CHAPTER 2

LITERATURE REVIEW

2.1 Mangrove ecosystem

Mangrove ecosystem is a unique system consisting of two major components, the mangrove structure and the relationship between food and energy flow. The structure of mangrove ecosystem comprises producers, consumers and decomposers. The energy in the ecosystem will one-way transfer from the producers, phytoplankton and other green plants, to the consumers in the higher trophic levels. The fertile mangroves produce mangrove materials such as leaves, twigs and flowers, to the ecosystem. These fallen mangrove materials become progressively enriched in protein and serve as a food source for the primary consumers, including filter, particulate, and deposit feeders (molluscs, crabs, and polychaete worms). At the same time, bacteria and fungi will decompose the fallen mangrove materials into dedritus. The secondary consumers in mangrove ecosystem are small shrimps, forage fish species and the juveniles of the larger predatory species. Anyway, those consumers will be consumed by other predators in the higher trophic level (Aksornkoae, 1989).

The relationship between food and energy flow in mangrove ecosystem is an important keyword on the study about mangrove community and the consideration on mangrove resource management. The food chain in mangrove can be classified into two types, grazing and detritus food chain (de Sylva, 1975). The grazing and the detritus food chain begin from green plants and detritus, respectively, to other animals in the higher tropic levels (Figure 2.1).

2.2 Mangrove environment related to fish species

Mangrove estuary is one of the most complex of all environments (Baban, 1997). Their importance in terms of carbon fixation, fishery habitat, nutrient assimilation, water storage and sediment stabilisation has been recognised for a long time (Odum, 1983). Mangrove areas such as mangrove canals, small waterways and etc, are traditionally important sources of food and shelter for estuarine aquatic animals. Especially, they serve as nursery ground, permanent habitats and breeding ground of fish and shrimp (Odum, 1969).

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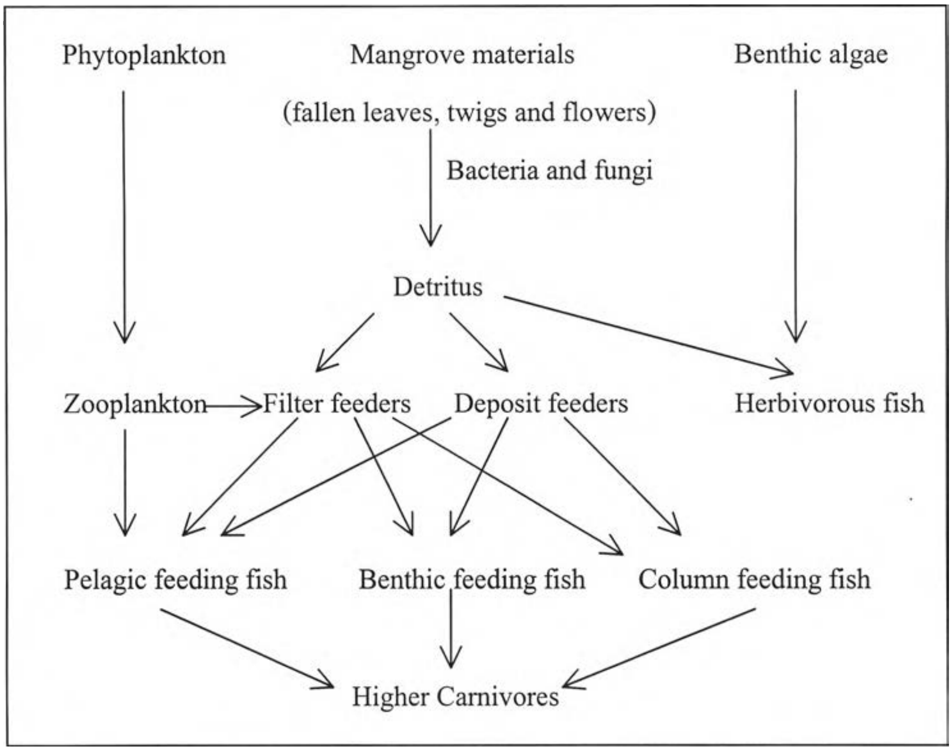

Figure 2.1: Food chain in mangrove (adapted from Ong and Sasekumar, 1984)

Monkolprasit (1966) studied on species composition of fish in Khlong Wan, Prachuab Khiri Khan province, during June 1963 to May 1965. All 72 species from 31 families of fish were collected by cast net, dip-net and trap. In 1982, the study on species composition of fish in the same area with the same fishing gears used conducted by Monkolprasit (1983) classified mangrove fish into four groups, true resident, partial resident, tidal visitor and seasonal visitor. Meanwhile only 25 species from 20 families were found. She also noted that the mangrove deterioration was one of the several causes of fish species decreased.

Monkolprasit (1994) studied on species composition of fish in Khlong Lad Khao and Khlong Kradare-jare. Khlong Lad Khao passes the undisturbed mangrove of Phang-nga bay and Khlong Kradare-jare passes the disturbed mangrove of Ban Don bay. Khlong Lad Khao was deeper and wider than Khlong Kradare-jare. The push net with 14 metres wide and 1.6 metres deep, was used for specimen collecting at Khlong Lad Khao while another push net with 4 metres wide and 1 metre deep, was used at Khlong Kradare-jare. Fish collecting was carried out in three stations of each canal. Station 1 was located at about 200 metres offshore along the mangrove fringe just at the mouth of each Khlong. Station 2 was located in Khlong at about 1 kilometre away from the mouth of Khlong and station 3 was located in Khlong at about 3 kilometres upstream. Two trips of fish collecting were conducted at Khlong Kradare-jare during wet and dry season but one trip was done at Khlong Lad Khao in Phang-nga bay. However, the fish species found from Khlong Lad Khao were more than from Khong Kradare-jare. Eighty-two species from 40 families were found from Khlong Lad Khao and major groups were in family of Leiognathidae (11%), Engrualidae (7.3%), Clupeidae (6.1%), Gobiidae (4.9%) and Perophthalimidae (4.9%). Fifty species from 26 families were found from Khlong Kradare-jare and major groups were in family of Leiognathidae (10%), Engrualidae (8%), Clupeidae (8%), Gobiidae (8%). Most fish found from both canals were relatively small and preferred to eat small plants, diatoms, foraminifera, algae, invertebrates, small animals and particularly crustacean.

The study on the ingress of fish into mangrove creeks in Selangor, Malaysia, of Leh and Sasekumar (1991) supported the hypotheses that mangrove deforestation reduced the fishery resource in term of species number of fish. The results indicated that 40 species belonging to 24 families of fish were found from the undisturbed mangrove creek while 15 species belonging to 12 families were found from the disturbed mangrove creek. There were significant differences on overall mean fish density and species abundance between those creeks ($P<0.05$). At the same time, the dominant fish were carnivore (69.2%) and omnivore (15.4%). Other trophic groups were detritivore(2.6%), herbivore (5.1%), a mixed between omnivore-carnivore (5.1%), and a mixed between herbivore-omnivore (2.6%).

Jeffery, Low and Chou (1994) studied on the fish diversity of Singapore mangroves from April 1992 to December 1993. Barrier net, gill net, trammel net and hand net were used for sampling. Fifty-nine (39 %) of fish species were represented from mangrove areas and Gobiidae was the most diverse family with 16 species. From the study, they noted that the destruction of mangrove at the study sites caused the fish diversity to be lower than it should be.

The invading fish in mangrove waterways might be exchanged by suitable surrounding as well as high density of mangrove, wide range of tidal characteristic, turbidity of water, optimum salinity and productive nursery ground for nursing and feeding (Aksornkoae et al., 1989). Najim, Daham and Yousif (1990) stated that the distribution of 47 species of fish found from the Shatt Al-Basrah Canal, an estuary in southern Irag, related to the salinity of water in the canal. Fifteen species were freshwater fish that moved into the canal during high flood season. The remaining 32 species were euryhaline and stenohaline marine fish.

The distribution of fish also depended on other conditions. The floodgates at the lower Clarence River system of southeastern Australia affected the available fish habitat, especially in term of reduction in natural fringing vegetation. The floodgates blocked the access of fish from getting into estuarine nursery and feeding area (Pollard and Hannan, 1994).

On western coast of the south of Thailand, Satapoomin and Poovachiranon (1997) found 232 species from 69 families of fish collected from five mangrove sites. Several fishing gears, push net, gill net, beam trawl, hand net, rotenone and tea-seed powder extract, were used for fish collecting from 1991 to 1994. Major 14 families found were Gobiidae, Leiognathidae, Carangidae, Mugilidae, Lutjanidae, Engraulidae, Tetraodontidae, Clupeidae, Syngnathidae, Ambassidae, Gerreidae, Mullidae, Eleotridae and Cynoglossidae. In result, they noted that the species richness of fish related to the environmental condition of those mangrove sites such as hyposaline water, high turbid water, and muddy bottom in small channels or creeks of the estuaries through the bays.

Salinity change affecting the habitat of fish was tested in mangrove of northern-east Florida Bay. Salinity was between 0 to 58 parts per thousand at upstream, 19.5 to 54 ppt. at midstream and 30 to 50 ppt. at downstream. The 77 species of fish collecting indicated that the species number of large fish was lower at upstream than at midstream and downstream while benthic and water column fish abundance did not vary along the gradient (Ley and Janet, 1992).

The influence of turbidity and salinity on fish distribution was studied in the Embley mangrove estuary in tropical northern Australia. Thirty-three species from 45 species of common fish found within the estuary showed relationship with the turbidity and salinity. Fifteen species related to turbidity only, 11 species were abundance in turbid water while 4 species were more common in clear water. Nine species related to salinity only, 7 species preferred brackish water and two species were common in fresh water. The remaining 19 species were influenced by both turbidity and salinity (Cyrus and Blaber, 1992). The salinity and turbidity might limit the upstream movement of some fish species in estuaries during wet season. However the stenohaline group of fish was able to extend into the upstream when the salinity and turbidity are similar throughout the estuary during the early and late dry season (Blaber and Blaber, 1980; Loneragan et al., 1987).

Howell and Simpson (1994) reported the bottom-dissolved oxygen (DO) affected on the abundance of fish and mean length of finfish. Eighteen species of fish were examined and the frequency found of 15 species was greater at sites that had more than 3 mg/l of bottom DO than the sites that had less than 2 mg/l of bottom DO. Meanwhile, the less frequency found of the other 3 species was at sites with 2-3 mg/l of bottom DO.

The mangrove fish always move among the surrounding habitats for feeding, breeding and etc. Chong, Wee and Sasekumar (1991) found 59 fish species that commonly presented in mangrove creeks, estuaries and mudflats at inshore water off the mangrove-fringed coast of Selangor, Malaysia. As well as Sesekumar et al. (1994) found 88, 86 and 51 species of fish in mangrove channels, mudflats and inshore water of Matang, Malaysia, respectively. The abundant species were in family of Ambassidae (18%), Sciaenidae (17.5%), Clupeidae (16.9%), Engraulidae (16.7%), Ariidae (4.8%), Leiognathidae (4.7%) and Scatophagidae (4.5 %). Seventy-four percent of fish species found from mangrove channels were also found in mudflats while 48% were found in inshore waters. Forty-eight percents of fish species found in mudflats were sampled in inshore waters. The high percentage of species similarity between mangrove channels and mudflats showed the movement of fish species between these habitats.

Most mangrove fish were represented by juvenile and small size. At the same time, the variation of species richness depends on the sampling stations and periods. In Selangor, Malaysia, the study on community of mangrove fish conducted by Sasekumar, Chong and Leh (1991) showed a total of 70 fish species caught by gill net and most of fish were juvenile.

In Indonesia, Martosewojo and Soedibjo (1991) studied on the fish community of Grajagan River which covered by mangrove on its both sides. Three fishing gears, beach seine, gill net and trap net were used for fish sampling in March, May and October 1987 and in February, May and September 1988. Fishing gears were set at the mouth of creeks, near the open sea during the first sampling and then were moved into other creeks to upstream during the second survey. All 82 species from 32 families of fish were found and almost all specimens were young fish.

Juvenile and adult fish in a subtropical *Rhizophora stylosa* mangrove, Tin Can Bay, Australia, were studied by Halliday and Young (1996). The samplings were done every second lunar month from November 1991 to November 1993. All 3,320 fish specimens were collected, representing 42 species. Economic fish in family of Atherinidae, Mugilidae, Gerreidae, Sparidae and Sillaginidae represented more than 76% by number. The dominant fish of the community were detritivore and intermediate carnivore. The small fish moved at least 43 metres into the mangrove during high tide. By moving well into the mangrove forest, small fish were probably less vulnerable to be predated by larger fish (Vance et al., 1996).

Phytoplankton and zooplankton are also important food of juvenile and larger fish in mangrove ecosystem. Phytoplankton is important producer to higher trophic levels. It is a good source of nutrition for zooplankton, herbivorous and omnivorous fish. According to the study of Mallin, Paerl and Rudek (1991) noted that high phytoplankton productivity in the Neuse River estuary, North Carolina, might be important factor contributing to the high finfish and shellfish production in the water source.

2.3 Mangroves and human activities

Many mangrove areas around the world have been converted to various human activities. Particularly, shrimp farming that had grown dramatically in Asia and Latin America over the past decades. In Thailand, the shrimp farms had been expanded particularly in mangrove areas of the coastal provinces such as Chantaburi and Trat. Srethasirote (1995) pointed out that 65 % of decreased mangrove area at Welu estuary, Chanthaburi, was due to the expansion of shrimp farming. About 82.62 km^2 of shrimp farm areas (78.33 %) were located in former mangrove area.

Shrimp farming is an unsustainable activity because it is the main cause of environmental degradation (Larsson, Folke and Kautsky, 1994). The shrimp pond effluent caused the hyper-nutrification of estuarine ecosystem and threatened the natural aquatic animals (Hopkins et al. 1995). Gajaseni and Boonkong (1982) indicated the mangroves that were converted to shrimp farming had lower biomass, species number and diversity index than the natural mangrove.

The destroying of mangrove ecosystem not only affected the aquatic animals and the environment but also affected small-scale fisherfolks who earn their lives by fishing in coastal estuaries. Boonchuwong (1996) noted that the capture yield of small-scale fisheries of Thailand had been decreased and the composition of aquatic animals captured by small-scale fisheries had been changed since 1989. The catches of squids and molluscs were increased while the catches of the other aquatic animals were decreased. Especially, the capture yield of natural mangrove shrimp had been decreased drastically due to the expansion of shrimp farming since 1986. He also stated that the drainage of polluted water from shrimp farms into the estuaries resulted in the decreasing of the natural production of natural mangrove shrimp.

Moreover, the improper management of shrimp farming also caused the social impact at Khung Kraben Bay, Chantaburi province. For example, the group of shrimp farmers drained the sewage water from their shrimp farms into public water sources and plantation areas of the neighbour. Meanwhile, the group of agriculturists agreed that the discharge of polluted water and sedimentation from shrimp farms into surrounding area caused the agricultural land nearby became the salt soil and could not be used for agriculture any more (Yothaphant, 1991).

In Nakhon Sri Thammarat province, the collapse of shrimp farms from the lacking of water management caused the rapidly spread of the polluted water in public and natural water sources. The wide expansion of polluted water not only caused the decrease of aquatic animals in water sources nearby but also caused the abandon shrimp farms due to the lacking of unpolluted water for shrimp farming. Most of those local shrimp farmers had to change their career to be the labours. At the same time, the local fishermen lost the abundant fishing sources as well as the agriculturists lost their fertile land for agriculture (Coastal Resources Institute, 1995).