

Stocking and Recapture of Freshwater Prawn (*Macrobrachium rosenbergii* De Man) in a Run-of-River Type Dam (Pak Mun Dam) in Thailand

P. SRIPATRPRASITE and C. KWEI LIN

Agricultural and Aquatic Systems and Engineering Program
School of Environment Resources and Development
Asian Institute of Technology, P.O.Box 4, Klong Luang
Pathumthani 12120, Thailand.

Abstract

The Pak Mun Dam is the first run-of-river type dam in Thailand. It was constructed across the lower Mun River, 5 kms upstream from its confluence with the Mekong River. Upon closure of the Pak Mun Dam in 1994, a freshwater prawns (*Macrobrachium rosenbergii*) stocking program was initiated to increase the value of fish production in the reservoir that was drastically affected by the dam operation. The total number of freshwater prawn stocked in the reservoir was 22 million post larvae (PL30) from 1995 to 2000. As a run-of-river type dam, some of the stocked prawns were also dispersed to downstream through outflow of spillways and turbines. This study aimed to evaluate distribution and seasonal patterns of prawn production in the Pak Mun Dam. The data collected from fishermen operating in reservoir and downstream include the number and weight of prawn catch from May 1999 to April 2000. The average weight of prawn caught from the reservoir was 236.5 ± 102.1 g. Freshwater prawn production was 79.5 % from the reservoir and 20.5 % downstream. The total yield was $16,646 \text{ kg} \cdot \text{year}^{-1}$ with a value of 122,027 USD $\cdot \text{year}^{-1}$ (1USD=37 baht), contributing to 53.8 % of the total fish catch by weight ($30,960 \text{ kg} \cdot \text{year}^{-1}$) and 97 % of economic value from the reservoir. Records showed that prawn could be harvested 8 months after stocking with an estimated recapture rate of 1%. This study shows that the freshwater prawn stocking program has been a successful effort in fishery management in the Pak Mun Dam.

Introduction

Freshwater prawn (*Macrobrachium rosenbergii* De Man) is indigenous to South and Southeast Asia. Thailand has been a major producer with an annual production of 15,000 tonnes. There are two sources of freshwater prawn production: one is natural production from rivers, lakes, reservoirs, and two is from aquaculture in ponds and pens. Aquaculture although gives high production, requires high investment for seed, feed, labor and management. The average

production from pens and ponds in Thailand was 1,075 and 780 kg/ha respectively (New and Singholka, 1985; New, 1988). While natural production was lower than aquaculture, it benefits poor fishermen in many parts of Thailand, where prawn post larvae are widely released for stock enhancement.

The Pak Mun Dam was constructed across the lower Mun River, 5-km upstream from its confluence with the Mekong River in Northeastern Thailand. The Dam was designed with a multi-purpose scheme for electricity power generation, irrigation development, flood control, fisheries production and recreation (TEAM, 1982). The dam was constructed of rock-fill and roller compacted concrete with these dimensions: 6 m wide, 300 m long, 17 m high, and included 8 gates of spillway (EGAT, 1991, 1994). The Pak Mun Dam is the first run-of-river type dam in Thailand that generally has the same daily outflow as inflow and water level of the reservoir typically fluctuates annually within a small range (Hill and Hill, 1994). To facilitate fish migration between the Mun and the Mekong Rivers, a fish ladder was incorporated with the Pak Mun Dam (Pholprasit et al. 1997).

The Pak Mun Reservoir covers 4,909 ha over 30 km along the Mun River meandering riverbanks with stones, stumps, weed bed and wetland. For generating electricity the water level of reservoir is maintained at 108.0 m mean sea level (msl) in rainy season and 105.5 m (msl) in dry season. The reservoir is managed by the Fisheries Conservation Unit of the Pak Mun reservoir. The laws of fishery management stipulate certain closed areas and closed seasons for fishing activity from 15 May to 16 September each year. Five hundred meter downstream from the dam is a restricted area where capture fisheries is not permitted in order to increase the number of fish ascending the fish ladder. In reservoir, the Department of Fisheries has stocked native fish species and Electricity Generating Authority of Thailand (EGAT) stocked freshwater prawn annually since 1994.

The freshwater prawns stocking program was aimed to increase the value of fish production in the Pak Mun reservoir. As a run-of-river type dam, some freshwater prawns were lost with outflow of spillways, turbines and downstream migration. This research was designed to evaluate production, recapture rate and value of freshwater prawn fisheries in the Pak Mun Dam.

Materials and Methods

The data on prawn fisheries were collected during one year from May 1999 to April 2000. Study areas covered 30-km upstream (reservoir) from the Pak Mun Dam to Amphoe Pibun Mungsaharn and 5-km downstream from the dam to confluence with the Mekong River. Data were collected on stocking time and place, number and source of seed supply, and economics. Four survey groups collected data of freshwater prawn production from interviewing fishermen and middleman: 2 groups in reservoir checking fishing boats and other 2 groups in downstream checking landing sites. Individual length (cm) and weight (g), total number and sexes of prawn were recorded. The number of fisherman in each sampling day was also recorded.

Upon closing of the Pak Mun Dam in 1994, the Electricity Generating Authority of Thailand (EGAT) and the Department of Fisheries (DOF) stocked 20 million juveniles of freshwater prawn in reservoir during 1995-1998. The average prawn catch was 11,675 kg·year⁻¹ with market value of 113,826.7 USD·year⁻¹ (Table 1).

During the study period in 1999-2000, two million juveniles (PL30) of freshwater prawn were stocked in the reservoir. Those juveniles were transported in a cool container truck at 18°C for 10 hr (640 km) at night from a commercial hatchery in Supanburi province. Prawns were packed in 15-liter plastic bags and each bags contained 2,000 prawns. Price of the juvenile prawn was 0.00378 USD each (1USD=37Baht). The length and weight of the prawn were in the range of 1-1.5 cm and 0.01-0.02 g respectively. Prawns were stocked 2 times in 1999, the first on 19 May at Ban Tung Lung, 6-km upstream from dam, and the second on 2 June at Krang Sa Pue, 30 km from the dam.

The freshwater prawn in the Pak Mun Dam was harvested by fishermen from the reservoir and downstream. Normally, fishermen catch freshwater prawn in reservoir daily in early morning; and in downstream when the turbine generators stopped with normal water flow. There were 3 types of fishing gear used to catch freshwater prawn: long line hook, gill net and harpoon gun. Fishermen set up long line hook and gill net from evening (18.00-20.00 hr) until early morning (04.00-07.30 hr). Catch with harpoon gun is done in clear water during the day. Harvested prawn was sold to middleman or restaurant at 5, 9 and 12 USD·kg⁻¹ for small size (<150 g), middle size (151-300 g) and large size (>301 g) respectively.

The appropriate timing for harvest was estimated on the basis of the relationship between timing of stocking and growth of prawn as shown in the following equation:

$$W = a + bT$$

where W = Weight of freshwater prawn (g)
 T = Timing of stocking freshwater prawn (month)
 b = Growth rate of freshwater prawn
 a = Y intercept

The relationship between weight and time of stocking is effect during intermediate size classes of prawn.

Table 1. Stocking and production of freshwater prawn (*Macrobrachium rosenbergii*) in the Pak Mun Dam during 1995-1998

Year	Stocking (Million PL)	Landing (kg)	Value (USD)
1995	7		
1996	5	12,689	119,560
1997	5	11,679	117,920
1998	3	10,657	104,000
Average	-	11,675	113,826.7
Total	20	35,025	341,480

Note: 1USD=25Baht in 1996-1997; 1USD=35Baht in 1998

Production of freshwater prawn was estimated on the basis of average catch per day per fisherman, number of fishermen, and number of fishing day.

$$P = A * N * D$$

where P = Production of freshwater prawn ($\text{kg}\cdot\text{month}^{-1}$)
 A = Average catch of freshwater prawn per fisherman per day (kg)
 N = Number of fishermen per day
 D = Number of fishing days per month

The price of freshwater prawn was size dependent and the product value was calculated in following equation:

$$V = P * Q$$

where V = Value of freshwater prawn (USD)
 P = Price of freshwater prawn (size $<150\text{ g} = 5\text{ USD}\cdot\text{kg}^{-1}$), (size $151\text{--}300\text{ g} = 9\text{ USD}\cdot\text{kg}^{-1}$), (size $>300\text{ g} = 12\text{ USD}\cdot\text{kg}^{-1}$),
 Q = Size of freshwater prawn ($<150\text{ g}$, $150\text{--}300\text{ g}$, $>301\text{ g}$) (kg)

Analysis of variance (ANOVA) was used to determine the seasonal difference in prawn harvested ($P<0.05$). All parameter values were examined for normal distribution before analysis and were transformed into logarithmic or square root prior to analysis. Simple regression was used to determine the relationship between timing of stocking and weight of freshwater prawn. Length and weight of freshwater prawn were expressed as $\text{mean}\pm\text{SE}$. All collected data were evaluated in term of production market, value and percent recapture of freshwater prawn in the Pak Mun Dam.

Results and Discussion

The average weight of freshwater prawn caught in the reservoir was $236.5\pm102.1\text{ g}$, and the weight varied during hot, rainy and cool season at 288.1 ± 94.9 , 337.6 ± 88.9 and $156.5\pm21.4\text{ g}$ respectively. However, there was no significant difference ($P>0.05$) in average weight between hot, rainy and cool seasons (Table 2). There were little harvests in October and November while water level was high and turbid. The average weight of freshwater prawn caught in reservoir ranged from 250 g to 450 g during the rainy season between May and September compared to $150\text{--}200\text{ g}$ during the dry period from December to April (Fig. 1). The prawn caught came from those stocked in previous year (1998) and mixed sizes of previous stock combining stock of the present year (1999).

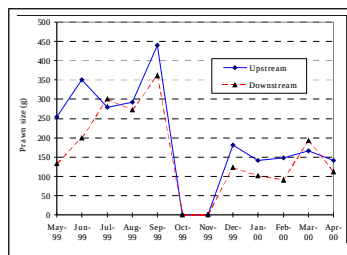


Fig. 1 Average weight of freshwater prawn in reservoir (upstream) and downstream during May 1999-April 2000

The relationship between the weight of freshwater prawn and time of stocking can be expressed as:

$$W = -118.2 + 28.6 T \quad R^2 = 0.720(\text{eq } 1)$$

Accordingly, the prawns were estimated to grow to 110.6 g in 8 months (T=8), with an average growth rate of 28.6.g.month⁻¹.

The highest average catch of freshwater prawn was 2,981.3±470.2 kg·month⁻¹ in cool season and it decreased to 893.7±1,053.2 kg·month⁻¹ in hot season, and 236.7±215.1 kg·month⁻¹ in rainy season. The monthly production was significantly different (P<0.05) between hot, rainy and cool seasons (Table 2).

The average number of fishermen sampled was 10.2±3.9 per sampling day and 72.7±39.1 fishermen·month⁻¹. The catch of freshwater prawn peaked at 2,430 kg·month⁻¹ in June 1999, and were 2,710, 3,524.2, 2,709 kg·month⁻¹ in December 1999, January, February 2000 respectively. The harvest pattern and size range indicate that the production of the first peak was from those stocked in 1998 and the second production stocked in May 1999 (Table 3 and Fig. 2).

As the Pak Mun Reservoir was a run-of-river type, some portion of prawn stocked in reservoir ended up downstream below the dam. The result showed that 79.5 % of prawn production was caught in reservoir and 20.5 % downstream. The total combined catch was 16,646 kg with 101,122 prawns during one-year period of data collection. The value of prawn was estimated at 122,027 USD (Table 4).

Based on the data collected during the period between May 1999 and April 2000, the recapture prawn was 1.0 % of the stocked post larvae. Under the stocking program the total number of stocked freshwater prawn during 1995-2000 was 22 million post larvae and recaptured prawn was 217,871, or 1 % stocked. The cost of stocked post larvae was 84,025 USD and the return was 463,507 USD over 5 years (Table 5).

Table 2. Mean±SE in weight and production of freshwater prawn in reservoir and downstream, in 3 periods of a year during 1999-2000.

Location, seasons	Mean ± SE in weight of freshwater prawn (g)	Mean ± SE in production of freshwater prawn (kg·month ⁻¹)
Reservoir	236.5 ± 102.1	1,322.9 ± 1,349.5
Hot season (Mar-Jun)	228.1 ± 94.9 ^a	893.7 ± 1,053.2 ^a
Rainy season (Jul-Oct)	337.6 ± 88.9 ^a	236.7 ± 215.1 ^a
Cool season (Nov-Feb)	156.5 ± 21.4 ^a	2,981.3 ± 470.2 ^b
Downstream	189.7 ± 89.5	310.7 ± 394.7
Hot season (Mar-Jun)	159.4 ± 43.5 ^a	74.2 ± 40.0 ^a
Rainy season (Jul-Oct)	283.5 ± 66.9 ^a	386.9 ± 488.1 ^a
Cool season (Nov-Feb)	104.8 ± 16.1 ^a	524.3 ± 476.7 ^a

Note: Mean ± SE in each column indicated with different letters (a b) are significant different at P<0.05 and same letters (a) are no significant different at P>0.05.

Table 3. Average catch and catch effort of freshwater prawn in reservoir during 1999-2000

Month	Average weight of prawn(g·day ⁻¹)	Number of Fishermen Sampled	Number of Fishermen	Fishing days	Production of prawn (kg·month ⁻¹)
May-1999	85.0	6	48	22	89.6
Jun-1999	1,763.4	4	53	26	2,430.0
Jul-1999	72.3	11	66	27	128.9
Aug-1999	244.1	10	64	31	484.3
Sep-1999	73.3	6	55	24	96.8
Oct-1999	0.0	6	47	19	0.0
Nov-1999	0.0	10	25	17	0.0
Dec-1999	783.7	11	133	26	2,710.0
Jan-2000	1,111.0	11	122	26	3,524.2
Feb-2000	598.9	15	156	29	2,709.6
Mar-2000	424.9	16	58	28	690.0
Apr-2000	324.5	16	45	25	365.1
Mean	548.1	10.2	72.7	25.0	1,322.9
SE	517.3	3.9	39.1	3.9	1,349.5

Note: October and November rice harvesting season

Table 4. Total catch of freshwater prawn in the Pak Mun Dam during 1 year data collection

Weight	Upstream (kg)	Downstream (kg)	Total (kg)	Number (no)	Value (USD)
Total	13,228.5	3,417.6	16,646.1	101,122	122,027
Mean ± SE	1,322.9 ± 1,349.5	310.7 ± 394.7	1,513.3 ± 1,486.4	9,193 ± 11,200	11,094 ± 10,254.6
Max	3,524.20	1,062.80	4,007.10	30,520	28,521
Min	0	0	0	0	0
%	79.5	20.5	100		

Note: October and November rice harvesting season of fishermen: 1USD=37 Baht

Table 5. Percent recapture and value of freshwater prawn in the Pak Mun Dam during 1995-2000

Year	Stocking (Million PL)	Cost (USD)	Recapture (no)	% recapture	Value (USD)
1995	7	19,600	-	-	-
1996	5	14,000	42,296	0.60	119,560
1997	5	30,000	38,930	0.68	117,920
1998	3	12,857	35,523	0.69	104,000
1999-2000	2	7,568	101,122	1.00	122,027
Total	22	84,025	217,871	1.00	463,507

Note: 1USD=25Baht in 1995-1997; 1USD=35Baht in 1998; 1USD=37Baht in 1999-2000

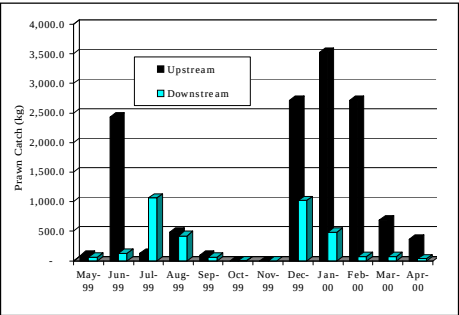


Fig. 2. Monthly catch of freshwater prawn in reservoir (upstream) and downstream during May 1999-April 2000

Harvesting time lasted for 8 months after the new stocking in May. Based on size distribution, the captured prawns belonged to two batches of stocking. The bigger prawn caught in June-August came from those stocked in the previous year (1998). The mixed sizes of the second harvest in December-February indicated that they came from these stocked in current year (1999) and pre-

vious year (1998). In comparison, prawns cultured in ponds were harvested in 5 to 8 months (New 1988), and in mixed rice-prawn culture in Vietnam, culture period was 3-4 months (Lin and Lee 1992; Tuyen 1993).

Among three harvest methods, the harpooning is selective for large sized prawns with least damaging to smaller prawn and non-target fish. The catch of prawn increased in cool season during December-February when water was clear and more fishermen were engaged.

The estimated percent recapture of freshwater prawn in the Pak Mun Dam was about 1 %, which was lower than in Ubolrattana Reservoir's 2.1% (Benjakarn, 1984). One of the reasons for lower recapture in the Pak Mun Dam was the loss to downstream where the catch consisted 20.5 % of the total landing.

Economically, the cost of 100 juvenile prawns was 0.378 USD and the value of recaptured 1 prawn of 100 g size was 0.54 USD at 5.4 USD·k⁻¹. The net profit for the investment was at least 0.163 USD, equivalent to 43 % return based on 1 % recapture rate.

With total annual fish production of 30.96 tons and commercial value at 125,508 USD, fisheries production is also an important income source for the community living around the Pak Mun reservoir (Sripatrprasite, 2002). The catch of freshwater prawn was 16.65 tons with a value of 122,027 USD, which consisted of 53.8 % of total fish production by weight and 97.2 % of market value.

Based on estimated catch of 16,646 kg during 1999-2000 the average harvest was 3 kg·ha⁻¹·year⁻¹. In comparison, the catch of freshwater prawn in the Songkhla Lake in southern Thailand was 221 tons or 2.11 kg·ha⁻¹·year⁻¹ in 1992 (Potaros and Methong, 1993).

Conclusion

The study shows that the freshwater prawn stocking program was a successful scheme in fishery management in the Pak Mun Dam, because the net profit for investment was 43 % return base on 1 % recapture rate. Nevertheless, production of freshwater prawn requires proper management for stocking and harvesting. Freshwater prawns need to be stocked annually because it cannot sustain propagation of population in freshwater habitat. The prawn should be stocked in suitable places distant from the dam to prevent wash out to downstream, and in places with natural shelters to prevent predation and to provide rich feeding ground. Furthermore, nursing post larvae to juveniles prior to stocking them would increase survival. To maximize economic yield, regulation on harvest size and season should be enforced.

Acknowledgments

The authors would like to thank the fishermen who cooperated in this study, the staff of the Fisheries Conservation Unit who shared data and lent

logistic support, also to the EGAT staff for providing some data and guarded the sample site. Authors are also greatly indebted to the MRC (Mekong River Commission) for providing financial assistance.

References

- Benjakarn, M. 1984. Stocking *Macrobrachium rosenbergii* in Ubolrattana Reservoir. Fisheries development in Ubolrattana Reservoir. Division of Inland Fisheries, Department of Fisheries, Bangkok. 30 pp.
- EGAT. 1991. Pak Mun hydropower project. Public Relation Department, Electricity Generating Authority of Thailand, Bangkok. 43 pp.
- EGAT. 1994. Pak Mun hydropower project. Hydropower Construction Department. Report no 511-101-3710, Electricity Generating Authority of Thailand, Bangkok. 40 pp.
- Hill, M. T. and Hill, S. A. 1994. Fisheries ecology and hydropower in the Mekong River. An evaluation of the Run-of-River Project. The Mekong Secretariat, Bangkok. 120 pp.
- Lin, C. Kwei and C. Lee. 1992. Production of freshwater prawns in the Mekong Delta. NAGA 15:24-26.
- New, M B. 1988. Freshwater prawns; Status of global aquaculture 1987. NACA technical paper manual 6, Bangkok, Thailand. 58 pp.
- New, M. B. and S. Singholka. 1985. Freshwater prawn farming; a manual for the culture of *Macrobrachium rosenbergii*. FAO fisheries technical paper 225, Rome, Italy. 118 pp.
- Pholprasith, S et al. 1997. Fisheries passing through the Pak Mun fish ladder. Technical paper no193. National Inland Fisheries Institute, Department of Fisheries. Bangkok. 140 pp.
- Potaros, M. and P. Methong. 1993. The natural production of giant freshwater prawn in Songkhla Lake 1992. Thai fisheries gazette 46:221-227.
- Sripatprasite, P. 2002. Effects of fish ladder on migratory fish species and fisheries in Pak Mun Dam. Third draft dissertation. School of Environment and Resource Development, Asian Institute of Technology. Thailand. 239 pp.
- TEAM. 1982. Environment and ecological investigation of Pak Mun project. Volume II: Main report. TEAM Consulting Engineers Co, Ltd. Bangkok. 280 pp.
- Tuyen, N. Q. 1993. Rice freshwater prawn farms in Mekong Delta, Vietnam. NAGA 16:18-20.