Thailand: Mangrove-friendly shrimp farming

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Status of aquaculture

Fisheries production mainly comes from marine fisheries (>75% of total) (Figure 1). However, the highest value comes from the culture of black tiger shrimp (*Penaeus monodon*) which is over 72% (260,200 tons) of coastal aquaculture production in 1995. Thailand's long coastline -- 2,600 km -- means that there are many areas suitable for shrimp culture.

Status of mangroves

Area and distribution
Mangrove forests are found along muddy coastlines and in estuaries. Within the Gulf of Thailand, mangroves occur from Trat province in the eastern region to Prachuuab Kirikhan in the central zone. On the east coast of the southern region, they occur from Chmphon province to Pattani, and on the west coast, from Satun province to Ranong (Table 1, Figure 2).

Biodiversity
The mangrove vegetation in Thailand has a rich, well-developed flora: 55 genera and 77 species belonging to 36 families of trees and shrubs (Santisuk *et al.* 1988). However, human activities have directly contributed to their degradation.

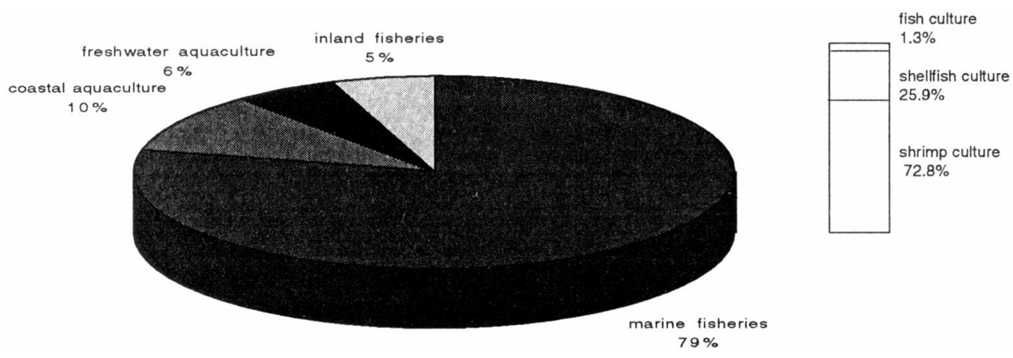

Figure 1. **Fisheries production in Thailand by sector, 1995** (Kongsangchai 1995)

Table 1. **Existing mangrove forests in Thailand, 1993**

Region	Provinces	Mangrove forest areas	
		Area (ha)	% of total
1	Trat	7,668	4.55
	Chantaburi	4,072	2.42
	Rayong	680	0.40
	Chonburi	92	0.06
		12,512	7.42
2	Chachoengsoa	536	0.32
	Samut Prakan	312	0.19
	Bangkok	200	0.12
	Samut Sakhon	1,819	1.08
	Samut Songkram	924	0.55
	Phetchaburi	2,068	1.23
	Prachuab Kiri Khan	40	0.02
		5,899	3.50
3	Chumpphon	3,293	1.95
	Surat Thani	3,164	1.88
	Nakhon Si thammarat	7,996	4.74
	Pattalung	128	0.08
	Songkhla	548	0.33
	Pattani	1,295	0.77
		16,424	9.74
4	Ranong	19,308	11.45
	Phangnga	30,716	18.21
	Phuket	1,548	0.92
	Krabi	28,527	16.91
	Trang	24,328	14.42
	Satun	29,420	17.44
		133,847	79.35
	TOTAL	168,682	100.00

Causes of mangrove destruction

The existing mangrove forest area in Thailand has decreased by more than 50% in the past 32 years (1961-1993). The rate of deterioration is approximately 6,200 ha per year. The major causes include shrimp farming, mining, and other human activities (Table 2).

Utilization of mangrove areas

Because large mangrove areas have been converted into shrimp farms and residential areas, there is conflict between the government and the people who occupied the mangrove areas. In order to resolve the conflict, the government decided to classify the mangrove areas as follows:

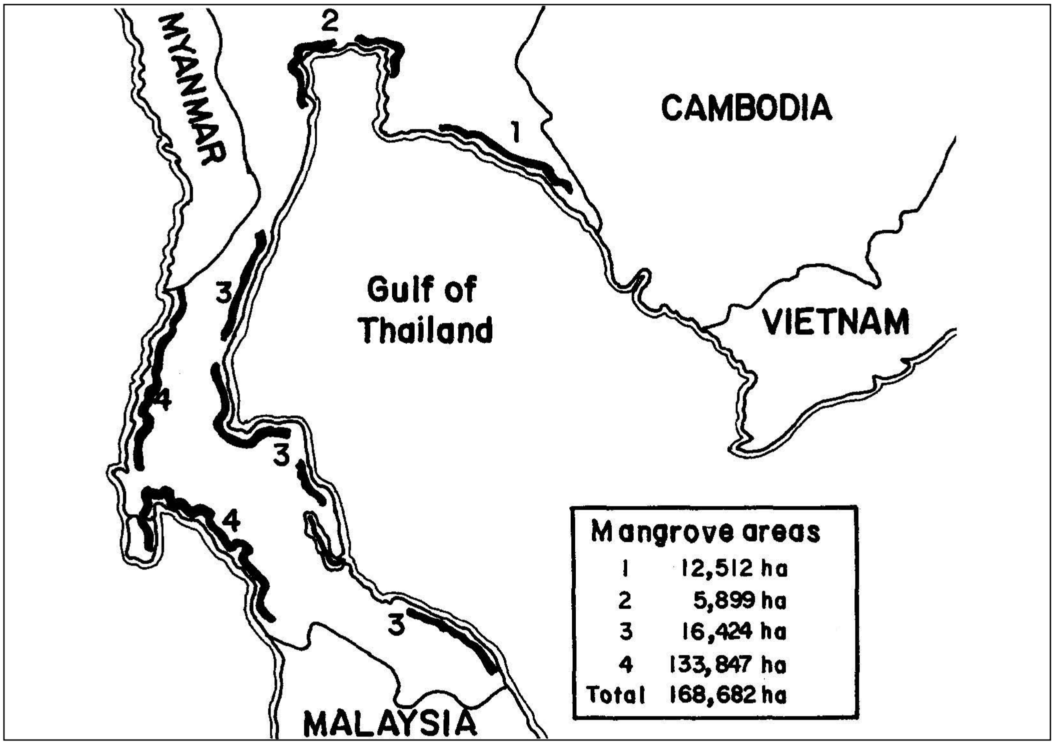

Figure 2. **Mangrove areas of Thailand**

Table 2. **Conversion of mangrove areas by various human activities** (Kongsangchai 1995)

Activities	Change in area (ha)	
	Before 1980	1980-1986
Shrimp farming	26,036	84,223
Mining	926	4,526
Others (urbanization, salt production, agriculture, etc)	53,630	2,132
Total	80,592	90,880

Preservation zone -- 36,278 ha - this is mangrove forest areas with no allowance for development activities.

Economic zone A -- 199,689 ha -- this is mangrove forest areas that can be used only for sustainable forest activities, for example, community forest, mangrove forest plantation for forest production.

Economic zone B -- 130,081 ha -- this is mangrove forest areas where development and other activities are allowed provided some caution is exercised as these activities could affect the environment. These include areas that are agricultural, industrial, and commercial in nature.

Mangrove-friendly shrimp farms

Impact of shrimp farming

Shrimp farming has the greatest impact on mangroves in Thailand. From 1980 to 1986, shrimp farms were established by clear-cutting mangroves. Many problems have since arisen, as follows:

Physio-chemical:

- Acid-sulphate soils due to exposure of the cleared land to oxygen
- Water-logging and rise in water salinity and temperature, affecting the growth of living organisms
- Increased coastal erosion and sediment and waste deposits from land to sea

Biological:

- Changing species diversity and population density

Ecological:

- Discharge of wastes from shrimp ponds leads to change in natural water equilibrium. It leads to eutrophication in shrimp farm areas

Constraints in shrimp farming

Most of Thailand's shrimp culture have developed into intensive culture. The "open system" is a common technique used by shrimp farmers where they take in and discharge water from/to the surrounding waterway. However, success of the farm would depend on the environment outside the farm. Shrimp farms could easily become corrupted like what happened in the upper part of the Gulf of Thailand in 1984-1990. Shrimp died because of eutrophication and diseases when the water supply became contaminated with pollutants such as organic matter, plankton bloom, pesticides, etc. The pollutants came from land (residential, agriculture, industrial) and/or effluents from shrimp ponds themselves. Moreover, the destruction of the mangroves around the farms aggravated the problem. Mangroves could have helped absorb some of these wastes (Figure 3).

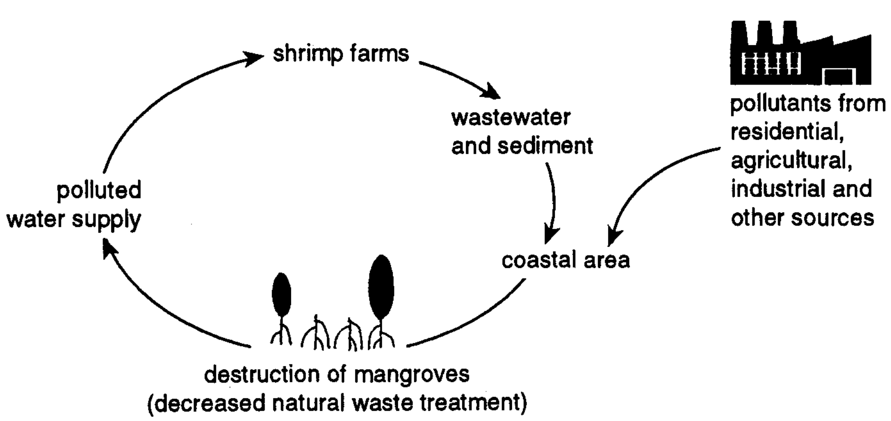

Figure 3. **Corruption of shrimp culture operations in the upper Gulf of Thailand**

Studies on closed and recirculating water system for tiger shrimp
The Phetchaburi Coastal Aquaculture Station in Laam Pakbia, Banleam District was initially operated to conduct studies on *Anemia* culture. But with the problems of shrimp farms, the station started research work on closed and recirculating water system. This work is made under the project "Recovery of shrimp culture in the upper part of the Gulf of Thailand" beginning 1995.

The project mainly emphasized the use of biological treatment of waste products in shrimp culture and the ecological management of the culture system (Figure 4). The following are the conditions:

- Shrimp culture should be carried out in areas which have been affected by pollution for some time
- Shrimp culture must be harmless to the environment outside the farms, with minimal waste discharge as much as possible

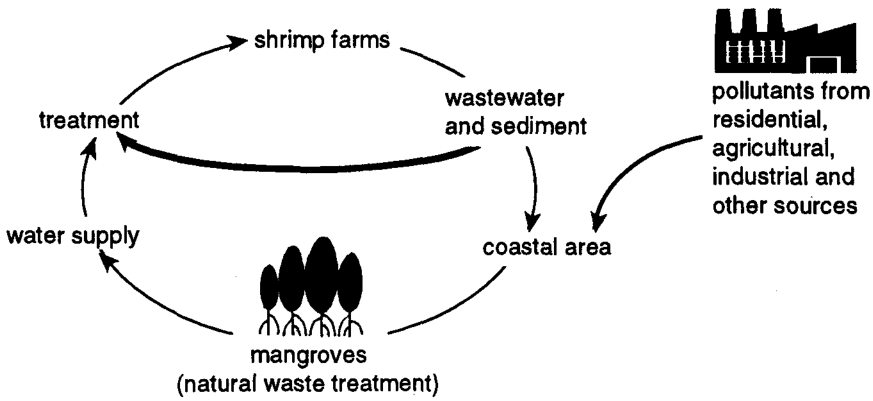

Figure 4. **Shrimp culture with waste treatment**

The studies on closed system shrimp culture mainly relate to waste management inside the farms since the most important waste products from shrimp ponds are culture water and waste sediment. Initial results are discussed below:

Biological control of water quality in closed and recirculating water system
Water quality parameters -- oxygen, ammonia, BOD, etc -- usually fluctuate, stressing the shrimp and causing the culture to be discontinued in some instances. Biological water controls may be applied to improve water quality. Examples of these are food web management and the use of treatment ponds.

- Food web management in shrimp ponds (Figure 5)

  Most private shrimp farms attempt to kill unwanted fishes which compete with shrimp for food and space by using tea seed powder or other chemical products. However, this practice disconnects the food web in shrimp ponds.

  There is an indirect relationship between water quality and the food web. In ponds that do not have plankton feeders, zooplankton (rotifers, copepods) sometimes increase in number rapidly by consuming phytoplankton. But most of them die after all the phytoplankton are consumed. When this occurs, water in the ponds become clear, accompanied by the reduction of oxygen and a rise in ammonia caused by the decomposition of plankton cells by bacteria. These conditions stress shrimp and reduce their resistance to diseases.

Shrimp farmers can release fishes that are plankton feeders to prevent all these from happening. This can be done on the first month of culture. The suitable fish species must be small so they do not interrupt shrimp behavior and can adapt and reproduce in seawater (0-30 ppt) easily. Guppy, platy and sail fin (all are aquarium fishes) are suitable.

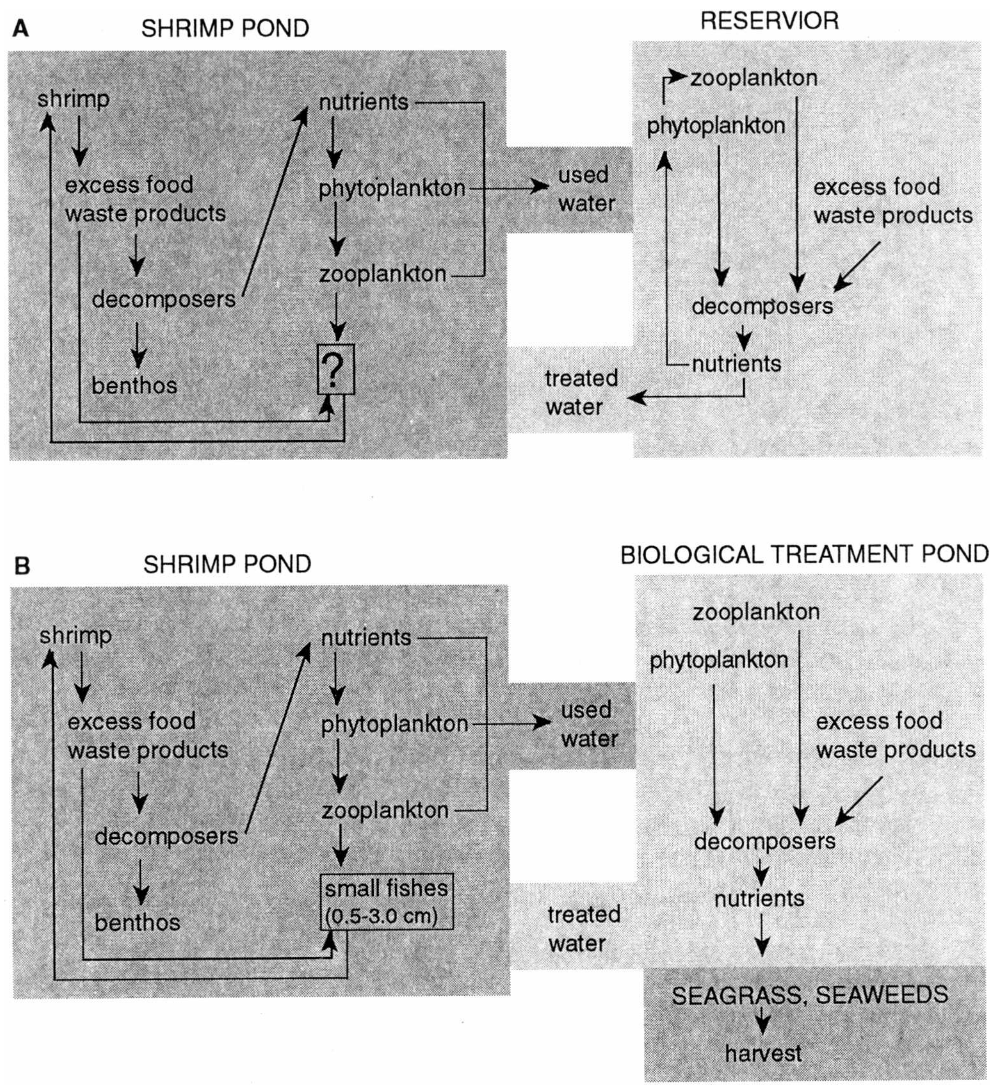

Figure 5. **The use of reservoir (A) vs. the use of biological controls (B)** that include food web management in shrimp ponds and use of treatment ponds

- Biological treatment ponds or polyculture ponds

  Treatment ponds are of two purposes: (1) purification of used water from shrimp ponds and recirculation of treated water back to shrimp ponds; and (2) purification of raw sea water (sometimes contaminated by pollutants). With regards to modification of reservoirs to become biological treatment ponds, here are some disadvantages of reservoirs (Figure 5):

  No aeration for increased degradation of organic substances.

  Most shrimp waste product is converted into phytoplankton biomass, and this is impossible to remove from the water. This means that plankton and nutrients may still cause eutrophication in shrimp ponds afterwards.

  But there are methods to increase the efficiency of water treatment in reservoirs such as:

  Installation of aerators so that organic substances can be degraded faster.

  Growing of macrophyte on the reservoir's bottom to absorb excess nutrients, for example: seaweeds (*Gracilaria*, *Caulerpa*) and sea grass (*Ruppia*). Let the nutrients be converted into plant biomass which can be removed or harvested out of the system.

  Release of carnivorous fish in the reservoirs to prey on or control the population of herbivores that graze on seaweeds and seagrasses.

  Frequent harvest of seaweeds and/or seagrasses as an indirect way of removing nutrients out of the system. Moreover, the plant biomass may be utilized for other purposes such as agar extraction (*Gracilaria*) and livestock feed.

Sediment treatment

Waste sediment affects the environment the most. It settles on the pond bottom and is easy to see after shrimp harvest. The sediment consists of organic matter, ammonia, hydrogen sulfide, and other kinds of waste products from shrimp. Although sediment discharge is inhibited by the law of environment protection, the best way to treat or handle it has not been established. In Thailand, there are many trials being done, for instance, the use of waste sediment as fertilizer.

The Phetchaburi Coastal Aquaculture Station is testing a mechanical approach. A device that is normally used to plow paddy fields is modified to turn over and aerate the sediment. The purpose is two-fold:

(1) Some gases released from bacterial activity during degradation of organic substances are accumulated in waste sediment such as ammonia, hydrogensulfide, methane, etc. By plowing or turning over the sediment, these gases can evaporate so that organic degradation by bacteria is increased.

(2) Plowing can increase oxygen penetration into the sediment, so that (aerobic) bacterial activity is enhanced.

Sediment treatment can be done once a week, at least three times. The pond bottom will be improved and shrimp farmers will be able to culture shrimp in the next crop without discharging waste sediment.

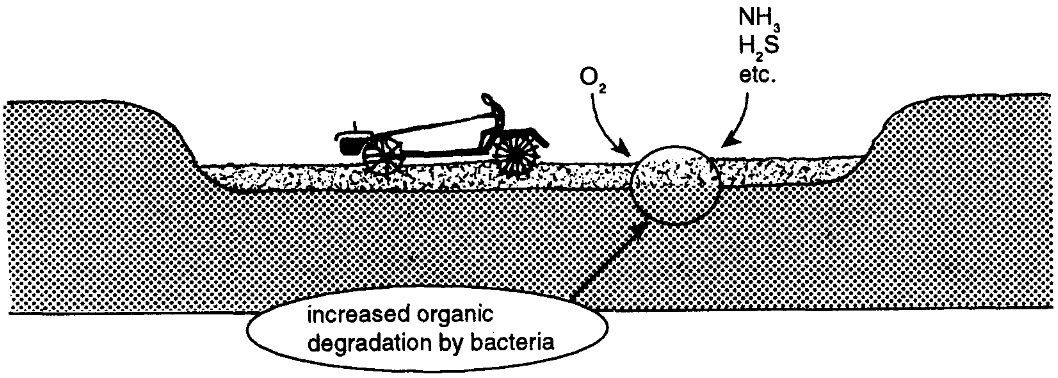

Figure 6. **Sediment treatment of shrimp ponds**

Silvofisheries or aquaculture in mangroves

The Phetchaburi Coastal Aquaculture Station is studying silvofisheries or aquaculture in artificial mangroves (=modified ponds) (Figure 6). The dikes are built in order to get a longer line for growing mangroves. The culture of shrimp or fish can be done intensively or extensively in the waterways. Mangrove and aquaculture can be interdependent -- mangroves absorb nutrients and waste products from aquaculture, and the cultured shrimp/fish can use natural food made abundant by mangroves. Theoretically, the supplementary food requirement of cultured species will decrease.

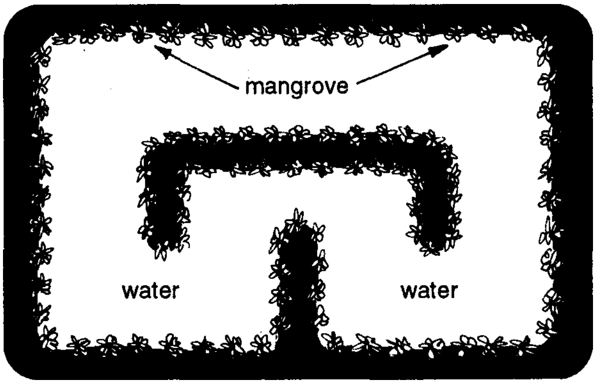

Figure 7. **Thailand's silvofisheries model**

Conclusion

Studies on "mangrove-friendly shrimp culture" in Thailand are on-going, and there are some evidence that the new method of managing shrimp culture has lower environmental impact. It is clear that shrimp farms in the future need to have some kind of water and sediment treatment system. Besides lower impact to the environment, the use of mangrove treatment may be the new approach to increase the mangrove area in Thailand.

References

Department of Fisheries. 1995. Fisheries Statistics of Thailand, 1995. Fisheries Economics Division, Department of Fisheries, Thailand. 86 p

Havanond S. 1995. Mangrove resource management in Thailand. Proceedings of the Ecotone IV; Surat Thani, Thailand. 177-183 p

Kongsangchai J. 1995. Problems of mangrove degradation in Thailand. Proceedings of the Ecotone IV; Surat Thani, Thailand. 119-128 p

Santisuk T, Patanaponpaiboon P and Ubolcholaket A. 1988. Floristics (trees and shrubs) and ecology of the mangrove vegetation of Thailand. National Research Council of Thailand. 110 p