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Fish Species Diversity and Ichthyomass in Pak Mun Reservoir, Five Years after Impoundment

T. JUTAGATE[1], T. LAMKOM[1], K. SATAPORNWANIT[1,3], W. NAIWINIT[1], and C. PETCHUAY[2]

[1]*Faculty of Agriculture*
Ubon Ratchathani University
Warin Champrab, Ubon Rathchathani
Thailand. 34190

[2]*Faculty of Science*
Ubon Ratchathani University
Warin Champrab, Ubon Rathchathani
Thailand. 34190

[3]*Faculty of Fisheries*
Kasetsart University
Chatuchuk, Bangkok
Thailand. 10900

Abstract

The fish species diversity and ichthyomass at Pak Mun Reservoir were appraised. Eight stations at the reservoir were sampled. The number of species and Shannon's diversity index ranged from 22 to 31 and 1.54 to 3.07, respectively. Common species were *Tridentiger ocellatus, Tetrodon leiurus, Clupeichthys aesarnensis, Oxyeleotris marmorata, Hampala dispar, Barbodes gonionotus, Puntius stigmatosomus, Parambassis siamensis, Macrognathus semiocellatus* and *Cyclocheilichthys mekongensis*. The similarity index revealed a high correlation between the adjacent stations but decreased as the distance increased. Seasonal changes have no effect on ichthyomass.

Introduction

The Pak Mun Dam, constructed for hydroelectrical power and irrigation, is located in Kong Jiem district, Ubon Rathchathani province, NE, Thailand. The dam was built across the Mun River, six kilometers upstream from where the Mun enters the Mekong River. It was inaugurated to impound in 1994 (Wongpattana 1996). The reservoir is considered as the run-of-river type. The water level near the dam site increased about 10 m compared to before impoundment. For fish species diversity, the World Commission on Dams (WCD) reported that about 96 fish species were found in the Mun River compared with the initial count of 265 species, with 56 species considered as completely

extinct (WCD 2000). Meanwhile the environmental impact study (EIA) (Team consultant engineering 1982) reported that the fish species found in the impoundment area were 73 from 19 families. This is similar to other reservoir fisheries studies, which found, that after construction, the dam would adversely affect fisheries primarily by 1) altering the seasonal flood to which many species of fish and many fishing folk have adapted 2) blocking the migratory route of many species such as the commercially valuable species, shad (Hilsa ilisha, Clupeidae) in India (Scudder and Conelly 1985) and 3) flooding of spawning and other habitats. Moreover, Roberts (1993) mentioned that a very serious threat to fish could be the riverside industries, that depend on cheap hydroelectric power.

Unpublished fishery studies relating to the lower Mekong Basin, prepared under the auspices of the Mekong Committee reported values of 60 $kg \cdot ha^{-1}$ for the upstream Mun River tributary to the Mekong. The value of 60 $kg \cdot ha^{-1}$ is a mean of several estimates, which fell from 120 $kg \cdot ha^{-1}$ at low water to 5 $kg.ha^{-1}$ during the rising flood (Welcomme 1985). The expected fish production after impoundment was 220 $kg \cdot ha^{-1}$ but the present status shows that it is only about 10 $kg \cdot ha^{-1}$ and lower than in the downstream area (WCD, 2000)

The objective of this study was to investigate the fish species composition and ichthyomass at the Pak Mun Reservoir, at specific points, where a lot of changes occurred after impoundment due to the increase in water level.

Materials and Methods

The study was conducted from April 1999 to April 2000. Seining (mesh size = 30 mm.) was done at 8 stations at the Pak Mun Reservoir area, namely; Huay Hai, Tung Lung, Wang Sabang, Pak Bung, Kun Leum, Sai Mun, Chard, and Hin Sung (Fig. 1). The operation was conducted 3 times to represent the seasons and twice at each sampling station. Shannon's diversity index, H', (Eq. 1), the relative evenness, J', (Eq.2) and the index of relative importance, %IRI, (Eq. 3) were used as tools to explain diversity and the major species in each station, respectively.

$$H' = -\sum_{i=1}^{s} P_i \ln(P_i) \quad (1)$$

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

where P_i is the relative abundance, H_{max} = ln (S), and S is the total number of individuals for all species in the sampling station (Begon et al. 1990)

$$\%IRI_j = \left\{ \left[(\%W_j + \%N_j) * \%F_j \right] / \sum_{i=1}^{s} \left[(\%W_i + \%N_i) * \%F_i \right] \right\} * 100 \quad (3)$$

where $\%W_j$ and $\%N_j$ are percentage weight and number of each species of

total catch, $\%F_j$ is percentage frequencies of occurrence of each species in total number of samplings, and S is the total number of species (Kolding 1989). Equations 1 and 2 were calculated using the PASGEAR software (Kolding 1998). Similarity index, SI was derived following Mountford's method (Saraisuwan 1981);

$$SI = [2W/(A * B)] * 100 \quad (4)$$

where A and B are numbers of species found in stations A and B, respectively. W is the number of species that occur at both stations. The maximum SI-values were grouped together and then iterated until the last pair was grouped.

Results

The species found in this study were shown in table 1. However, only goby *T. ocellatus* and pufferfish *T. leiurus* were found at every station at all times. The number of species and families ranged from 22 to 31 and 12 to 17, respectively. Maximum diversity index (H') was 3.07 at Kun Leum station with a relative evenness (J') of 0.90. The minimum H'- and J'- values were found at Ban Chard station, which were 1.54 and 0.49, respectively. (See Table 2.)

IRI-values are shown in figure 2. In terms of %IRI, *T. ocellatus* was ranked as no. 3 or higher at 6 stations. Furthermore, except for Wang Sabang station, *T. ocellatus* showed its importance at the other remaining stations (IRI-value > 5%). The other species were Thai river sprat *C. aesarnensis* and barb *C. mekongensis,* which were caught at 4 stations and *T. leiurus*, 3 stations. Overall, the 3 most important species in this study were *T. ocellatus, C. aesarnensis* and *C. mekongensis* with IRI-values at 10.7, 17.0 and 19.6, respectively.

Fig. 1. Location of sampling stations. 1 - Huay Hai; 2 - Tung Lung; 3 - Wang Sabang; 4 - Pak Bung; 5 - Kun Leum; 6 - Sai Mun; 7 - Chard; 8 - Hin Sung

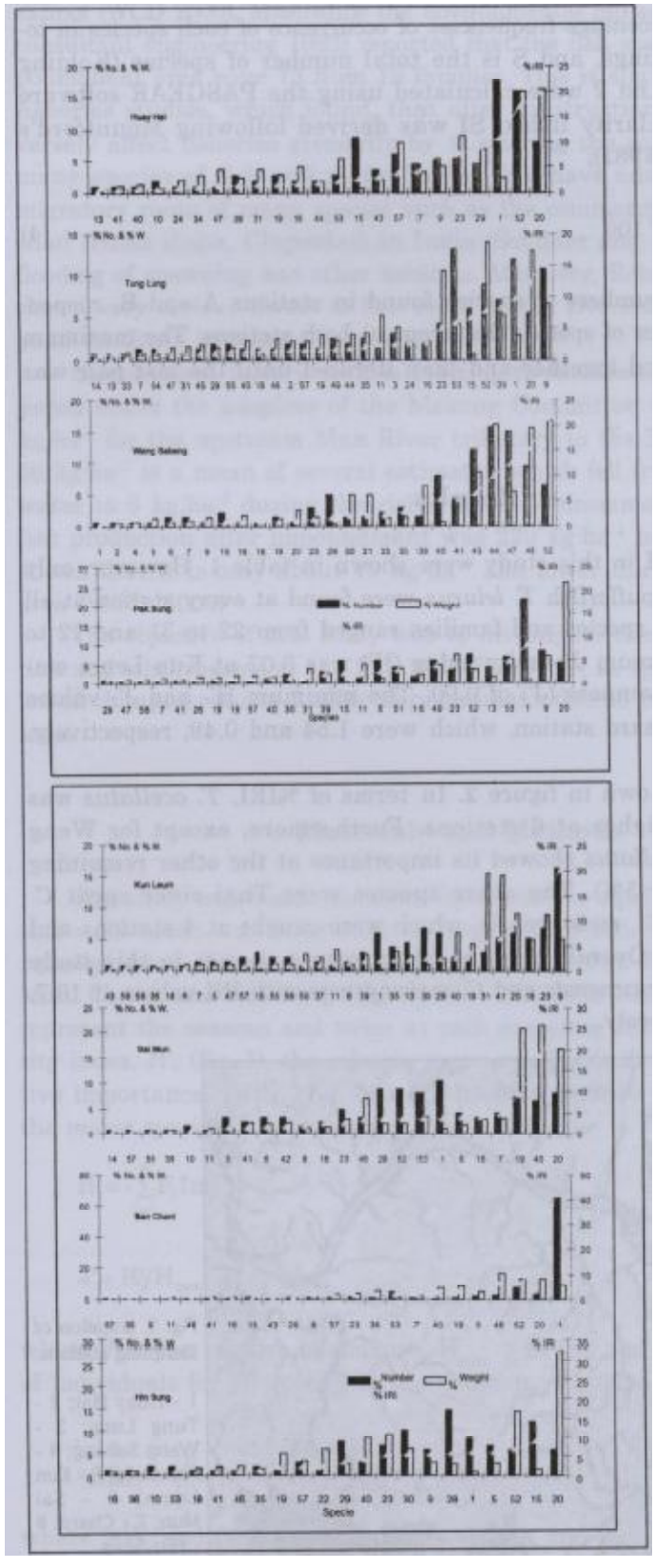

Fig. 2. Species composition and IRI-value at each station.

The similarity index showed high relation between adjacent stations and less relation when distance between stations increased (Fig. 3). The SI-value was highest between Sai Mun and Ban Chard; 76.6%. High values were also seen at Huay Hai and Tung Lung, 74.1% and Pak Bung and Kun Leum, 73.7%. Between sites near and far from the dam, the similarity index fell to 61.2%.

The Chi-square test showed significant difference of ichthyomass before impoundment from the EIA report (Team consultant engineering 1982) and this study (χ^2 = 61.46, d.f. = 4, P-value < 0.01). On table 3, it appears that seasons had no effect on ichthyomass. Ban Chard had the highest ichthyomass at 8.3 ± 2.0 kg·ha^{-1} whereas the others had around 5 kg·ha^{-1}. Differences of ichthyomass from each station were not examined due to "pseudo-replication" problem (Hurlbert 1984).

Table 1. List of species found.

No	Species	Family	No	Species	Family
1	*Clupeichthys aesarnensis*	Clupeidae	31	*Channa striatus*	Channidae
2	*Micronema bleekeri*	Siluridae	32	*Channa micropeltes*	Channidae
3	*Kryptopterus cryptopterus*	Siluridae	33	*Channa gachau*	Channidae
4	*Ompok bimaculatus*	Siluridae	34	*Oreochromis niloticus*	Cichlidae
5	*Toxotes chatareus*	Toxotidae	35	*Setipinna melanochor*	Engraulidae
6	*Chonerhinus modesta*	Toxotidae	36	*Pangasius siamensis*	Pangasiidae
7	*Euryglossus harmandi*	Synapturidae	37	*Laides hexanema*	Pangasiidae
8	*Achiproides leucorhynchos*	Synapturidae	38	*Pteropangasius cultratus*	Pangasiidae
9	*Tetrodon leiurus*	Tetrodontidae	39	*Coius undecimradiatus*	Lobotidae
10	*Xenentodon cancila*	Belonidae	40	*Barbodes gonionotus*	Cyprinidae
11	*Anabas testudineus*	Anabantidae	41	*Puntius stigmatosomus*	Cyprinidae
12	*Trichopsis vittatus*	Belontiidae	42	*Cyclochelichthys apogon*	Cyprinidae
13	*Trichogaster trichopterus*	Belontiidae	43	*Labiobarbus leptocheilus*	Cyprinidae
14	*Betta splendens*	Belontiidae	44	*Labiobarbus spilopleura*	Cyprinidae
15	*Parambassis siamensis*	Chandidae	45	*Labiobarbus lineatus*	Cyprinidae
16	*Macrognathus semiocellatus*	Mastacembelidae	46	*Cirrhinus microlepis*	Cyprinidae
17	*Mastacembelus armatus*	Mastacembelidae	47	*Pristolepis fasciatus*	Pristolepidae
18	*Mastacembelus circumcinctus*	Mastacembelidae	48	*Notopterus notopterus*	Notopteridae
19	*Oxyeleotris marmorata*	Eleotridae	49	*Puntius partipentazona*	Cyprinidae
20	*Tridentiger ocellatus*	Gobiidae	50	*Osteochilus hasselti*	Cyprinidae
21	*Mystacoleucus marginatus*	Cyprinidae	51	*Labeo stigmapleura*	Cyprinidae
22	*Morulius chrysophekadion*	Cyprinidae	52	*Cyclochelichthys mekongensis*	Cyprinidae
23	*Cyclocheilichthys enoplos*	Cyprinidae	53	*Wallagonia attu*	Siluridae
24	*Barbodes altus*	Cyprinidae	54	*Hypopthalmichthys molitrix*	Cyprinidae
25	*Puntius daruphani*	Cyprinidae	55	*Puntius schwanefeldi*	Cyprinidae
26	*Puntius leiacanthus*	Cyprinidae	56	*Oteochilus lini*	Cyprinidae
27	*Rasbora dusoensis*	Cyprinidae	57	*Thynnichthys thynnoides*	Cyprinidae
28	*Rasbora trilineata*	Cyprinidae	58	*Gyrinocheilus aymonieri*	Gyrinocheili-dae
29	*Hampala dispar*	Cyprinidae			
30	*Hampala macrolepidota*	Cyprinidae	59	*Botia modesta*	Cobitidae

Table 2 Number of species and family, diversity index and relative evenness.

Station	Species	Family	Shannon diversity index H'	Relative evenness J'
Huay Hai	23	17	2.72	0.87
Tung Lung	31	15	2.98	0.87
Wang Sabang	26	14	2.73	0.84
Pak Bung	26	15	2.77	0.85
Kun Leum	31	17	3.07	0.90
Sai Mun	24	12	2.92	0.92
Chard	23	15	1.54	0.49
Hin Sung	22	12	2.73	0.88

Discussion

When the environment changed from riverine to lacustrine due to impoundment, only species that can adapt and proliferate in standing water were found such as *T. ocellatus* and *C. aesarnensis*, especially *C. aesarnensis,* which is known to be able to adapt to running as well as to standing water (Costa-Pierce and Soemarwoto 1990, Jutagate et al. 2001). It was observed that catches at each station were composed mainly of small-bodied fish species, which is common when sampling in the littoral zone. These include *C. aesarnensis, T. ocellatus* and *T. leiurus*, with their maximum lengths of 7, 9 and 17 cm, respectively. *C. mekongensis* can reach 23 cm. but is commonly found at 15 cm. (Rainboth 1996). Total fish species found in this study were 59 compared to the WCD (2000) reported 96 species in the upstream region. Non-fish taxa found included the giant freshwater prawn *Macrobrachium rosenbergii,* Palaemonidae. This crustacean, however, was introduced to the Pak Mun Reservoir from the stocking program (Head of Pak Mun fisheries conservation unit, pers. comm.). The species similarity index gradually decreased when the distance between two stations increased. This could be due

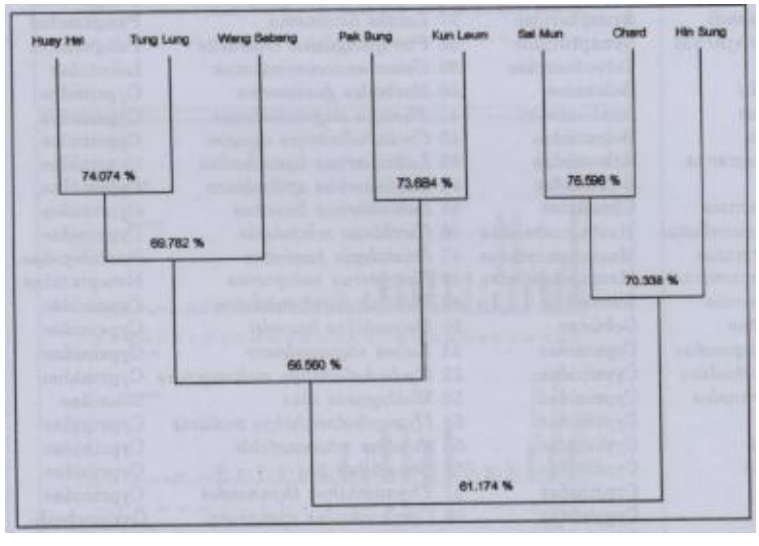

Fig. 3. Similarity index at each station.

Table 3. Ichthyomass (kg.ha^{-1}).

Station	Rainy	Winter	Summer	Mean ± SD
Huay Hai	1.94	2.90	6.22	3.69 ± 2.25
Tung Lung	2.62	1.77	5.67	3.35 ± 2.06
Wang Sabang	5.31	4.95	6.22	5.49 ± 0.66
Pak Bung	0.83	4.95	4.38	3.39 ± 2.23
Kun Leum	3.25	6.36	2.84	4.15 ± 1.92
Sai Mun	9.81	4.24	6.21	6.75 ± 2.82
Ban Chard	7.42	10.61	6.93	8.32 ± 2.00
Hin Sung	4.55	2.12	5.40	4.02 ± 1.70
Mean ± SD.	4.46 ± 2.99[a]	4.74 ± 2.84[a]	5.49 ± 1.31[a]	

to the flow rate and water quality at each station since the average difference in water level between the nearest and the farthest dam site station was about 2 m (Electricity Generation Authority of Thailand unpubl. data).

The EIA study (Team consultant engineering 1982) found the following species to be abundant: silver rasbora (*Rasbora myeri*, Cyprinidae), barb (*P. daruphani*), *C. aesarnensis*, speckled horseface loach (*Acanthopsis choirorhynchos*, Cobitidae), and catfish (*Mystus cavasius*, Bargridae). The preferred habitat of the first four species is in running water while the last one tolerates both flowing and standing water (Rainboth 1996). This is in contrast with the main species in this study that like slow flowing or standing water. The other reservoirs in the northeastern part of Thailand are considered as of the lake type. The important species in 1999 in terms of yield were the catfish (*Mystus* spp., Bagridae), Chevron snakehead (*C. striatus*), Nile tilapia (*O. niloticus*), Silver barb (*B. gonionotus*), *T. ocellatus*, marble goby (*O. marmorata*), carps (*Hampala* spp.) and some other carps (Fisheries Conservation Division, unpubl. data).

The increase in water level to about 10 m after impoundment resulted in the steepness of the littoral zone. Average ichthyomass was 4.9 ± 2.4 $kg \cdot ha^{-1}$. It is lower than the results from previous studies, which were 9.4 $kg \cdot ha^{-1}$ at the expected impounded area and 71.3 $kg \cdot ha^{-1}$ at the Kong Jiem district area (Team consultant engineering 1982, Duangsawasdi and Duangsawasdi 1992). Recently, WCD (2000) revealed the estimate at around 10 $kg \cdot ha^{-1}$ in the upstream area. Differences between this work and previous studies might be due to the sampling site and the abundance of food, such as plankton. Since the dam had to maintain the water level for power generation, a slight change in the water level unveiled the non-significant level of ichthyomass among seasons. In contrast Sirinthorn, a lake type nearby (about 20 km away) had peak catches after 4 years of impoundment (1972 to 1975) from 42.6 $kg \cdot ha^{-1} \cdot yr^{-1}$ to 138.1 $kg \cdot ha^{-1} \cdot yr^{-1}$ and then gradually decreased until stable (Fisheries Extension Division 1995). The two peaks during and a few years after impoundment of this reservoir were probably due to the movement of fish to the drawdown zone to feed and breed as it became inundated. The reduced amount of bush was due to natural bushclearing while the increased mobility of fish resulted in higher catchability coefficient (Bernacsek 1984).

Conclusion

The main species found by this study that can adapt in the standing water environment were *T. ocellatus*, *C. aesarnensis* and *C. mekongensis*. Adjacent stations showed a high value of similarity index (> 70%) but it gradually decreased as the distance from the dam increased. Ichthyomass at each station was not seasonal but differences occurred due to the location of the stations, where higher ichthyomass were found at stations farther from the dam site.

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References

Begon, M., J.L. Harper and C.R. Townsend. 1990. Ecology: individuals, populations and communities, 2nd edition. Blackwell Scient. Publ., 945 pp.

Bernacsek, G.M. 1984. Dam design and operation to optimize fish production in impounded river basins; Based on a review of the ecological effects of large dam in Africa. CIFA Tech. Pap. 11. FAO, Rome. 97 p.

Costa-Pierce, B.A. and O. Soemarwoto. 1990. Biotechnical feasibility studies on the importation Clupeichthys aesarnensis Wongratana, 1983 from Northeastern Thailand to the Saguling Reservoir, West Java, Indonesia, pp. 329-363. In B.A. Costa-Pierce and O. Soemarwoto (eds.); Reservoir fisheries and aquaculture development for resettlement in Indonesia. ICLARM Tech. Rep. 23.

Duangsawasdi, M. and S. Duangsawasdi. 1992. Fishery resource and fisheries activities in Mun River. Fish. Tech. Pap. No. 136. Department of Fisheries, Thailand. 53 p. (In Thai)

Fisheries Extension Division. 1995. Reservoir and it fisheries resource. Department of Fisheries, Thailand. 41 p. (In Thai)

Hurlbert, S. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54(2): 187-211.

Jutagate, T., S.S. De Silva and N.S. Mattson. 2001. Socio-economic status of the Thai river sprat (Clupeichthys aesarnensis; Wongratana, 1983) lift-net fishers in Sirinthorn Reservoir, Thailand. In S.S. De Silva (ed.); Reservoir & Cultured based Fisheries: Biology and Management. ACIAR Proceeding No. 98, Canberra. pp. 309-313.

Kolding, J. 1989. The fish resources of Lake Turkana and their environment – Thesis for the Cand. Scient degree in Fisheries Biology and Final Report of KEN 043 Trail Fishery 1986 – 1987. University of Bergen. 262 pp.

Kolding, J. 1998. PASGEAR; A data base package for experimental or artisanal fisheries data from passive gears: A short introduction manual. University of Bergen, Norway. 54 p.

Rainboth, W.J. 1996. Fishes of the Cambodian Mekong. FAO, Rome. 265 p.

Roberts, T.R. 1983. Just another dammed river? Negative impacts of Pak Mun Dam on fishes of the Mekong Basin. Natural History Bulletin of Siam Society: 41: 105-133.

Saraisuwan, A. 1981. Distribution of phytoplankton in some Chaing Mai's polluted water bodies, M.Sc. Thesis. Chaing Mai University, Chaing Mai.

Scudder, T. and T. Conelly. 1985. Management systems for riverine fisheries. FAO Fish. Tech. Pap. 263. FAO, Rome. 85 p.

Team consulting engineering, co. ltd. 1982. Environmental and ecological of Pak Mun Project, Vol. 2: Main Report.

Wongpattana, A. 1996. Pak Mun: The lessons are clear, but is anyone listening? Watershed Vol. 1 No.3: 16-23. (In Thai)

WCD, World Commission on Dams. 2000. The Pak Mun Dam in Mekong River Basin, Final Draft. Available: www.dams.org.

Welcomme, R. L. 1985. River fisheries. FAO Fish. Tech. Pap. No. 262. 330 p.

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