzing the difference among CPUE in each month, which was transformed to ln(1+CPUE) (Green, 1979), by equation

$$Y_{ij} = m + a_i + \text{Œ}_{ij} \text{ ---------- (1)}$$

where, Y_{ij} was ln(1+CPUE) of the i^{th} month in the j^{th} station, m was the grand mean ln(1+CPUE), a_i was the month effect and Œ_{ij} was the error term. The SYSSTAT program (Wilkinson, 1989) was used as a tool in statistical analysis.

Information of incomes from fishing activities, from 1990 to 1999, was derived from the data, collected by the Interior Ministry staff for development planning. In this study, the 2002 income was calculated from the payment, paid to the data collectors. Changes in their fisheries and fishery-related activities were from group discussions with representatives, local fishers, in the study area.

RESULTS

Fish species composition

During the study period, there were 184 fish species from 44 families found. Among these, 34 species were Mekong endemic species, 11 were introduced species and 48 were species claimed by the fishers that they were not seen in the study areas for a long time, therefore were defined as uncommon species (Table 1). Most catches were from five families *viz.* Cyprinidae, Pangasidae, Bagridae, Siluridae and Cobitidae. Also included in the catches were two common stocking fishes namely carp, *Cyprinus carpio* (Linn.) and Nile tilapia, *Oreochromis niloticus* (Linn.) as well as a stocking shellfish, giant freshwater shrimp, *Macrobrachium rosenbergii* (De man). After the opening of the sluice gates, H' values continuously increased until November, when the water receded, and then tended to decline slightly. The lowest H' value was in July and the peak was in November, and the index ranged from 1.92 to 3.14 (Table 2).

Species, that probably extirpated from the Mun River before construction of the dam (Schouten *et al.*, 2000; Roberts, 2001) were also caught *viz.* mad barb, *Leptobarbus hoeveni* (Bleeker), giant mottled eel, *Anguilla marmorata* (Quoy & Gaimard), Laotian shad, *Tenualosa thibaudeaui* (Durand), Mekong giant catfish, *Pangasinodon gigas* (Chevey) and sheathfish, *Wallagonia leeri* (Bleeker). Moreover, many species, which were not in the list of reportedly utilized fishes of the Pak Mun fish ladder (Pholprasith *et al.*, 1997), were also found in the upstream area.

Fisheries

Catch per unit of fishing effort (CPUE) ranged from 0.38 to 1.70 and 0.61 to 2.71 kg set^{-1} $night^{-1}$ in down- and up-stream, respectively (Table 3). From the c^2-test, there was difference in CPUE between the two main sampling areas (P-value = 0.039) and CPUE tended to increase after the gate-opening, especially in the upstream area (Figure 2). However, a similar decline was observed in CPUE from February to April and an increase, again in June, in both down- and up-stream areas. From ANOVA, there was no statistical difference in terms of monthly ln (1+CPUE) in the down- and up-stream areas, where P-values are 0.087 and 0.558, respectively. However, from LSD-test, ln

(1+CPUE) in downstream in February and June were significant different from each other (P-value < 0.05) (Table 3). When categorized into groups, Pangasiisd, Bagriids, Siluriids and some Cyprinids, a homogenous group in the wet season showed statistical difference (P-value < 0.05) to the other months (Jutagate, *accepted*). The black shark minnow, *Morulius chrysophekadion* (Bleeker) and Pangasiids largely contributed in all catches in terms of weight and number, respectively (Figure 3).

For the changes in the fishing-gear use by discussing with the local fishers and observing, decreasing of the water level in the upstream area allowed the resumption of trap fisheries, especially in the rapid areas. On the other hand, during the normal condition of sluice gate closing, well operated fishing gear such as small lift net ("*Dahng*" in Thai), used to fish Thai river sprat, *Clupeichthys aesarnensis* (Wongratana) and small shrimps, could not be employed during the trial period, since the amount of target species and shrimps decreased. No such changes were observed in the use of longline and gillnet but the fishers mentioned that the yields were higher when the gates were opened than during the closing of sluice gate period.

Socio-economics aspects

The income from fishing activities alone showed a remarkable change in the past ten years (1992-2002) from 4,336 (±783) Thai Baht yr^{-1} per household in 1992 to 16,366 (±116) Thai Baht yr^{-1} per household in 2002. During this period, the trend of increasing income continued from 1990 to 1996 and then declined from 1999 to date (Figure 4). Peak income was in 1996, two years after impoundment.

In terms of fishery-related traditional activities, the interviewees, from the group of fishers, claimed that the benefits gained from this trial period were that when they helped one another to fish, they had strengthened their relationships among neighbors and locals on joint use of fishing gears techniques and fishing maneuvers were transfered to the younger generation. Furthermore, household members, who went to work in other cities came back home to fish again.

DISCUSSION

Fish species diversity in the Mun River, especially in Ubon Ratchathani Province area has fluctuated considerably from 115 (Tantong and Siripan, 1969), 75 (Team Consulting Engineers, 1982), 68 (Duangsawasdi and Chookajorn, 1991), 70 (Duangsawasdi and Duangsawasdi, 1992), 152 (Schouten *et al.*, 2000) and, recently, 59 species in the reservoir area (Jutagate *et al.*, 2001). The differences in number may have been from misidentified fishes and misuse of sampling techniques. Unfortunately, specimens from previous studies were not maintained for further re-checking. However, in this study, all specimens were collected and maintained at the Ubon Ratchathani University Museum of Fisheries (UBUMF).

The high Shannon diversity (H') index in November, which was the period of the start of the dry season, meant that the fishers could use many types of gear. Moreover, this was also the time that the adult fishes and new recruits migrated back to the main stream (Poulsen and Jørgensen, 2000). Continuous increasing of CPUE at the upstream area indicated the migration of the downstream fishes from the Mekong River. Homogeneous grouping of CPUE data refers to the occurrence of the migration (Warren, 1999). It is believed that the three main purposes of migration, in this river system, are reproductive, trophic and dispersal (Warren *et al.*, 1998). In Mekong River system, indigenous fish species present more or less migratory habits in both longitudinal and lateral, where a raising of the water level and changes in water color and turbidity are among the main triggers to migrate upstream and then move back

to the main stream when the water level recedes (Poulsen and Jorgensen, 2000). The remarkably high CPUEs in June and February were good indicators, respectively, of the upstream and downstream migration. Dry season upstream migrations of some species were also observed by Warren *et al.* (1998).

Contributions of *P. gigas*, Bagrid catfish, *Hemibagrus nemurus* (Val. in Cuv. & Val.) and *M. rosenbergii* implied the success of fish stocking program of the EGAT cooperating with Department of Fisheries (DOF). One of *P. gigas* was found with a labeled tag in its first dorsal fin base and the two latter market-species were stocked annually. Meanwhile, Java barb, *Barbodes gonionotus* (Bleeker) and minnow *Labiobarbus leptocheilus* (Val. in Cuv. & Val.), which were stocked from 1999-2000 at a high rate (Head of Pak Mun Fishery Conservation Unit, *pers. com.*), were never found in large numbers in any catches. It could imply that the rapid areas were not the suitable niches for these two species.

Tongkum (1991) reported that the income from fisheries of the main two impacted districts, Khong Jiem and Pibun Mungsaharn, was 16,893 Thai Baht yr^{-1} per household. Peak income from fishery occupation was in 1996, due to the increase in fish production after impoundment, and this was always lapper in newly dammed reservoirs elsewhere in Thailand (for example, Ubolratana and Sirinthorn), before income dropped and then stabilized (Fishery Extension Division, 1995). The slight increase in income from 1990 to 1994 was due to the increase of fish prices from the changes of the value of Thai Baht. The fluctuation in 1999 and 2002 was probably caused by the closing and opening the sluice gates.

In regard to any optimized fishery management which can be measured, Charles (2001) stated that there were three main paradigms in fishery management *viz.*, conservation, rationalization and social/community. A proper management scheme should balance these three paradigms. However, with the management of the Pak Mun Dam, fishes and fisheries were on one side and the electric generation was on another side. In terms of conservation and social/ community paradigms, the fish migratory issue must get priority. Meanwhile, the power supply was amongst the most important in the rationalization paradigm.

From the fisheries viewpoint, since the fish ladder does not perform well and is not suitable for many species found in the Mun River (Schouten *et al.*, 2000), the fishes should have a chance to migrate upstream to complete their life cycle. Allowing the opening of all sluice gates at a particular time, especially during the rainy season, this should be considered by the authorized organizations and the Thai Government. However, the dilemma occured because from July until 15th September was still in the closed fishing season but from the observation during the study period, the fishers fished heavily during this period. Therefore, the Pak Mun Fishery Conservation Unit should concentrate on patrolling and stopping any forbidden fishing gear uses during this time to let the fishes have a chance to move upstream.

CONCLUSIONS

1. During the study period, the number of fish species and income from fisheries increased considerably compared to the previous closed sluice gate period.

2. Most fish species likely migrated upstream in the beginning of the rainy season and migrated down stream after the water receded in beginning of the dry season.

3. If any compromised management is implemented to meet the requirements of both fisheries and power supply, in terms of fisheries, the period of opening the sluice gates, which covers the rainy season, should be considered.

Table 1 Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
	Family Dasyatidae (stingrays)					
1	*Himantura polylepis* (Bleeker)	Freshwater giant stingray			*	
	Family Notopteridae (featherbacks)					
2	*Notopterus notopterus* (Pallas)	Bronze featherback				
3	*Chitala blanci* (Aubenton)	Royal featherback			*	
4	*Chitala lopis* (Bleeker)	Giant featherback			*	
5	*Chitala ormata* (Gray)	Clown featherback				
	Family Anguillidae (true eels)					
6	*Anguilla marmorata* Quoy & Guimard	Giant mottled eel			*	
	Family Clupeidae (herrings)					
7	*Clupeichthys aesarnensis* Wongratana	Thai river sprat	*	*		
8	*Tenualosa thibaudeaui* (Durand)	Mekong shad		*		
	Family Engraulidae (anchovies)					
9	*Setipinna melanochir* (Bleeker)	Freshwater anchovy				
	Family Cyprinidae (carps or barbs)					
10	*Barilius koratensis* Smith	Korat barilius				
11	*Cyprinus capio* Linnaeus	Common carp	*			*
12	*Hypophthalmichthys molitrix* Valenciennes	Bighead carp				*
13	*Paralaubuca typus* Bleeker	Silver knife barb	*			
14	*Paralaubuca barroni* (Fowler)	Barron knife barb				
15	*Luciosoma bleekeri* (Steindachner)	Bleeker Apollo shark				
16	*Macrochirichthys macrochirus* (Valenciennes)	Laotain sword barb			*	
17	*Parachela maculicauda* (Smith)	Scissortail Asian hatchet				
18	*Parachela oxygastroides* (Bleeker)	Giant Asian hatchet				
19	*Raiamas guttatus* (Day)	Trout barb	*			
20	*Amblypharyngodon chulabhornae* Vidthayanon & Kottelat	Chao Fah rasbora				
21	*Esomus metallicus* Ahl	Striped flying barb	*			
22	*Rasbora sumatrana* (Bleeker)	Sidestripe rasbora				
23	*Rasbora myersi* Brittan	Silver rasbora				
24	Rasbora rubrodorsalis *Donoso-Buchner & Schmidt*	*Red fin rasbora*				
25	*Rasbora borapetensis* Smith	Red tail rasbora				
26	*Rasbora spilocerca* Rainboth & Kottelat	Dwarf scissortail rasbora				
27	*Rasbora trilineata* Steindachner	Scissortail rasbora				
28	*Leptobarbus hoeveni* (Bleeker)	Mad barb				
29	*Probarbus jullieni* Sauvage	Seven-line barb			*	
30	*Thynnichthys thynnoides* (Bleeker)	Tiny scale barb	*			
31	*Amblyrhynichthys truncatus* (Bleeker)	Bigeye barb			*	

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
32	*Cosmocheilus harmandi* Sauvage	Bala shark				
33	*Cyclocheilichthys heteronema* (Bleeker)	Branched barbel sensory barb			*	
34	*Cyclocheilichthys apogon* (Val. in Cuv. & Val.)	Beardless sensory barb	*			
35	Cyclocheilichthys armatus *(Val. in Cuv. & Val.)*	*Silver sensory barb*				
36	*Cyclocheilichthys repasson* (Bleeker)	Pointed nose sensory barb	*			
37	*Cyclocheilichthys enoplos* Bleeker	Giant sensory barb	*			
38	*Cyclocheilichthys furcatus* Sontirat	Mekong sensory barb		*	*	
39	*Mystacoleucus marginatus* (Val. in Cuv. & Val.)	Yellowtail hook barb	*			
40	*Mystacoleucus atridorsalis* Fowler	Spotted black tip hook barb		*	*	
41	Mystacoleucus ectypus *Kottelat*	*Black tip hook barb*		*		
42	*Puntioplites proctozysron* (Bleeker)	Cubic barb	*			
43	*Puntioplites falcifer* Smith	Longfin cubic barb		*		
44	Sikukia gudgeri *(Smith)*	*Gudger barb*	*	*		
45	*Barbodes altus* (Gunther)	Golden barb	*			
46	*Barbodes gonionotus* (Bleeker)	Java barb	*			
47	*Barbodes schwanenfeldi* (Bleeker)	Tinfoil barb	*			
48	*Hypsibarbus malcomi* (Smith)	Malcom barb				
49	*Hypsibarbus suvatti* Rainboth	Suvatti barb				
50	*Hypsibarbus wetmorei* (Smith)	Wetmore barb				
51	*Hypsibarbus lagleri* Rainboth	Lagler barb		*	*	
52	*Discherodontus ashmeadi* (Fowler)	Red tail barb		*	*	
53	*Poropuntius deauratus* (Val. in Cuv. & Val.)	Yellow tail brook Barb	*	*		
54	*Scaphognathops bandanensis* Boonyaratpalin & Sirungroj	Bandan sharp-mouth barb	*	*		
55	*Scaphonathops stejnergeri* Smith	Stejnerger sharp- mouth barb	*	*	*	
56	*Hampala dispar* Smith	Spotted wolf barb	*	*		
57	*Hampala macrolepidota* (Kuhl & van Hasselt in van Hasselt)	Banded wolf barb	*			
58	*Puntius chola* Hamilton	Chola common barb				
59	*Puntius aurotaeniatus* Tirant	Samet common barb				
60	*Puntius binotatus* (Val. in Cuv. & Val.)	Spotted common barb				

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
61	*Puntius orphoides* (Val. In Cuv. & Val.)	Red cheek common barb	*			
62	*Puntius partipentazona* Fowler	Siamese tiger barb				
63	*Bangana behri* Fowler	Mekong dolphin labeo			*	
64	*Henicorhynchus siamensis* (Sauvage)	Common Siamese barb				
65	*Henicorhynchus lineatus* (Smith)	Striped Siamese barb		*	*	
66	Henicorhynchus lobatus *(Smith)*	*Pointed nose Siamese barb*				
67	*Henicorhynchus ornatipinnis* Roberts	Red fin Siamese barb		*	*	
68	*Cirrhinus microlepis* Sauvage	Giant violet Siamese barb	*		*	
69	*Cirrhinus chinensis* Gunther	Mud carp			*	
70	*Cirrhinus migrala* (Hamilton)	Mrigal				*
71	*Morulius chrysophekadion* (Bleeker)	Crow Labeo	*			
72	*Labeo dyocheilus* (McClelland)	Thick lip labeo			*	
73	*Labeo rohita* (Hamilton)	Rohu				*
74	*Labiobarbus leptocheilus* (Val. in Cuv. & Val.)	Striped longfin labeo	*			
75	*Lobocheilus melanotaenia* (Fowler)	Bluegill labeo			*	
76	*Osteochilus hasselti* (Val. in Cuv. & Val.)	Red spotted robust labeo	*			
77	*Osteochilus melanopleura* (Bleeker)	Black eye robust labeo				
78	*Osteochilus lini* Fowler	Lin robust labeo		*		
79	*Osteochilus microcephalus* (Val. in Cuv. & Val.)	Black striped robust labeo	*			
80	*Osteochilus waandersi* (Bleeker)	Black striped robust labeo				
81	*Crossocheilus oblongus* Kuhl & van Hasselt in van Hasselt	Oblong algae eater		*	*	
82	*Crossocheilus reticulates* (Fowler)	Reticulated algae eater				
83	*Crossocheilus atrilimes* Kottelat	Mekong algae eater		*		
84	*Epalzeorhynchos munense* (Smith)	Mun red tail shark	*		*	
85	*Epalzeorhynchos frenatus* (Fowler)	Red fin shark	*		*	
86	*Mekongina erythrospila* Fowler	Mekong Labeo		*	*	
	Family Characidae					
87	*Myletes bidens* (Spinx & Agassiz)	Pacu				*
	Family Gyrinocheilidae (algae eater)					
88	*Gyrinocheilus pennocki* Fowler	Spotted algae eater		*	*	
	Family Cobitidae (loaches)					
89	*Acanthopsis* sp.1 (large spotted)	Horse face loach	*			
90	*Acanthopsis* sp.2 (small spotted)	Horse face loach	*			

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
91	*Acanthopsoides* sp.1	Pygmy Horse face loach				
92	*Botia helodes* Sauvage	Tiger botia	*			
93	*Botia eos* Taki	Sun botia	*		*	
94	*Botia lecontei* Fowler	Silver botia				
95	Botia morleti *Tirant*	*Skunk botia*	*			
96	*Botia modesta* Bleeker	Redtail botia	*			
97	Lepidocephalichthys hasselti *(Val. in Cuv. & Val.)*	*Hasselt sand loach*				
98	*Lepidocephalichthys* sp.1	Sand loach				
	Family Balitoridae (river loaches)					
99	*Homaloptera smithi* Hora	Smith climbing loach			*	
100	*Nemacheilus pallidus* Kottelat	Spotted brook loach			*	
	Family Bagridae (Bagrid catfishes)					
101	*Pseudomystus siamensis* (Fowler)	Bubble bee mystus				
102	*Mystus atrifasciatus* Fowler	Mekong striped mystus		*		
103	*Mystus mysticaetus* Roberts	Southeast Asia striped mystus				
104	*Mystus singaringan* (Bleeker)	Long adipose mystus				
105	*Mystus bocourti* (Bleeker)	High fin mystus				
106	*Hemibagrus* sp.1	White bagrus		*		
107	*Hemibagrus nemurus* (Val. in Cuv. & Val.)	Yellow bagrus	*			
108	*Henmibagrus filamentus* (Fang & Chaux)	Filamentous bagrus				
109	*Hemibagrus wyckii* (Bleeker)	Black bagrus				
110	*Hemibagrus wyckioides* (Chaux & Fang)	Red fin bagrus				
111	*Bagriichthys obscurus* Ng	Shortfin blunt-nose catfish				
112	*Bagriichthys macracanthus* (Bleeker)	High fin blunt-nose catfish				
	Family Pangasiidae (river catfishes)					
113	*Pangasianodon gigas* Chevey	Mekong giant catfish		*	*	
114	*Pangasianodon hypophthalmus* (Sauvage)	Iridescent shark catfish			*	
115	*Helicophagus waandersi* Bleeker	Rat mouth shark catfish				
116	*Pangasius pleurotaenia* (Sauvage)	Big eye shark catfish	*			
117	*Pangasius conchophilus* Roberts & Vidthayanon	Snail eating shark catfish				
118	*Pangasius bocourti* Sauvage	Bocourt shark catfish	*			
119	*Pangasius macronema* Bleeker	Long barbel shark catfish				

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
120	*Pangasius larnaudii* Boucourt	Black eye shark catfish				
121	*Pangasius sanitwongsei* Smith	Sanitwong shark catfish			*	
	Family Schilbeidae (Schilbeid catfishes)					
122	*Laides longibarbis* (Bleeker)	Flatted barbel shark catfish				
	Family Siluridae (sheathfish)					
123	*Belodontichthys truncatus* (Bleeker)	Dracula sheathfish				
124	*Hemisilurus mekongensis* Bornbursh & Lundberg	Mekong sheathfish		*	*	
125	*Micronema apogon* (Bleeker)	Bronze sheathfish				
126	*Micronema bleekeri* (Gunther)	Blue sheathfish				
127	Micronema micronema *(Bleeker)*	*Gray sheathfish*			*	
128	*Kryptopterus cheveyi* Durand	Chevey sheathfish				
129	*Kryptopterus palembangensis* Bleeker	Giant glass catfish			*	
130	*Kryptopterus cryptopterus* (Bleeker)	Riverine sheathfish	*			
131	*Ompok siluroides* (Lecepede)	Black ear sheathfish				
132	*Wallago attu* (Schneider)	Crocodile sheathfish				
133	*Wallagonia leeri* Bleeker	Black sheathfish			*	
	Family Sisoridae (Sisorid catfishes)					
134	*Bagarius yarrelli* Sykes	Crocodile catfish				
135	*Glyptothorax lampris* Fowler	Torrent catfish				
	Family Clariidae (walking catfishes)					
136	*Clarias batrachus* (Linnaeus)	Walking catfish				
137	*Clarias macrocephalus* Gunther	Broad-head walking catfish				
138	*Clarias* sp.1 (hybrid)	Hybrid walking catfish				*
	Family Loricariidae (sucker armer cat)					
139	*Hypostomus plecostomus* (Linnaeus)	Lorica sucker catfish				*
	Family Mochokidae					
140	*Synodontis eupterus* Boulenger	Longfin upside-down catfish				*
	Family Salangidae					
141	*Neosalanx* sp.1	Mekong salang		*	*	
	Family Sundasalangidae (Noodlefish)					
142	*Sundasalanx mekongensis* Kottelat & Ng	Mekong noodlefish		*		
	Family Poecilidae					
143	*Poecilia reticulata* (Peters)	Guppy				*

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
	Family Oryziidae (rice fish)					
144	*Oryzias minutilus* Smith	Pygmea rice fish				
145	*Oryzias sinensis* Chen, Uwa & Chu	Chinese rice fish			*	
	Family Hemirhamphidae (halfbeaks)					
146	*Dermogenys siamensis* Fowler	Siamese half beak				
	Family Belonidae (needlefishes)					
147	*Xenentodon canciloides* (Bleeker)	Long beak tropical gar	*			
	Family Syngnathidae (pipefishes)					
148	*Doryichthys contiguus* Kottelat	Pygmy pipefish		*	*	
	Family Indostomidae					
149	*Indostomus spinosus* Brite & Kottelat	Spiny tropical		*	*	
	Family Synbranchidae (swamp eels)	stickleback				
150	*Monopterus albus* (Zieuw)	Swamp eel				
	Family Mastacembelidae (spiny eels)					
151	*Macrognathus semiocellatus* Roberts	Ocellated spiny eel				
152	*Macroghathus siamensis* (Gunther)	Peacock spiny eel				
153	*Mastacembelus favus* Hora	Tire track spiny eel				
154	*Mastacembelus armatus* (Lacepede)	Zig-zag spiny eel				
	Family Chaudhuriidae (dwarf swamp eels)					
155	*Chaudhuria caudata* Annandale	Burmese spineless eel			*	
	Family Ambassidae (glassfishes)					
156	*Parambassis siamensis* (Fowler)	Siamese glassfish	*			
	Centropamidae					
157	*Lates calcarifer* (Bloch)	Barramundi			*	
	Family Scienidae (drums)					
158	*Bosemania microlepis* (Bleeker)	Smallscale croaker			*	
	Family Coiidae (Tiger fish)					
159	*Coius undecimradiatus* Roberts & Kottelat	Narrow-band tigerfish		*		
	Family Toxotidae (archerfishes)					
160	*Toxotes chatareus* (Hamilton)	Largescale archerfish				
	Family Cichlidae (cichlids)					
161	*Oreocromis niloticus* (Linnaeus)	Nile tilapia				*
	Family Eleotridae (sleepers)					
162	*Oxyeleotris marmorata* Bleeker	Marbled sleeper goby				
	Family Gobiidae (gobies)					
163	*Branchygobius mekongensis* Larson &	Mekong Bubble bee		*	*	
	Vidthayanon	goby				
164	*Glossogobius giuris* (Hamilton)	Gangetic tank goby		*	*	

Table 1 (cont.) Species found during the opening the Pak Mun Dam sluice gate's trial.

No.	Scientific name	Common name	A	B	C	D
165	*Tridentiger ocellatus* (Fowler)	Mekong ocellate goby		*		
166	*Gobiopterus chuno* (Hamilton)	Glass goby			*	
167	Uniden. goby	Deep water goby		*		
	Family Nandidae (leaffishes)					
168	*Nandus oxyrynchus* Ng, Vidthayanon & Ng	Leaf tigerfish			*	
169	*Pristolepis fasciatus* (Bleeker)	Compressed perch	*			
	Family Anabantidae (climbing perch)					
170	*Anabas testudineus* (Bloch)	Climbing perch	*			
	Family Belontiidae (gouramies)					
171	*Betta smaragdina* Ladiges	Mekong fighting fish		*		
172	*Trichogaster pectoralis* (Regan)	Snakeskin gourami				
173	*Trichogaster trichopterus* (Pallas)	Three spot gourami				
174	*Trichopsis schalleri* Ladiges	Colorful croaking gourami				
175	*Trichopsis vittatus* (Cuv. in Cuv. & Val.)	Croaking gourami				
	Family Osphronemidae (giant gouramies)					
176	*Osphronemus goramy* Lacepede	Giant gourami			*	*
	Family Channidae (snakeheads)					
177	*Channa limbata* (Cuvier)	Red tail snakehead				
178	*Channa lucius* (Cuv. in Cuv. & Val.)	Marble snakehead				
179	*Channa striata* (Bloch)	Green tail snakehead	*			
180	*Channa micropeltes* (Cuv. in Cuv. & Val.)	Giant snakehead			*	
	Family Soleidae (soles)					
181	*Brachirus harmandi* (Sauvage)	Ovate sole				
	Family Tetraodontidae (puffers)					
182	*Chonerhinus nefastus* Roberts	Green bottle puffer				
183	*Tetraodon leiurus* Bleeker	Spotted green puffer				
184	*Tetraodon cambodgensis* Chabanaud	Ocellated puffer				

Note: A: Species, which reportedly utilize fish-ladder (Pholprasith *et al.*, 1997)
B: Mekong endemic species
C: Uncommon species
D: Introduced species

Table 2 Shanon's diversity indice and relative evenness during the study periods.

Month	Shanon's index ± SE	Relative evenness ± SE
July 2001	1.92 ± 0.65	0.55 ± 0.20
August 2001	2.92 ± 0.18	0.81 ± 0.50
September 2001	2.12 ± 0.57	0.58 ± 0.17
October 2001	3.10 ± 0.18	0.81 ± 0.04
November 2001	3.14 ± 0.13	0.82 ± 0.02
December 2001	2.70 ± 0.32	0.76 ± 0.08
January 2002	2.35 ± 0.33	0.70 ± 0.09
February 2002	2.45 ± 0.27	0.73 ± 0.07
Martch 2002	2.16 ± 0.33	0.66 ± 0.09
April 2002	2.49 ± 0.23	0.71 ± 0.07
May 2002	2.44 ± 0.37	0.66 ± 0.09
June 2002	2.50 ± 0.23	0.74 ± 0.06

Table 3 Average CPUE at Pak Mun Reservoir from July 2001 to June 2002.

Month	CPUE ± SD (kg set^{-1} $night^{-1}$)		ln (1+CPUE)	
	Downstream	Upstream	Downstream	Upstream
July	0.43 ± 0.10	1.40 ± 0.95	0.358^{ab}	0.875^{ab}
August	0.38 ± 0.17	1.71 ± 0.94	0.322^{b}	0.998^{ab}
September	0.64 ± 0.35	0.61 ± 0.18	0.495^{ab}	0.476^{a}
October	0.59 ± 0.17	1.17 ± 0.27	0.464^{ab}	0.775^{ab}
November	0.85 ± 0.28	1.67 ± 0.34	0.615^{ab}	0.982^{ab}
December	0.69 ± 0.28	1.94 ± 0.70	0.525^{ab}	1.078^{ab}
January	0.50 ± 0.17	2.62 ± 0.97	0.405^{ab}	1.287^{ab}
February	1.62 ± 0.69	2.71 ± 1.06	0.963^{c}	1.312^{b}
Martch	0.98 ± 0.39	2.28 ± 0.77	0.683^{ab}	1.188^{b}
April	0.79 ± 0.14	1.54 ± 0.45	0.584^{ab}	0.932^{ab}
May	0.73 ± 0.22	2.04 ± 0.45	0.548^{ab}	1.112^{ab}
June	1.70 ± 0.16	2.19 ± 0.77	0.993^{c}	1.160^{b}

Note: the same letter, in each column, mean that there is no significant different ($\mu = 0.05$)

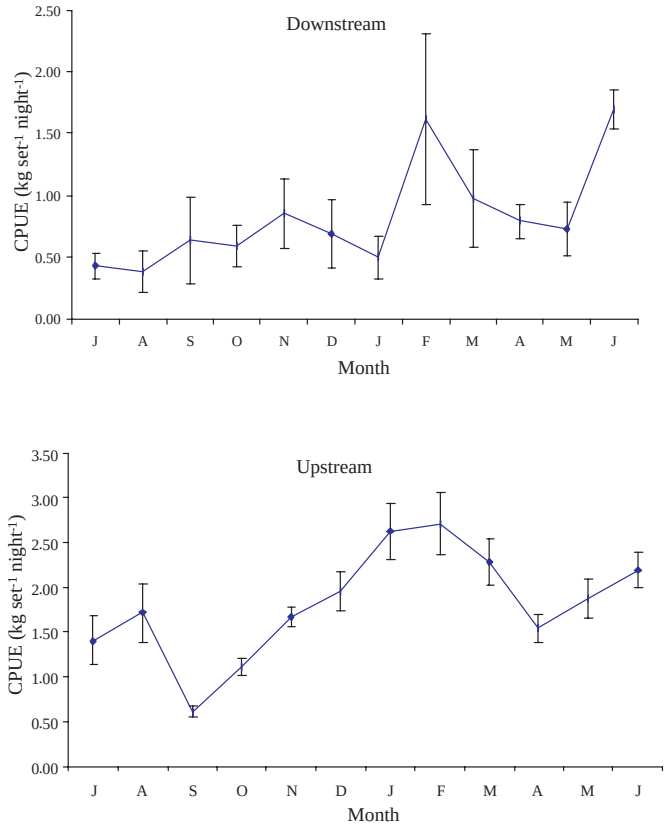


Figure 2 Temporal changes in CPUE ± SD (kg set^{-1}) during the study periods.

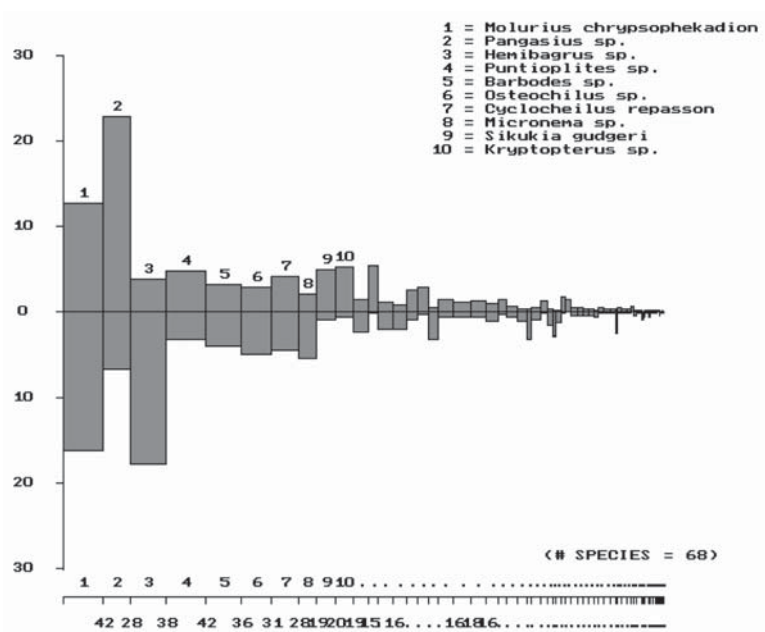


Figure 3 Contribution of catches during the study periods.

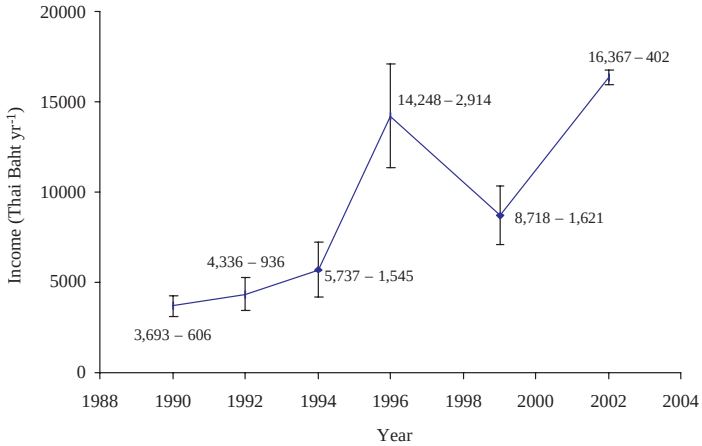


Figure 4 Changes in income ± SD (Thai Baht yr^{-1}) per household from fisheries at the study area from 1990-2002.

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