CHAPTER I

INTRODUCTION

Coral reefs and seagrass beds are considered to be among the important components of coastal marine habitats which containing high diversities and densities of fishes and other invertebrates. Among this important attributes they are able to serve as shelters and food availabilities (Goldman and Talbot, 1976; Kikuchi and Peres, 1977; Sale, 1977; Ogden and Zieman, 1977; Thayer et al., 1978; Heck and Orth 1980). In the areas where coral reefs and seagrass beds are adjioned, the connection between these habitats occur (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Ogden, 1980; Robblee and Zieman, 1984; Heck and Weinstein, 1989). The interactions among coral reefs and seagrass beds had been categorizied. They are physical interactions, transfer of nutrients, particulate organic matter and animal migrations. Off these, the animal migrations could easily recognized as the most important indicator or biological determinant of the connections between coral reefs and seagrass beds.

~~The interrelationship of fish communities in coral reefs and~~ seagrass beds, such fish migration, was demonstrated over 30 years ago by the pioneering work of Randall in 1963 (cited by Robblee and Zieman 1984). Two types of fish migrations are known: 1) Short-term migrations which are either diel or seasonal; 2) Life-history migrations between ecosystems. Typically, adults of diurnal resting schools, such as squirrelfishes (Holocentridae), cardinalfishes (Apogonidae), snappers (Lutjanidae) and grunts (Haemulidae), find shelter in caves or crevices of reef and migrated to feed over adjacent seagrass beds at night (Starck and Davis, 1966 cited by Zieman, 1982; Robblee and Zieman 1984), while active diurnal fishes, such as parrotfishes (Scaridae), surgeonfishes

(Acanthuridae) and wrasses (Labridae) migrate to feed over adjacent the seagrass beds (Ogden and Zieman,1977). Juvenile form of some reef fishes, i.e., Lutjanidae, Serranidae, Lethrinidae and Haemulidae, etc., use the seagrass bed as the nursery grounds, and they migrate in deeper waters associated to the reef while as adults (Weinstein and Heck, 1979).

The interrelationship of fish communities on migration between coral reefs and seagrass beds had been mostly conducted in Florida and Caribbean (Randall, 1965; Ogden and Zieman, 1977; Weinstein and Heck, 1979; Ogden, 1980; Zieman, 1982; Robblee and Zieman, 1984; Heck and Weinstein, 1989), only few works had been carried out in the ASEAN region (Nateekanjanalarp, 1990; Dolar, 1991; Dolar and Lepiten, 1991; Fortes, 1991; Vergara and Fortes, 1991; Sudara et al., 1991, 1992). In Thailand, Nateekanjanalarp (1990) and Sudara et al., (1991,1992) reported that several families of reef fishes, such as Holocentridae, Lutjanidae, Lethrinidae, Serranidae and Apogonidae, assemblages in the seagrass beds have been using the area as feeding and nursery grounds. To date the coastal marine resources of the ASEAN region are deteriorating and being destroyed by anthropogenic activities but the knowledge concerning coral reef and seagrass communities and their interrelationships are still limited. Thus, researches on these valuable resources must be encouraged in order to conserve and manage the use of these resources to their maximum potential but in sustainable manner before it is too late.

Comparision of various sites in the Gulf of Thailand from preliminary survey resulted that at Nai Wog Bay, Pha-Ngan Island has been chosen for this study site because present of both areas of coral reef and seagrass bed are adjoining. The coral reef is in good condition with high percent cover of living coral and the seagrass bed is quite extensive.

The objectives of this study are as follow :

1. To study the fish community structures in the coral reef and seagrass bed at Nai - Wog Bay, Ko Pha-Ngan ;
2. To study the migration patterns of fishes between coral reef and seagrass bed at Nai - Wog Bay, Ko Pha-Ngan including the feeding habits;
3. To study the functional relationship among these two habitats by using fish species composition and migration.

Review of Literatures

Coral Reef Fish Community

Coral reefs are known as the biotic complexity and high productivity and there are no areas richer in faunal species than flourishing coral reefs (Goldman and Talbot, 1976). The fact that reef fish communities are diverse is well known (Sale, 1980 cited to Bakus, 1966; Smith and Tylor, 1972; Talbot and Goldman, 1972). There are more than 500 species of fishes in the Caribbean Sea, 200 species in the Philippines, 1500 species in the Great Barrier Reef and 440 species in Hawaii (Goldman and Talbot, 1976; Sale, 1980), but in Thai waters, number of species of reef fishes recorded are rather low which was 300 species (Monkolprasit, 1981), 200 species in the Gulf of Thailand (Manthachitra and Sudara, 1991) and 265 species in the Andaman Sea (Satapoomin and Chansang, 1992).

The community parameters, such as species richness, individual abundance and species composition, have been used in several studies to describe and assess reef fish communities and the changing of these parameters in relation to the reef environment is known to be as biotic and physical factors in both spatial and temporal functions. Sale (1980) revealed that biotic factors, such as predation and competition were unpredictable factor and physical factors, such as availability of living space and impacts of storm and wave action, were predictable factors. He also suggested that biotic factors will be most important in the deeper, less physically disturbed regions while storm and wave action must have affect the availability of living space by directly creating or destroying habitat which their most pronounced effects on the shallower parts of a reef.

Several studies examined the relationships between the substratum variables or living space with species richness and abundance of resident fish communities, and found strong positive correlation between the amount of living coral cover and fish density and abundance (Carpenter et al.,1981; Reese, 1981; Bell and Galzin, 1984; Manthachitra and Sudara,1991; Manthachitra et al.,1991) whereas some others found low or non correlation at all (Luckhurst and Luckhurst, 1978; Mcmanus et al., 1981; Bell et al., 1985). In the Gulf of Thailand, Manthachitra and Sudara (1991) and Satumanatpan and Sudara (1992) found the strong positive correlation between the amount of living coral cover with species richness and abundance of fishes. They also reported that fish species richness and abundance of the east coast reefs were lower than the west coast reefs due to the condition of the coral where percent cover of living coral found lower in the east coast than the west coast.

There are a few studies of the influenced of storm or wind and wave action on reef fish communities among the periods (seasons) or the temporal changes in reef fish communities. Sale (1980) suggested that the temporal changes in reef fish communities were directly and/or indirectly influenced by storm or wind and wave action, particularly in the small reef area and shallower parts of a reef. Sale and Douglas (1984) found the species richness to be more consistant than fish abundance through heterogeneity was significant among reef and seasons. In the Philippines, Hilomen and Yap (1991) found the temporal changes in reef fish communities

(Pomacentridae and Labridae) that species richness of fish was constant throughout the study period whereas fish abundance was largely varried, it was low in December and high in June. They noted that December was preceeded by a relative strong typhoons and immediately after typoons, reef fish abundance generally drastically decreased. Miclat et al. (1991) also found the drastic dropped in fish communities after 2 super typoons hit the Philippines reefs and presumed that the devastation of reef fish communities was to be effect of the two super typoons.

Seagrass Fish Community

Seagrass beds have traditionally been known to be inhabited by diverse and abundance fish fauna and often serve as nursery or feeding grounds for fish species that will ultimately be of commercial, recreation or sport fisheries value (Zieman, 1982). Seagrass bed can provide availability of shelter or living space for protection of fishes from the predators and food resources (Kikuchi and Peres, 1977; Thayer et al., 1978; Heck and Orth, 1980; Kikuchi, 1980). From the studies carried out in various parts of the world, it is possible to indentify a numbers of major characteristics of fish assemblages associated within seagrass bed such as there is usually a greater diversity and abundance of fish associated within seagrass bed than within "bare" substrate, fish associated within seagrass bed for different lenght of time and/or different stage of their life history, many species of fish settle in seagrass beds from the plankton, thus seagrass bed are important nursery ground for fish, the abundant foliage, detritus and infauna of seagrass bed are generally under utilized as food by fish, instead planktonic and epifaunal crustaceans nourish the majority than fish species, different species of fish occur at different positions within the seagrass canopy, the relative abundance and composition of fish species found in seagrass bed depend on the proximity of other habitats (e.g. reefs), and on the day-night cycle, assemblages of fish from different seagrass habitats often vary in species composition, even when these habitats are adjacent (Kikuchi, 1974; 1980; Kikuchi and Peres, 1977; Ogden and Zieman, 1977 Weinstein and Heck, 1979; Robblee and Zieman, 1984; Middleton et al., 1984; Bell and Pollard, 1989).

Seagrass beds are generally better habitats for fish than bare substrata and a greater number of fish species and individuals occur in seagrass bed. Kikuchi (1966) found more fish species richness and abundance collected from *Zostera* bed than the adjacent bare substratum, sand, muddy sand, sandy mud and mud, in Tomioka Bay. Yokel (1975 cited by Zieman 1982) used a trawl to collected fish from seagrass bed and bare sand-shell bottom in Florida, and reported to be about 3-5 times greater densities of fishes in seagrass bed than bare sand-shell bottom. These was similar to the other regions, Chesapeake Bay, USA (Heck and Thoman, 1984), Australia (Dybdahl, 1979 and Ward and Yong, 1982 cited by Bell and Pollard, 1989; Bell et al.,1987) and the Philippine (Dolar, 1991; Vergara and Fortes, 1991). In Thailand, Nateekanjanalarp (1990) also found higher fish species richness and abundance caught from the *Enhalus acoroides* bed than the adjacent sand bottom at Chaweng Beach, Koh Samui.

Kikuchi (1966) was the first who classified the fish assemblages associated with seagrass bed, *Zostera marina*, in Tomioka Bay, Japan, into 4 categories as the following: 1. Permanent residents; 2. Seasonal residents; 3. Transients; 4. casual species. Permanently resident fishes are typically small in size, less mobile. More cryptic species spend their entire life within the seagrass bed and this category are not directly commercial value but are often characteristics of the seagrass habitats. Seasonal residents are fish which spend their juvenile or subadult stage or spawning season in the seagrass bed and this category is mostly of commercial fishery value. Transients are fishes that diurnally or nocturnally occur in seagrass bed in the course of foraging over variety of habitats and this category is also mostly of commercial fishery value. Causual species are fishes that only appear infrequently and unpredictably within the seagrass bed.

Kikuchi and Peres (1977) recognized the differences or variations of animal communities in different ecological or geographical situations that may be explained : a) by difference in structural patterns of seagrass bed, i.e., host plant species, growth form, biomass, and adjacent habitats, etc; b) by direct influence of physiochemical environmental conditions, i.e., salinity, turbidity, tidal cycle and range, current and wave, etc.; c) by different climatic and zoogeographic regions. These factors closely intermingle with each other and it is difficult to attribute the difference in animal communities to any one of them.

Heck and Westone (1977) found the species richness and abundance associated of fishes within seagrass beds in Panama were increased with increasing plant biomass or habitat complexity. Heck and Orth (1980) hypothesized that plants with more foliose leaves which have greater surface area per unit weight ought to provide more protection than plants with simpler leaves which will have lower surface area per unit weight. They also suggested that diversity and abundance of juvenile fishes and macroinvertebrates would be related to plant surface area per area of bottom substrate. Thus the habitat complexity should also increase with increasing vegatation density thereby leading to increase in species richness and abundance of juvenile of fishes and invertebrates. Bell and Westoby (1986) stressed that leaf height was also importance to fishes associated within seagrass beds as high leaf could provide more habitat complexity and protection than short leaf.

Yokel (1975 cited by Zieman 1982), using a trawl, reported greater fish abundance was collected from thick seagrass bed than thin seagrass bed in the Ten Thousand Island regions of south Florida. Middleton et al. (1984) studied differences in fish communities of two seagrass beds, *Zostera capriocorni* and *Posidonia australis*, in Botany Bay of New South Wales, Australia, and reported that the species richness and abundance of fishes were not found to be significantly different between the two habitats although more species and abundance were associated with *Zostera*. They noted that *Zostera* which is smaller species general supported smaller species and juvenile fishes whereas *Posidonia*, the larger species, supported larger species and large juvenile fishes.

Bell and Pollard (1989) suggested that diversity and abundance of fishes also related to the adjecent habitats. Where seagrass adjoined the reefs, juvenile and adult fishes migrated from reefs to utilized seagrass beds for nursery and foraging areas (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Ogen, 1980; Robblee and Zieman, 1984; Heck and Weinstein, 1989). This migration would increase in abundance and diversity of seagrass fish assemblages. Nateekanjanalarp (1990) and Sudara et al. (1992) reported that more fish diversity and abundance were collected from the high density and biomass of seagrass than lower. They also found higher diversity and abundance of fishes from the seagrass-reef contact than seagrass alone. Many families of reef fish were found, i.e., snappers (Lutjanidae), emporers (Lethrinidae), rabbitfishes (Siganidae), squirrelfishes (Holocentridae), cardinalfishes (Apogonidae), groupers (Serranidae), butterflyfishes (Chaetodontidae) and wrasses (Labridae), etc.

Very few works touch on of the variations of seagrass fish communities due to physiochemical factors. Kikuchi (1966) noted that during the strong wind and wave action period, seagrass bed may not be suitable to inhabit. Therefore, many fishes would move to the other more stable habitats. Zieman (1982) revealed that in the clearest water, higher and less variable salinities or the buffered environmental conditions, the seagrass may account for the increased species richness and abundance of fishes and can serve as nursery grounds for juvenile of fishes. Sogard et al.(1989) concluded that the physical factors of water circulation, salinity and temperate play an influenced role to fish communities residing in seagrass beds on Florida Bay, and the extreme salinity and temperature may result in direct mortality of stenohaline species (larval and juvenile stage respectively).

Diversity and abundance of fish in seagrass bed are usually greater at night than at during the day time (Bell and Pollard, 1989). This is because many cryptic species are more vulnerable to trawling (the most common method of collecting seagrass fish) at night, and also because of nocturnal migration of reef fishes and movement of diurnal planktivores from water column to nocturnal sheltering sites beneath the canopy (Adam, 1976; Orth and Heck, 1980; Bell and Hamelin-ViVien, 1982; Stoner, 1983; Leber and Greening, 1986 cited by Bell and Pollard, 1989). These occurrence had also been reported from Japan (Kikuchi, 1966), Caribbean Sea (Weinstein and Heck, 1979), Philippines (Dolar, 1991; Vergara and Fortes, 1981) and Thailand (Nateekanjanalarp, 1990).

Migration of Fish Between Coral Reefs and Seagrass Beds

In the tropical sea, coral reefs and seagrass bed are often adjoin and prominent faunal interrelationships occur (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Unesco, 1983; Robblee and Zieman, 1984). Coral reef are known for the diversity and abundance of their fish and invertebrate fauna (Goldman and Talbot, 1976; Sale, 1980) while seagrass bed are recognized as nursery ground for many important commercial and forage organisms as well as some of the reef species (Weinstein and Heck, 1979; McRoy and Helfferich, 1980; Ogden, 1980; Zieman,1982; Weinstein and Heck, 1989). Unesco (1980) stated that faunal interrelationship particularly faunal migrations were the most important biodeterminant of the connection between coral reefs and seagrass beds. Two types of migrations between coral reefs and seagrass beds were categorized : 1) Live-history migrations between two ecosystems; 2) Short-term feeding migrations between ecosystems which either diurnal or seasonal. The net results of both is a transfer of energy from system where development and/or feeding occur to the system which shelters the adults.

The nursery function of seagrass bed is due mainly to the availabity of shelter for juvenile fishes including species of commercial and recreation value. The abundant supply of organic detrital food resulted in numerous and abundant juvenile fishes from the adjacent habitat, to have earlier life stage in the seagrass bed and move away from the seagrass bed to their adult habitats, such as coral reef, as they grow (Kikuchi and Peres, 1977; Kikuchi, 1980; Ogden, 1980; Zieman, 1982; Unesco,1983; Birkeland, 1985; Bell and Pollard, 1989). Spawning of many species usually takes place away from the seagrass bed, e.g. coral reef, offshore or bay, etc., and small juvenile then move into the seagrass canopy, but few species actually spawn among the seagrass (Kikuchi, 1966, 1974, 1980; Zieman, 1982; Bell and Pollard, 1989).

Weinstein and Heck (1979) reported that the juvenile reef fishes of the families Lutjanidae, Haemulidae, Scorpeanidae and Serranidae were abundantly found in the Panamanian seagrass beds and concluded that these juveniles apparently used the seagrass beds as nursery grounds during their early life stage, while as adult they were normaly found in deepers waters associated with the reef themselves. Zieman (1982) also found the juvenile of Haemulidae, Lutjanidae, Mullidae, Scaridae and Acanthuridae of reef used the seagrass bed as nursery area in Florida. In the Gulf of Thailand, Nateekanjanalarp (1990) and Sudara et al.(1992) concluded that seagrass beds were the nursery ground for reef fishes such as Lutjanidae, Lethrinidae, Nemipteridae, Siganidae and Serranidae.

The exploitation of seagrass beds as a nursery ground forjuvenile of reef fishes were restricted by the size class. As their sizes were increased and too large to find a shelter in the canopy of seagrasses to avoid detection by predators, they were excluded from the seagrass bed to the adjacent coral reefs to find shelters which more protection in crevices and cave by day, and migrated to the seagrass beds to feed at night when predation was less intense (Ogden and Zieman, 1977; Ogden, 1980; Zieman, 1982). The adult of reef fishes (nocturnal or carnivorous species respectively), they were not found over seagrass beds during the day but were found abundant diurnally on coral reefs and at night over seagrass bed adjacent to coral reefs (Stark and Davis, 1966; Davis, 1967 cited by Zieman, 1982).

Migration of fish from the coral reefs to the seagrass beds for feeding grounds by diurnal cycle had been observed in several studies that the day active reef-associated fishes included the herbivores, omnivores and small carnivores diurnally presented in the seagrass beds whereas the active nocturnal carnivorous reef fishes migrated to the seagrass beds at night (Ogden and Zieman, 1977; Weinstein and Heck, 1979; Ogden, 1980; Zieman, 1982; Robblee and Zieman, 1984; Bell and Pollard, 1989).

Randall (1965) reported that the herbivores reef fishes of West Indies such as parrotfishes (Scaridae: *Scarus* and *Sparisoma*) and surgeonfishes (Acanthuridae : *Acanthurus*) were the most important group fed upon the seagrasses. At least 30 species of Caribbean reef fishes fed directly on seagrasses, such as parrotfishes (Scaridae), surgeonfishes (Acanthuridae), porgies (Sparidae), halfbeaks (Hemirhamphidae) and rabbitfishes (Siganidae) were the most important seagrass consumers. The other omnivorous, filefish (Monocanthidae) and damselfish (Pomacentridae) small carnivorous; wrassefishes (Labridae) and butterflyfishes (Chaetodontidae) (Randall, 1965; McRoy and Helfferich, 1980; Weinstein and Heck, 1979; Robblee and Zieman, 1984).

Nocturnal carnivorous fish also found to be exploiting seagrass beds long distances from reefs at night which include the members of the families Haemulidae, Lutjanidae, Holocentridae, Lethrinidae, and Apogonidae (Ogden and Zieman, 1987; Weinstein and Heck, 1979; Robblee and Zieman, 1984). The nocturnal migrations of resting school of French grunts (*Haemulon flavolineatum*) and white grunts (*H. plumieri*), these species form large heterotypic resting school associated with particular coral formations on a series of patch reefs within Tague Bay, St. Croix US. Vergin Island. As dusk approches, the grunts schools stream over to coral reef to specific assembly points on the reef edges and then migrated into the surrounding seagrass beds on pathway that remain constant for years and the distance traveled may be 1 kilometer. or further. The migrating grunt school broke up and fed individually on seagrass associated invertebrates through the night gathering and returning to the reef on the same pathway at dawn (Ogden and Enhrich, 1977 cited by Ogden and Zieman, 1977). The nocturnal migration of other reef fishes *Lutjanus griseus* and *L. synagris* in Florida Bay were also found similar ~~to pattern~~ migration of grunts (Zieman,1982).