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NATIONAL REPORT

on

Seagrass in the South China Sea

THAILAND

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Abbreviations and Acronyms

DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Works
DLD	Department of Livestock Development
DMCR	Department of Marine and Coastal Resources
DMR	Department of Mineral Resources
DNP	National Park, Wildlife and Plant Conservation Department
DoA	Department of Agriculture
DoF	Department of Fisheries
DPT	Department of Public Works and Town & Country Planning
DWR	Department of Water Resources
EIA	Environmental Impact Assessment
LDD	Land Development Department
MD	Marine Department
MONRE	Ministry of Natural Resources and Environment
MOT	Ministry of Transport
NEB	National Environment Board
NEQA	Enhancement and Conservation of National Environmental Quality Act
NGO	Non Governmental Organization
ONEP	Office of the Natural Resources and Environmental Policy and Planning
PAO	Provincial Administration Organization
PCA	Pollution Control Area
PCD	Pollution Control Department
PEAP	Provincial Environmental Quality Management Action Plan
RFD	Royal Forest Department
RID	Royal Irrigation Department
SAO	Sub-District Administration Organization
TAO	Tambon (Sub-District) Administration Organization
UNCLOS	The United Nations Convention on the Law of the Sea

1. INTRODUCTION

Seagrasses occur in Thailand's waters of the Gulf of Thailand and the Andaman Sea. They cover an approximate area of 10,400 hectares (7,900ha in Andaman Sea and 2,500ha in the Gulf of Thailand) and are represented by 12 species (Poovachiranon, 2000). Seagrass provides shelter, nursery grounds, and feeding habitats for marine animals, particularly fish and crustaceans (Poovachiranon, 2000). Sea turtles and dugongs also utilise seagrass beds (Poovachiranon, 2000; Nateekanjanalarp and Sudara, 1992).

Seagrass beds in Thailand are classified into three types: mangrove-associated beds, shallow sandy-bottom beds, and coral reef associated beds (Poovachiranon, 2000). Seagrasses are denser and more abundant in the Andaman Sea than in the Gulf of Thailand (Poovachiranon, 2000).

2. REVIEW OF NATIONAL DATA AND INFORMATION

2.1 Geographic Distribution

Seagrasses occur in many locations along Thailand's Gulf of Thailand and Andaman Sea coasts. The occurrence, community structure, and biomass of seagrasses have been studied at 19 different provincial locations, with 12 species having been observed (UNEP, 2004). Seagrass is more dense and abundant in waters of the Andaman Sea (Poovachiranon, 2000). *Halophila ovalis* is the most widely distributed, because of its ability to grow in varieties of habitat. *Enhalus acoroides*, the largest species, is also common in the major seagrass areas (UNEP, 2004). Seagrass sites are shown in the map of Figure 1.

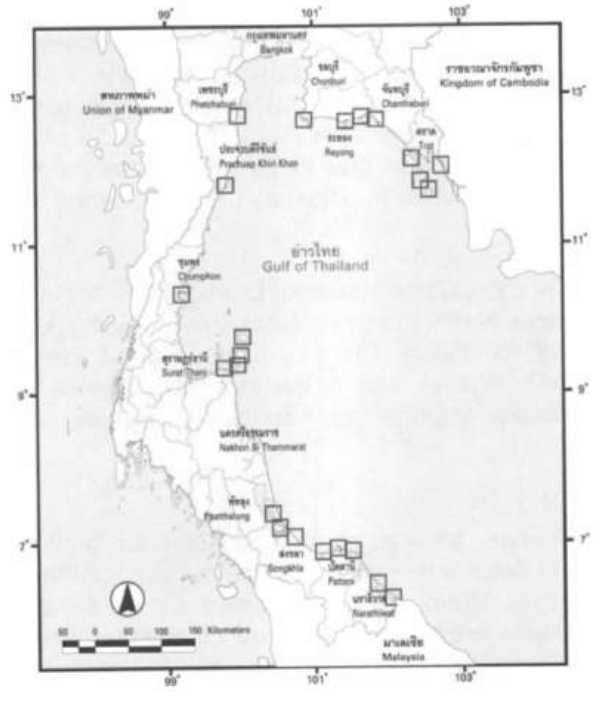

Figure 1 Seagrass sites in the Gulf of Thailand.

2.2 Physical and Chemical Characteristics

Seagrasses normally grow in the tidal zone along the shore. Variations in physical and chemical factors such as salinity, water depth, light penetration, tidal range, water quality, and bottom sediment can influence seagrass distribution. This chapter summarises available information from studies and surveys of water quality and bottom sediments in seagrass areas conducted by the Pollution Control Department (PCD), under the project entitled "Survey of Coastal Water Quality in coastal waters of the Andaman Sea and the Gulf of Thailand".

General Environmental Characteristics of Seagrass Areas

Substrate Type
Seagrass have similar root systems to terrestrial plants. The appropriate substrate for seagrass growth and survival should be muddy sand so that the roots can spread out through the substrate and attach to the small sediment particles. *Enhalus acoroides*, the large species at Chaweng Beach, Samui Island grows on medium to coarse-grained sand and coral rubbles. The smaller *H. uninervis*, *H. ovalis*, *H. ovata*, and *H. decipiens* thrive on fine to medium sand (Nateekanjanalarp, 1990).

Current
Seagrass distribution and growth are influenced by wave action and currents. Although their roots are firmly attached to the substrate, strong wave and current action can easily remove the seagrass. Seagrass can normally be found in areas of low energy and wave action, especially semi-enclosed bays. The Gulf of Thailand is a semi-enclosed sea in which three sides are surrounded by land: north and west by Thailand, east by Cambodia and south by Malaysia. It connects with the South China Sea. The current speed in the Gulf at a depth of 5m is less than 0.07m/s (Wattayakorn *et al.* 1998). Water movement in the Gulf is strong and the water mass exchange rate is low. Movement of water masses in the Gulf can be classified into two patterns. During the southwest monsoon (March to August), water masses moves in an anticyclonic gyre, while a cyclonic gyre movement occurs during the northeast monsoon (September to November).

Monsoon Exposure
Seagrass can grow in both tropical and temperate zones. Although seasonal variation is not obvious in the tropical areas (Hillman *et al.* 1989), differences between seasons caused by the monsoon can be noticed in terms of stormwater and run-off in the Gulf of Thailand. River run-off discharges a large amount of fresh water into the sea during the southwest monsoon. In addition, higher water temperatures are observed during summer (April to May). This freshwater and high water temperature influences seagrass distribution and growth. For example, seagrasses in shallow water and exposed to sunlight during low tides have lower growth rates and higher mortality rates during summer (Lewmanomont *et al.* 1991). Large amounts of nutrients from run-off also discharge into the coastal areas, often resulting in increased seagrass growth. In some areas like Khung Krabane Bay, organic matter is flushed from aquaculture activities into the bay (Tookwinas and Sangrungruang, 1998).

Tidal Regime
There are two types of tides in the Gulf of Thailand. Diurnal tides occur on the east coast (Rayong, Chanthaburi, and Trat Provinces), and in Prachuap Khiri Khan Province to Chumphon Province. Mixed tides occur in the upper Gulf (Chonburi, Chachoengsao, Samut Prakan, Samut Sakhon, Samut Songkhram and Phetchaburi Provinces), and in the coastal provinces of southern Thailand (Surat Thani, Nakhon Si Thammarat, Phatthalung, Songkhla, Pattani and Narathiwat Provinces) (Hydrographic Department, 2001).

Water Depth
The growth of seagrass depends on energy from sunlight for photosynthesis. This factor also determines their distribution. In deep-water areas, the amount of light that reaches the plants is less and this inhibits photosynthesis. Water turbidity caused by suspended solids also blocks light penetration. Therefore, seagrasses are found in deep, but clear water. For example, they are observed at a depth of 9m adjacent to Kradat Island in Trat Province. If the water is turbid, i.e., a river mouth or canal outlet, seagrasses grow in the shallow water or in the inter-tidal zone such as Khung Krabane Bay (Aryuthaka *et al.* 1992). The distribution of seagrasses in Makhampom Bay, Rayong Province is 600m wide and 5km long at a depth of less than 2m during the lowest tide (Eastern Marine Fisheries Research and Development Center, 2003 – Personal Communication).

2.3 Biological Aspects

2.3.1 Seagrass

Ostenfeld (1902) reported a new species of *Halophila decipiens* in the Gulf of Thailand, and found 2 more species of *Halophila ovalis* and *Halodule uninervis*. Thereafter, den Hartog (1970) found 4 seagrass species, namely *Cymodocea rotundata*, *Thalassia hemprichii*, *Halophila ovata*, and *Halophila decipiens*. From 1989 to 1994, the ASEAN-Australia Coastal Living Resources Project encouraged research on seagrass distribution and seagrass fauna. Finally, Lewmanomont *et al.* (1991) reported 12

seagrass species from 7 genera of 3 families in Thai Waters. These include 1. Family Cymodoceaceae (3 genera: *Syringodium, Cymodocea, Halodule*), 2. Family Hydrocharitaceae (3 genera: *Halophila, Thalassia, Enhalus*), and 3. Family Potomogetonaceae (1 genus: *Ruppia*). Lewmanomont *et al.* (1996) observed that species of *Enhalus*, *Halophila* and *Cymodocea* were often associated with mangrove forests.

Lewmanomont *et al.* (1996) summarised that 10 seagrass species occur in waters adjacent to the 13 Gulf of Thailand coastal provinces of Chonburi, Rayong, Chanthaburi, Trat, Phetchaburi, Prachuap Khiri Khan, Chumphon, Surat Thani, Nakhon Si Thammarat, Songkhla, Pattani, Phatthalung, and Narathiwat. The species are:

1) *Enhalus acoroides* (L.f.) Royle
2) *Thalassia hemprichii* (Ehrenberg) Ascherson
3) *Halophila beccarii* Ascherson
4) *Halophila decipiens* Ostenfeld
5) *Halophila minor* (Zollinger) den Hartog
6) *Halophila ovalis* (R. Brown) Hooker f.
7) *Halodule pinifolia* (Miki) den Hartog
8) *Halodule uninervis* (Forsskal) Ascherson
9) *Cymodocea serrulata* (R. Brown) Ascherson and Magnus
10) *Ruppia maritima* Linnaeus.

In coastal waters of the Gulf of Thailand, seagrass species *Cymodocea rotundata* and *Syringodium isoetifolium* have only been reported to occur along the Andaman Sea coast, while *Ruppia maritima* is observed to only occupy the estuaries of four Gulf of Thailand provinces, namely Chonburi, Phetchaburi, Songkhla, and Pattani. The waters of several areas, especially those adjacent to islands, contain a diverse range of seagrass species. For example, eight species (*E. acoroides*, *H. decipiens*, *H. minor, H. ovalis*, *H. pinifolia, H. uninervis*, *C. serrulata*, and *R. maritima*) have been observed in Chonburi Province, while Surat Thani Province is home to seven species, including *E. acoroides*, *H. beccarii, H. decipiens*, *H. minor, H. ovalis*, *H. uninervis* and *T. hemprichii*. Mangrove associated seagrass beds also contain a high number species, with at least six species observed in such beds of Pattani Province, Chanthaburi Province and Trat Province. This, included *H. beccarii, H. decipiens*, *H. ovalis*, *H. pinifolia, H. uninervis*, and *R. maritime* in Pattani; *E. acoroides*, *H. decipiens*, *H. minor, H. ovalis*, *H. pinifolia,* and *H. uninervis* in Chanthaburi; and *E. Acoroides, H. beccarii, H. decipiens*, *H. ovalis*, *H. pinifolia, H. uninervis*, and *C. serrulata* in Trat. In Rayong Province, the five species of *H. decipiens*, *H. minor, H. Ovalis*, *H. pinifolia* and *H. uninervis* have been observed. While the five seagrass species namely *H. beccarii, H. ovalis*, *H. pinifolia, H. uninervis,* and *R. maritima* are present in Songkhla Province. The four species of *E. acoroides, H. ovalis*, *H. uninervis* and *T. hemprichii* are common in Nakhon Si Thammarat Province. Remaining seagrass beds provide a low number of species: one species (*R. maritime*) in Phetchaburi Province; and two species in Prachuap Khiri Khan Province (*H. ovalis* and *H. pinifolia*), Narathiwat Province (*H. beccarii* and *H. uninervis*), and Chumphon Province (*E. acoroides*, and *H. beccarii*). *H. ovalis*, *H. uninervis*, and *H. pinifolia* are common throughout the Gulf of Thailand.

2.3.2 Associated Marine Biota

Marine fauna of four seagrass beds in Khung Krabane Bay, Samui and Pha Ngan Islands, and Pattani Bay have been studied. They were comprised of meiofauna, nematodes, polychaetes, gastropods, pelecypods (bivalves), echinoderms, crustaceans (shrimp and crab), and fish.

Seagrasses at Khung Krabane Bay and Pattani Bay are categorised as mangrove associated, while those of Samui and Pha Ngan Islands are coral associated. Details on animals in each group are as follows:

1) Nematod

Aryuthaka (1991) showed that the density of mieofauna ranged from 1,472 to 7,539 individuals per $0.10cm^2$. No clear trend was observed in the mieofauna from the inner to the outer part of Khung Krabane Bay. The density of mieofauna was lowest in November. There were different groups of kinorrhynch, ostracod, amphipod, tardigrade, turbellarian, polychaete, halocarid, bivalve, and nauplii of unidentified crustacean. However, free-living nematodes represented the most dominant group (25% of the total density). These tiny marine organisms are mainly food for fish and shrimp feeding on the seafloor.

Munthum (2002) also reported the infaunal species such as nematodes were abundant in the seagrass bed at Khung Krabane Bay. 78 species belonging to 22 families were recorded.

2) Polychaete

Polychaete was also abundant in the seagrass area. With 27 families reported at Khung Krabane Bay, 27 families at Pattani Bay, 28 families at Samui Island and 19 families at Pha Ngan Island.

3) Gastropod

108 species belonging to 37 families of gastropods were recorded within four different seagrass locations. The most diverse was 55 species at Samui Island. 35 species were found at Pattani Bay, 25 species at Pha Ngan Island and 5 species at Khung Krabane Bay. Several species of these gastropods were edible, particularly species of Neritidae, including *Nerita polita* and *Nerita quatiensis*, and those of Potamididae, including *Cerithidea cingulata*, *C. squadrata* and *C rhizophorarum*. Local people who live along the coast collected *C. rhizophorarum*. Gastropod, in the family of Strombridae such as *Strombus canarium* and *Strombus vittatus* were collected in seagrasses by fishers. These shells are usually found for sale in the seafood restaurants. Cuttlefish, *Sepiella inermis* and squid, *Sepiotuethis lessoniana* are in the family of Sepiidae. They were also reported in the seagrass beds.

4) Pelecypod (Bivalve)

112 species, belonging to 35 families of pelecypods, were recorded within four different seagrass locations. The most diverse of pelecypod was 49 species at Pattani Bay. Pelecypods of only 38 species at Samui Island, 22 species at Khung Krabane and 12 species at Pha Ngan Island. Several families of the bivalves are quite common for consumption, such as Mytilidae (*Modiolus senhousii, M. margaritaceus*, *Musculus* spp., and *Perna viridis*). The family Pinnidae, particularly, *Pinna bicolor* is harvested from seagrasses. Economic bivalve species such as Pteriidae (*Pteria* spp.), Anomiiae (*Placuna placenta*), Veneridae (*Paphia luzonca*, *Tapes litterata* and *Tapes variegatus*) and Donacidae (*Donax* spp.) are commonly found in seagrasses.

5) Echinoderm

Echinoderms were reported at only three locations, including 7 species at Samui Island, 5 species at Pha Ngan Island, and 3 species at Pattani Bay. No information was available at Khung Krabane Bay. 12 species, belonging to 8 families of echinoderms were recorded within 3 different seagrass locations. Namely, *Astropecten indicus* and *Astropectin* spp. (Family Astropectinidae), *Macrophiotrix* spp. and *Ophiotrix* spp. (Family Ophiorichdae), *Ophiothauma heptactis* (Family Ophicanthidae), 1 unknown species (Family Ophicomodae), 1 unknown species (Family Ophiodermatidae), 3 *Amphiura sp.*, *Amphiura ieucaspis* and *Amphipholis squamata* (Family Amphiuridae), and 1 unknown species (Family Echinilampadidae). *Holothuria atra* (Family Holothuridae) was the only economically important sea cucumber reported from the seagrasses at Pha Ngan Island. The brittle star was found on sand flats. Local fishers usually collected them from the seagrass bed at low tide, then boil and dry them for selling.

6) Crustacean

Several families of decapodid, amphipodid, and isopodid crustacea predominantly represented crustaceans. Eighty-seven species belonging to 48 families of crustaceans were recorded within four different seagrass locations. The crustacean fauna is a very diverse group and a major component of macrofauna in the seagrass beds. It was numerically abundant, and it contributed to the high biomass as well. The crustaceans are mostly free swimming. Some others make burrows that protect them from predators, as well as temperature and salinity stress. Many species of shrimps, including *Peneaus merguiensis, Peneaus monodon, Peneaus semisulcatus, Metapeneaus* spp. and *Acetes erythraeus*, were caught in seagrasses. They are quite expensive seafood in the market. Swimming crab (*Portunus pelagicus*) and mud crab (*Scylla serrata*), the most popular seafood in Thailand, are commonly found in seagrass areas.

7) Fish

Fishes of seagrass beds in the Gulf of Thailand were identified from samples collected from four different areas. 152 species belonging to 58 families were recorded, of which 103 species, 56 species, 44 species and 28 species were reported at Pattani Bay, Khung Krabane, Samui Island and Pha Ngan

Island, respectively. The dominant group of fishes found in seagrasses showed a degree of overlap of the species pool of inshore fishes, such as *Siganus* spp. (seagrass dominated species) and mangrove dominated species such as *Ambassis* spp., *Leiognathus* spp. and *Secutor* spp. (Satapoomin and Poovachiranon, 1994). Approximately 70% of the economically important species have been recorded in the seagrass beds of Pattani Bay, Khung Krabane Bay, Samui and Pha Ngan Island, including catfish (*Arius sagor*), mullets (*Chelon subviridis* and *Chelon dussumeri*), barramundi (*Lates calcarifer*), grouper (*Epinephelus coioides, E. sexfasciatus, E. tauvina* and *E. bleekeri*), sillago (*Sillago sihama*), almaco jack (*Seriola rivoliana*), snapper (*Lutjanus carponotatus*), emperor (*Lethrinus miniatus*), croaker (*Johnieops vogleri*), rabbitfish (*Siganus javus* and *Siganus canaliculatus*) and short mackerel (*Rastrelliger brachysoma*). Although these group of fish were only juveniles or sub-adults.

2.3.3 Dugong

Dugongs are rarely sighted, although they are distributed along coastlines of both the Andaman Sea and the Gulf of Thailand. According to sightings and strandings of dugong in the Gulf, it is believed that small populations of dugong inhabit Chonburi, Rayong, Chanthaburi, Trat, Chumphon, Surat Thani and Pattani provinces. Aerial surveys of dugong conducted during January 2003 confirmed that dugongs exist in Rayong and Trat waters. Dugongs occasionally become entangled in fishing gears. Among the various types of gears, gill nets were the main cause of fishing-induced dugong mortalities. Education and awareness building of dugong and seagrass ecosystems are most important for conservation and protection of dugong and seagrasses in Thai waters.

2.3.3.1 Distribution of Dugong

In the Gulf, there has been little research conducted on dugong. Nateekanjanalarp and Sudara (1992) reported that dugongs used to be found at Ao Khung Krabane (Khung Krabane Bay), Chanthaburi Province, and Ao Makhampom (Makhampom Bay), Rayong Province, and on the east coast of the Gulf. They also reported evidence of two dead dugongs: one from Laem Singh, Chanthaburi Province and the other from Ao Makhampom.

Nevertheless, dugongs were occasionally found at Ao Makhampom and Paknam Prasae (mouth of the Prasae River), Rayong Province. Local people in Chanthaburi informed that dugongs are often seen feeding on seagrass at Ao Khung Krabane every year from December to January. A trawler or other fishing gear in Rayong province kills at least one dugong each year. At Chang Island, Trat Province, one dead dugong was found in 1996, and another five dead dugongs were found at Laem Klat in 1997. A dead calf, of about 30kg in weight, was found at Chong Samae San, Chonburi Province in April 1999 (Adulyanukosol, 1999).

2.3.3.2 Dugong Strandings and Causes of Death

Phuket Marine Biological Center has collected 61 stranding records of dugong from the Gulf. The majority of strandings occurred at Rayong Province (22 animals), followed by the provinces of Trat (13 animals), Surat Thani (8 animals), Chumphon (8 animals), Chonburi (4 animals), Chanthaburi (3 animals), Songkhla (1 animal), Nakhon Si Thammarat (1 animal), and Pattani (1 animal).

Cause of Death

In the past, local people in Rayong Province killed dugongs and consumed their meat as a protein source. Fishers would chase dugongs into shallow water or river mouths, and hit or spear them with harpoons and other instruments. In the southern part of the Andaman Sea coast, fishers chased dugongs into shallow waters and enclosed them in a net (Adulyanukosol, 1998; Adulyanukosol, 1999). The killing of dugong for food no longer occurs. However, they are occasionally caught in fishing gears. Table 1 indicates that fishing-induced dugong mortalities mostly occur due to trawler and gill net uses. When trapped inside a bamboo stake trap (pound net, set net), dugong mortalities may occur due to injuries caused by contact with bamboo and netting.

Table 1 Types of fishing gears that have caused dugong mortalities in coastal provinces of the Gulf of Thailand (N=47).

Province	Gill net	Barrier net	Trawler/Small trawler	Purse seine	Ray long line	Stake trap	Boat strike
Chonburi	2	-	1	-	-	-	1
Rayong	9	-	2	1	-	5	-
Chanthaburi	1	-	1	-	-	-	-
Trat	1	-	9	-	-	-	-
Chumphon	2	-	1	-	-	-	-
Surat Thani	1	3	3	-	1	-	-
Nakhon Si Thammarat	-	-	1	-	-	-	-
Songkhla	-	-	1	-	-	-	-
Pattani	1	-	-	-	-	-	-
Total	17	3	19	1	1	5	1

Source: modified from Adulyanukosol, (2002).

2.4 Threats to Seagrass

In the Gulf of Thailand, a number of factors cause destruction and loss of seagrass beds and associated biota, including:

- Fluctuations in freshwater input, mostly due to irrigation and land clearing, cause high salinity variation. This occurs in areas of enclosed sea such as Pattani Bay, Pattani Province, where salinity fluctuates significantly throughout the year, causing stress to the seagrass ecosystem.
- High sediment load from destruction of mangroves (sediment traps), and coastal developments, including construction of tourist resorts, ports and roads, channel dredging, and land reclamation.
- Wastewater discharged from shrimp farms and sewage from urban and industrial developments, with an associated increase of nutrients, resulting in the accumulation of organic sediments and hypoxia. The direct discharge of wastewater from shrimp farms into seagrass beds is present at Pattani Bay, Khung Krabane Bay, and Makhampom Bay.
- Fishery activities, including scouring of the benthos by push nets and trawls, harvesting of juveniles, and disturbance of seagrass while gleaning for clams, crabs, and other benthic burrowers at low tide.

Threats to seagrass in different provinces in the Gulf of Thailand are shown in Annex 2 to Annex 6.

3. NATIONAL AND INTERNATIONAL LEGISLATION AND INSTITUTIONAL ARRANGEMENTS

3.1 Thai Policy and Legislation Relevant to Seagrass Management

3.1.1 Thailand Policy

The Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality B.E. 2540-2559 (AD 1997-2016)[7] is the guideline for the Minister of Natural Resources and Environment to manage the environment. The present plan supports conservation and rehabilitation of coastal resources including seagrass. The plan also emphasises that development of coastal areas should have as little impact as possible on coastal resources. This policy further states in the 9th National Economic and Social Development Plan B.E. 2545 to 2549 (AD 2002 to 2006) that encourages the formulation of a master plan for the rehabilitation of the coastal and marine environment, as well as local participation in natural resources and environmental management. Therefore, according to the Policy and Prospective Plan for Environment B.E. 2540-2559 and the 9th Plan, Thai policy is now realise how important of the coastal and marine environment and to manage it, local participation is needed. However, since there is little recognition of the vital of seagrass area, the priority of conservation is the lowest, comparing to mangrove, coral reef, or wetland. In addition,

[7] *The National Environmental Board (NEB) submitted the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997 to 2016) to the cabinet for approval on 26 November 1996. This policy is the framework for a five year Environmental Quality Management Plan, and annual Provincial Environmental Quality Management Action Plan.*

the 9th Plan sets goals to be achieved in B.E. 2549 (AD 2006), such as having mangrove areas of no less than 1.25 million rai[8] in the last year of the plan.

Nevertheless, the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997-2016) is just a guideline and needs an action plan called "Environmental Quality Management Plan" for implementation.[9] The Environmental Quality Management Plan may be a short, intermediate, or long-term plan, and should contain work-plans and guidance for action on the following matters:

1) Management of air, water, and environmental quality and any other area of concern;
2) Pollution control from point sources;
3) Conservation of the natural environment, natural resources, or cultural environment pertaining to aesthetic values;
4) Estimation of financing to be appropriated from the government budget and allocated from the fund, which is necessary for implementation of the plan;
5) Scheme for institutional arrangements and administrative orders by cooperation and co-ordination among government agencies concerned, and between the public service and private sectors could be further promoted and strengthened, including the determination of a manpower allocation scheme necessary to implement the plan;
6) Enactment of laws and issuance of regulations, local ordinances, rules, orders, and notifications necessary for implementation of the plan; and a
7) Scheme for inspection, monitoring, and assessment of environmental quality by which the results of implementation of the plan and enforcement of law related thereto can be evaluated objectively[10].

After the Environmental Quality Management Plan has been published in the Government Gazette, the Governor of a Province (Changwat) of *an environmentally protected area* or a *pollution control area* is required, to formulate an action plan for environmental quality management at the Provincial level (PEAP). This is then submitted to the National Environment Board (NEB) for approval within one hundred and twenty days from the date on which the Governor of that Province is directed by the NEB to prepare the PEAP[11]. The Provincial Governor of a *pollution control area* must incorporate an action plan for reduction and eradication of pollution prepared by the local official[12] into the PEAP[13]. The Governor of a Province, which is not *an environmentally protected area* or *pollution control area*, may prepare a PEAP, within the framework of and in conformity with the requirements of the Environmental Quality Management Plan, and submit it to the NEB for approval[14].

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[8] *1 acre = 2.5 rai (approx.), 1 hectare = 6.25 rai (approx.)*

[9] *Section 35 of the NEQA. All related government agencies have to take actions within their powers and functions that are necessary for effective implementation of the Environmental Quality Management Plan and in order to ensure that actions are taken to achieve the objectives and goals as prescribed. It is also the Ministry of Natural Resources and Environment's duty to give advice to government agencies and state enterprises, which are concerned with the formulation of work-plans or the taking of any actions to implementing the Environmental Quality Management Plan.*

[10] *Section 36 of the NEQA.*

[11] *If, however, there is a reasonable ground, the said duration may be extended as appropriate by the NEB. Section 41 of the NEQA. In case any Province, which is required to prepare the action plan, fails or is incapable to evolve such a plan, or has prepared and submitted the plan as required but failed to get the approval of the NEB for any reason, the NEB must consider the nature of the problems encountered by that Province and evaluate whether its environmental quality is adversely affected to such an extent that any action is warranted to rectify the situation. If action is deemed necessary, the NEB must propose to the Prime Minister to issue an order directing the Ministry of Natural Resources and Environment to prepare the Provincial Action Plan on behalf of the Province in question.*

[12] *Section 4 of the NEQA. "Local Official" means:*
1) President of the Municipal Council within a municipality;
2) President of the Sanitary District Board within a sanitary district;
3) Provincial (Changwat) Governor within a local administration organisation;
4) Governor of the Bangkok Metropolitan Administration within Bangkok Metropolis;
5) Permanent Secretary of Pattaya City Administration within the City of Pattaya;
6) Head of a local administration in the administration of the local administration organisation other than 1) to 5) above, established under the specific law governing thereof, within such local administration organisation.

[13] *Section 60 of the NEQA.*

[14] *Section 37 of the NEQA. Currently, all Province have the PEAP, because the PEAP is a channel for receiving the budget (besides the government agencies located in Province submit an annual plan for budget appropriation) to manage the Province's environment, especially to build wastewater treatment plants and waste disposal facilities.*

The PEAP must be an action plan, which proposes a system of integrated management of environmental quality in conformity with the guidelines specified in the Environmental Quality Management Plan, taking into account the severity of the problems and economic, social, and environmental conditions of that Province, and should address and contain essential elements in the following matters:

1) Plan for control of pollution from point sources.
2) Plan for procurement and acquisition of land, materials, equipment, tools, and appliances that are essential for the construction, installation, improvement, modification, repair, maintenance, and operation of central wastewater treatment plants or central waste disposal facilities belonging to a government agency or local administration concerned.
3) Plan for collection of taxes, duties, and service fees for operation and maintenance of central wastewater treatment plants or central waste disposal facilities referred to in sub-Section 2) above.
4) Plan for inspection, monitoring and control of wastewater and other waste matters that are discharged from point sources of pollution.
5) Law enforcement plan for the prevention and suppression of violations of infringement of laws and regulations pertaining to pollution control, conservation of nature, natural resources, and cultural environment pertaining to aesthetic values.[15]

3.1.2 National Legislation Relevant to Seagrass Management

3.1.2.1 Regulations Related to Natural Occurrence Affecting Seagrass

Section 9 of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992) [the NEQA]

> In case there is an emergency arising from a natural disaster which will, if left without any remedial actions, aggrevatedly (*sic*) cause damage to the properties of the State,[16] the Prime Minister shall have the power to order,[17] as deemed appropriate, government agencies, states enterprises or any persons, including persons who are or may be the victims of such damage, to take prompt action, individually or jointly, in order to be able to control, extinguish, or mitigate the adverse effects of such damage.

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[15] *Section 38 of the NEQA. In addition, see Section 39. The Provincial Action Plan for environmental quality management to be given first priority for the consideration by the NEB must propose an estimate of budgetary appropriation and allocation from the (Environmental) Fund for the construction or procurement for the acquisition of a central wastewater treatment plant or a central waste disposal facility pursuant to Section 38 (Poovachiranon, 2000). In case any Province is not ready to take steps for the procurement or acquisition of a central wastewater treatment plant or central waste disposal facility, it may instead propose a plan to promote private investment in the construction and operation of wastewater treatment or waste disposal facilities in order to make available such services within its jurisdiction.*

[16] *Section 1304 of the Civil and Commercial Code. The domain public of State includes every kind of State property which is in use for the public interest or reserved for the common benefit, such as: (1) wasteland and land surrendered, abandoned or otherwise reverted to the State according to the land law; (2) property for the common use of the people e.g., foreshores, waterways, highways, lakes; (3) property for the special use of the State e.g., a fortress or other military buildings, public offices, warships, arms and ammunition.*

[17] *Section 9 of the NEQA. The Prime Minister may delegate the power to give orders to the Provincial Governor to exercise such power and act on his behalf within the territorial jurisdiction of that Province. The said delegation of power must be a written order and published in the Government Gazette. When any order is given by the Prime Minister, or by the Provincial Governor acting on behalf of the Prime Minister, such order must be published in the Government Gazette without delay. In addition, see Section 98. Any person who violates or refuses to observe the order issued by virtue of Section 9 or obstructs any act done in compliance with such order shall be punished by imprisonment not exceeding one year or a fine not exceeding one hundred thousand baht, or both.*

3.1.2.2 Pollution Control Regulations Related to Seagrass

1) The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992) [the NEQA]

Under Section 4 of the NEQA, "pollutant" means:

> Wastes,[18] hazardous substances[19] and other polluting substances as well as residues, sediments or the remainder of such matters, which are discharged from point sources of pollution[20] or naturally occur in the environment,[21] that have or are likely to have impacts on environmental quality[22] or to cause conditions poisonous or harmful to the health and hygiene of the public, and shall mean to include radiation, heat, light, noise, odor, vibration or other nuisances[23] emanated or discharged from point source pollution.

Pollutant according to the NEQA, therefore, includes the sediment that is the major threat to seagrass.

A. Section 9 of the NEQA

If there is an emergency or public danger arising from pollution caused by contamination and spread of pollutants which will, if left without any remedial actions, aggrevatedly *(sic)* cause damage to the properties of the State-seagrass, the Prime Minister could order,[24] as deemed appropriate, government agencies, states enterprises or any persons, including persons who are or may be the victims of such danger or damage, to take prompt action, individually or jointly, in order to be able to control, extinguish, or mitigate the adverse effects of such danger or damage. In case any polluters are known and can be identified, the Prime Minister is empowered to enjoin such persons from any acts, which may aggravate the adverse effects of pollution during the occurrence of the incident.

B. Pollution Control Area (PCA)[25]

A Pollution Control Area, therefore, could be announced if a pollution problem, such as dredging or wastewater, may adversely affect a seagrass area. Furthermore, after designation by the PCA that the area is critically affected, the Minister of MONRE could propose protective measures to control and solve the problem, e.g., prohibiting shrimp farming or reclamation of the sea.

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[18] *Section 4 of the NEQA. "Waste" means refuse, garbage, filth, dirt, wastewater, polluted air, polluting substances or any other hazardous substances which are discharged or originate from point sources of pollution, including residues, sediments, or the remainders of such matters, either in the state of solid, liquid or gas.*

[19] *Section 4 of the NEQA. "Hazardous Substance" means explosive substances, inflammable substances, oxidising and peroxide substances, toxic substances, pathogenic substances, radioactive substances, genetic transforming substances, corrosive substances, irritating substances, or other substances, whether chemical or not, which may cause danger to human-being, animal, plant, property, or the environment.*

[20] *Section 4 of the NEQA. "Point Source of Pollution" means any community, factory, building, structure, vehicle, place of business, activity, or any other thing from which pollution is generated.*

[21] *Section 4 of the NEQA. "Environment" means natural things, which form the physical and biological conditions surrounding man and man-made things.*

[22] *Section 4 of the NEQA. "Environmental Quality" means the balance of nature, being composed of animals, plants, natural resources and man-made objects which is for the benefit of subsistence of mankind and the sustenance of human-being and nature.*

[23] *Section 4 of the NEQA. "Nuisance" means nuisance according to the law on public health.*

[24] ***See** FN.13 **And See** Section 98 of the NEQA. Any person who violates or refuses to observe the order issued by virtue of Section 9 or obstructs any act done in compliance with such order shall be punished by imprisonment not exceeding one year or a fine not exceeding one hundred thousand baht, or both. In case the person who violates or refuses to observe the order or obstructs any act done in compliance with such order is the person who has caused danger or damage arisen from pollution, such person shall be punished by imprisonment not exceeding five years or a fine not exceeding five hundred thousand baht, or both.*

[25] *Presently, NEB announces the following areas as pollution control areas: Chonburi Province – Pattaya, Phuket Province, Krabi Province – Phi Phi Island, Songkhla Province – Had Yai and Songkhla 1992; Samut Prakan Province 1993; Pathum Thani Province, Nonthaburi Province, Samut Sakhon Province, and Nakhon Prathom Province 1994; Phetchaburi Province – BarnLaem, Muang, Tayang, Chaaum, Prachuap Khiri Khan Province – Hua Hin and Parnburi 1995.*

Nevertheless, it is the duty of the NEB to designate the PCA. Therefore, the process of promulgation might be too slow to respond to the pollution problems threatening seagrass. Secondly, there is no control point to indicate when pollution problems may become health hazards to the public or cause adverse impacts on environmental quality. Therefore, the response may be too late.

C. Environmental Quality Standards

The NEB has the power to prescribe by notifications, published in the Government Gazettes, the following environmental quality standards:

1) Water quality standards for river, canal, swamp, marsh, lake, reservoir, and other public inland water sources according to their use classifications in each river basin or water catchment;
2) Water quality standards for coastal and estuarine water areas;
3) Environmental quality standards for other matters.

Actually, both Environmental Quality Standards and Effluent Standards under the NEQA could be utilised to protect seagrass and prevent pollution that might harm seagrass. The related agency may regulate effluent standards from specific point sources that are known to be harmful to the seagrass area. In addition, the promulgation of water quality standards for water resources and coastal areas should set the standard that is suitable for the survival of seagrass.

3.1.2.3 Regulation of Activity in the Seagrass Area

1) The Constitution

A. Public Hearing

The Thai Constitution states that any person has the right to receive information and reasons from governmental organisations before permission is granted for the starting of a project or activity that might affect the environmental quality, public health or any interest of such person or other person. Such person also has the right to express himself or herself according to the law. As described, public participation even if only by public hearing, could avoid the use of areas that might affect seagrass, whilst raising the environmental awareness of Thais.

B. Decentralisation in Environmental Management

The power and budget of central government for land restoration has been transferred to the local administration under the Constitution and the Decentralisation Act B.E. 2542 (1999). The local administrations have almost full authority to govern themselves, including environmental management and education. However, critics of the process say that it is too slow, and does not provide the local administration with knowledge of environment issues. As a result, projects presently funded by the local administrations are infrastructure oriented, which sometimes cause environmental problems. It is, therefore, the urgent duty of central government to assist the local administration to understand the environment. This will benefit coastal resources, which need local authorities to survive.

2) The NEQA

A. Environmental Impact Assessment (EIA)

Most small projects, which may affect seagrass, do not need to complete an environmental impact assessment. Small projects alone may not affect the environment, but when concentrated in an area, they could have an environmental impact. Some activities also need to complete an EIA, such as tourism, but are not regulated under the NEQA. Some activists, therefore, are attempting to incorporate the Strategic Environmental Assessment (SEA)[26] into the EIA process.

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[26] *Proceedings of International Workshop on Public Participation and Health Aspects in Strategic Environmental Assessment, 23 to 24 November, 2000, p. 11, 13. [http://www.rec.org/REC/Publications/SEA/SEAWorkshop] SEA is a process to integrate environmental considerations into the highest levels of decision-making, including proposed policies, legislation, plans and programmes. In addition, SEA should be applied early in the decision-making process, before decisions have been made and when alternatives and options are still open. Within this definition, the boundaries of SEA are only generally drawn in relation to near-equivalent processes, such as policy appraisal and integrated planning, as well as to emerging approaches to sustainability appraisal.*

B. Conservation and environmental protected areas[27]

An environmentally protected area is designated by ministerial regulation if it is characterised as:

- Watershed area, or
- Characterised by unique natural ecosystems which are different from other areas in general, or
- Naturally composed of fragile ecosystems which are sensitive and vulnerable to destruction or impacts of human activities, or
- Worthy of being conserved due to its natural or aesthetic values or amenities, and
- Not yet designated as a conservation area.[28]

The ministerial regulation declares that an environmentally protected area must have one or more of the following protective measures:

1) Land use prescriptions for preserving the natural conditions of such areas, or for preventing their natural ecosystems or aesthetic values or amenities, from being adversely impacted.
2) Prohibition of any act or activities that may be harmful, adversely affect or change, the pristine state of the ecosystems of such areas.
3) Specifying types and sizes of projects or activities to be constructed or operated in such areas and those undertaken by government agencies, state enterprises or private entities, and which such entity has the legal duty to submit reports of environmental impact assessment.
4) Determination of management approach and method specific to the management of such areas, including the scope of functions and responsibilities of relevant government agencies, for the purpose of cooperation and coordination that are conducive to efficient performance of work towards the preservation of natural conditions, ecosystems or aesthetic values and amenities in such areas.
5) Prescriptions of any other protective measures, which are proper and suitable to the conditions of such areas.[29]

These measures are also used to control and solve environmental problems, which assume such critical proportions, that an immediate action has become imperative, and where no action has been taken by the government agencies concerned to rectify the situation due to a lack of clear legal authorisation or otherwise failure to do so, in a conservation area, a master town and country plan area, a specific town and country plan area, a building control area, industrial estate area, and a pollution control area.[30]

In the case of seagrass areas, the Minister of MONRE, with the advice of the NEB, could designate such areas to be Conservation and environmental protected areas. That would accomplish the objective of protecting seagrass when such areas are not in a conserved area, such as a national park. It also has more advantages, since the Minister has to establish the preventive measures at the same time as designating the Conservation and environmental protected area. Such preventive measures should be more suitable in managing seagrass. However, the process of designating an area is slow.

3) The Fisheries Act B.E. 2490 (AD 1947)

The objective of the Fisheries Act is to protect the water resources, which are characterised as *the fishing areas*.[31] According to Section 19, it prohibits any person:

- To fish or culture aquatic animals, unless they receive permission from the Director of Department of Fisheries. They must act according to the law.

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[27] *Currently, there are ministerial regulations announcing the following areas as environmentally protected areas: some parts of the sea of Pattaya City, a part of Phuket, some parts of the sea of Krabi, and NaChuen in Maha Sarakham Province.*

[28] *Section 43 of the NEQA.*

[29] *Section 44 of the NEQA.*

[30] *Section 45 of the NEQA.*

[31] *Section 4 (5) of the Fisheries Act. "Fishing Area" means beach, the sea that Thailand has the rights to fish in, and area where there is still water or flowing water such as sea, river, canal and pond etc. including public property. The public property includes forest and land whether it is public property or not where is flood in the rainy season.*

- To construct anything in a public fishing area, without official permission
- To throw away, discharge, or do anything, which results in a toxic substance (according to the Government Gazette)[32] being present in the fishing area.
- Commit an act that causes aquatic animals to be disoriented.
- To throw away, discharge, or do anything, which results in the presence of a substance in the fishing area that may harm the aquatic animal or pollute the fishing area, except for scientific experiments allowed by the authority.

Finally, in relation to fishing activities, there is a prohibition on the use of certain types of fishing gear within 3 kilometres of the coastline and a three-month prohibition of fishing during the spawning period of specific economically important fish species in the Gulf of Thailand.

The Fisheries Act has been the centre of discussion, as to whether seagrass should be regulated as an "aquatic animal" and therefore protected under this Act. At present, seaweed is an "aquatic animal" under the Act. There are two sides to the argument. One side says that the Court, when deciding the case, usually considers according to the definition of the related Act, not the general meaning. Therefore, seagrass even though it is not an "aquatic animal", could be under this Act.

Shrimp farms, which have a damaging impact on mangroves, and indirectly by sediment to seagrass, are also regulated by the Ministerial Notification in B.E. 2541 announced under the Fisheries Act. The Act requires the farmer to:

- Register with the authority,
- Have a wastewater treatment pond, and
- Discharge waste according to the Ministerial Notification.[33]

4) The National Park Act B.E. 2504 (AD 1961)

Section 16 of the Act stipulates that within the national park, persons are forbidden to change the course of, overflow, or dry up the water, in a river, creek, swamp or marsh. The Act also bans actions, which endanger or deteriorate water.[34] If the violation causes a change in condition of anything in the national park, the official has the power to order the offender to restore such thing to its former condition. The official may take the action by himself, if the offender fails to comply. However, the offender must pay for such expenses.

In addition, it is prohibited:

- To collect, take, or do anything resulting in the deterioration of wood, minerals or other resources within the National Park.
- To ride a vehicle in an area not established for such purpose, except if permission is given from an official.

5) The Wildlife Preservation and Protection Act B.E. 2535 (AD 1992)

Within the Wildlife Reserve as well as the no-hunting area, it is an offense to change a waterway, overflow, dry or poison a river, canal, swamp or pond. However, in the no-hunting area, a person can ask for permission to do such act from the authorities. Violators can be imprisoned for a term not exceeding seven years or be fined an amount not exceeding *one hundred thousand baht* or both.

This Act does not include penalties for harm to the habitat of the endangered species, dugong situated outside the Wildlife Reserve area. It should, since the major cause of extinction is the loss of habitat.

6) The Cabinet's decision

Many of Cabinet's decisions concern coastal resources. However, not much materialises from the decisions.

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[32] *The Ministerial Notification dated January 20, B.E. 2532 (AD 1989).*

[33] *The Ministerial Notification dated December 21, B.E. 2541 (AD 1998).*

[34] *The violator is liable to imprisonment for a term not exceeding five years or a fine not exceeding twenty thousand baht or both.*

3.2 International Laws and Seagrass Management in Thailand

Thailand became a Member of Ramsar Convention on Wetlands on 13 September 1998 and now has listed 10 sites as wetlands of international importance.

On 29 January 2004, the Convention on Biological Diversity (CBD) was enforced in Thailand. The Thai Biodiversity Policy and Plan, which implements the Convention in Thailand, mentions the plan to study and conserve the seagrass beds in Thailand.

Besides the international agreements, Thailand is also a Party to the Association of Southeast Asian Nations – ASEAN, which is a regional organisation.[35] The ASEAN agreements that declare to protect environment are:

- Prohibition on construction of anything in a public fishing area, without official permission
- Bangkok Declaration on the ASEAN Environment (Bangkok), 29 November 1984[36]
- ASEAN Declaration on Heritage Parks[37]
- Agreement on the Conservation of Nature and Natural Resources (Kuala Lumpur), 9 July 1985[38]
- Jakarta Resolution on Sustainable Development (Jakarta), 30 October 1987[39]
- The Kuala Lumpur Accord on Environment and Development Issued by the ASEAN Ministers for the Environment at the Fourth ASEAN Meeting of Ministers for the Environment (Kuala Lumpur), 19 June 1990[40]

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[35] *ASEAN was established on 8 August 1967 by the five original Member Countries, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand. Brunei Darussalam joined on 8 January 1984, Viet Nam on 28 July 1995, Laos and Myanmar on 23 July 1997, and Cambodia on 30 April 1999. The highest decision-making organ of ASEAN is the Meeting of the ASEAN Heads of State and Government. The ASEAN Summit is convened every 3 years. The ASEAN Ministerial Meeting (Foreign Ministers) is held on an annual basis. Ministerial meetings on several other sectors are also held: agriculture and forestry, economics, energy, environment, finance, information, investment, labour, law, regional haze, rural development and poverty alleviation, science and technology, social welfare, transnational crime, transportation, tourism, youth, the AIA Council, and the AFTA Council. Supporting these ministerial bodies are 29 committees of senior officials and 122 technical working groups. ASEAN cooperation on the environment began in 1977, when the ASEAN Sub-Regional Environment Programme 1 (ASEP) was drafted with assistance from the United Nations Environment Programme (UNEP). ASEP I was implemented by the ASEAN Expert Group on the Environment (AEGE) under the purview of the ASEAN Committee on Science and Technology (COST). The first AEGE meeting was convened in December 1978 for consideration of ASEP I objective. Subsequently, other ASEPs were developed and implemented annually. [http://www.aseansec.org/]*

[36] *[http://www.aseansec.org/1494.htm] Bangkok Declaration emphasises the desire to strengthen and enhance ASEAN regional cooperation. In the field of environmental protection, to meet the increasing and challenging environmental problems of the ASEAN region in the decade ahead, and to this end adopt the objectives and policy guidelines.*

[37] *[http://www.aseansec.org/15524.htm] The Declaration signed on 29 November 1984. It declared Koh Tarutao National Park and Ao Phangnga, Mu Koh Surin, Mu Koh Similan Marine National Park (among others) to be ASEAN Heritage Parks. As a result, ASEAN Members agree that common cooperation is necessary to conserve and manage ASEAN Heritage Parks for the development and implementation of regional conservation and management action plans as well as regional mechanisms complementary to, and supportive of, national efforts to implement conservation measures.*

[38] *[http://www.aseansec.org/1490.htm] In Article 3, the Agreement requires the Contracting Parties to, wherever possible, maintain maximum genetic diversity by taking action aimed at ensuring the survival and promoting the conservation of all species under their jurisdiction and control. To that end, they must adopt appropriate measures to conserve animal and plant species whether terrestrial, marine and freshwater, and more specifically (a) conserve natural, terrestrial, freshwater and coastal or marine habitats; (b) ensure sustainable use of harvested species; (c) protect endangered species; (d) conserve endemic species; and (e) take all measures in their power to prevent the extinction of any species or sub-species.*

[39] *[http://www.aseansec.org/1488.htm] The ASEAN member countries agree to adopt the principle of sustainable development to guide and to serve as an integrating factor in their common efforts. In addition, the ASEAN cooperative efforts be focused upon those common resources and issues that affect the common well-being of the people, of ASEAN, including, but not be limited to:*

- *The common seas;*
- *Land-resources and land-based pollution;*
- *Tropical rain-forces;*
- *Air quality; and*
- *Urban and rural pollution.*

[40] *[http://www.aseansec.org/1096.htm] The ASEAN Ministers for the Environment agree to initiate efforts leading towards concrete steps pertaining to environmental management, including:*

a. *The formulation of an ASEAN strategy for sustainable development and a corresponding action programme,*
b. *The harmonisation of environmental quality standards,*
c. *The harmonisation of transboundary pollution prevention and abatement practices,*
d. *The undertaking of research and development, and the promotion of the use of clean technologies.*

- Singapore Resolution On Environment And Development (Singapore), 18 February 1992[41]
- Bandar Seri Begawan Resolution on the Environment and Development 26 April 1994[42]
- Jakarta Declaration on Environment and Development 18 September 1997[43]
- Ha Noi Plan of Action[44]
- Kota Kinabalu Resolution on the Environment (Kota Kinabalu, Sabah, Malaysia) 2000[45]
- Yangon Resolution on Sustainable Development[46]

The ASEAN Ministers also consent to initiate efforts leading towards concrete steps pertaining to natural resource management, including:

a. the harmonisation of approaches in natural resource assessment,
b. the development of joint natural resource management programmes,
c. the development and harmonisation of procedures aimed at obtaining a better reflection of the state of natural wealth in the context of the System of National Accounts.

[41] *[http://www.aseansec.org/1187.htm] ASEAN member countries shall intensify cooperation in environmental management and protection in their common pursuit of sustainable development. In this regard, member countries shall work collectively towards the improvement of environmental quality, harmonisation of standards, and jointly promote the application, transfer and development of appropriate environmental technologies. Moreover, ASEAN shall continue to actively participate in and support international efforts in promoting the principles of sustainable development.*

[42] *[http://www.aseansec.org/2172.htm] The ASEAN Ministers for the Environment agree to adopt and implement the ASEAN Strategic Plan of Action on the Environment to (i) respond to specific recommendations of Agenda 21 requiring priority action in ASEAN; (ii) introduce policy measures and promote institutional development that encourage the integration of environmental factors in all developmental processes both at the national and regional levels; (iii) establish long-term goals on environmental quality and work towards harmonised environmental quality standards for the ASEAN region; (iv) harmonise policy directions and enhance operational and technical cooperation on environmental matters, and undertake joint actions to address common environmental problems; and (v) study the implications of AFTA on the environment and take steps to integrate sound trade policies with sound environmental policies. Furthermore, Bandar Seri Begawan Resolution declare 1995 as the ASEAN Environment Year to highlight ASEAN environmental issues and cooperative programmes, and to stimulate awareness of these issues among the ASEAN populace; broaden the participatory process in the area of the environment in ASEAN; and stimulate regional activities in the area of the environment.*

[43] *[http://www.aseansec.org/1910.htm] The ASEAN Ministers for the Environment agree to use, conserve, protect, restore and manage natural resources and the environment, including the conservation of biodiversity, in ways that help ensure long-term social, economic, and environmental benefits for current and future generations.*

[44] *[http://www.aseansec.org/687.htm] The Second ASEAN Informal Summit, held in Kuala Lumpur on 15 December 1997, adopted the ASEAN Vision 2020 which sets out a broad vision for ASEAN in the year 2020: an ASEAN as a concert of Southeast Asian Nations, outward looking, living in peace, stability and prosperity, bonded together in partnership in dynamic development and in a community of caring societies. In order to implement the long-term vision, action plans are being drawn up to realise this vision. The Hanoi Plan of Action (HPA) is the first in a series of plans of action building up to the realisation of the goals of the vision. The HPA has a six-year timeframe covering the period from 1999 to 2004. The progress of its implementation shall be reviewed every three years to coincide with the ASEAN Summit Meetings.*

[45] *[http://www.aseansec.org/650.htm] The ASEAN Ministers for the Environment agree to synergise the ASEAN Strategic Plan of Action on the Environment with the Regional Action Plan for Environmentally Sound and Sustainable Development, 2001-2005 for Asia and the Pacific Region with a view to (i) optimise the utilisation of limited resources in the implementation of the planned activities; (ii) accelerate our efforts in the realisation of the Regional Action Plan for the Protection of the Marine Environment from Land and Sea-based activities by the year 2004; and (iii) sustainably manage and wisely use our diverse biological resources and to exchange information on biodiversity conservation issues including biosafety and access to biological and genetic resources.*

[46] *[http://www.aseansec.org/15522.htm] Ministers responsible for environment of the ASEAN member countries agree to work towards a plan of action with a definite timeframe to harmonise environmental policies, legislation, regulations, standards and databases, taking into account national circumstances of member countries; as well as agree to pursue the idea of creating an ASEAN Environment Fund and task the ASEAN Secretariat in consultation with the ASEAN Senior Officials on Environment to develop the modalities for setting up such a fund.*

3.3 Institutional Arrangements Relevant to Seagrass Management

3.3.1 Policy Bodies

Level	Organisations	Duties
National	Office of Natural Resources and Environmental Policy and Planning (ONEP) [http://www.onep.go.th]	• Make Policy and Plans on natural resources and environmental conservation and management. (including seagrass) • Coordinate and make plans on natural resources and environmental management according to the Enhancement and Conservation of National Environmental Quality Act and other related regulations, including coordination of regulation implementation.
National	Office of the National of Economic and Social Development Board [http://www.nesdb.go.th/]	Advise policy on national economic and social development, which incorporates environmental management.
National	Department of Marine and Coastal Resources [http://www.dmcr.go.th]	Make suggestions for policy and planning of marine and coastal resources conservation, rehabilitation and management.
National	Pollution Control Department [http://www.pcd.go.th]	Suggest policy and plans for the enhancement and conservation of national environmental quality, in particular pollution control.
National	Department of Environmental Quality Promotion (DEQP) [http://www.deqp.go.th]	Coordinate and suggest plans and measures for the promotion and dissemination of natural resources and environmental conservation. (supporting seagrass bed education)
Province (Changwat)	Provincial Administration Organization (PAO) [http://www.thailocalgov.net/]	Make Provincial Administration Organisation development plans and coordinate Province development plans in accordance with the Cabinet's regulations. (The plans could include the conservation of seagrass beds.)

3.3.2 Monitoring Bodies

National	ONEP	Monitor and evaluate the implementation of policy, plans and measures, as well as producing an annual environmental outlook of Thailand. (Report on the seagrass bed situation every year.)
	PCD	Monitoring environmental quality and producing pollution reports. (See the trend of pollution in Thailand.)

3.3.3 Coordinating Bodies

National	ONEP	• Coordinate the cooperation between Thai and foreign organisations in implementing policy and plans of natural resources and environmental conservation and management. • Coordinate the implementation of international agreements with international organisations relevant to the Biological Diversity Convention, Ramsar Convention and other international agreements. (which related to seagrass bed conservation as stated in section 5.1.2)
National	DMCR	• Coordinate cooperation with international and foreign organisations on marine and coastal resources.
National	PCD	• Coordinate and execute the rehabilitation of contaminated sites and halt pollution occurrence, as well as assess environmental impact. • Coordinate and cooperate with other countries and international organisations in pollution management.
Province	PAO	• Coordinate and cooperate with other local administration organisations.

3.3.4 Research Bodies

National	DMCR	Study, research and develop the conservation and rehabilitation of marine and coastal resources, including threatened and endangered species.
National	Department of Fisheries [http://www.fisheries.go.th/]	Study and research fisheries and aquatic resources utilisation management.
National	Land Development Department [http://www.ldd.go.th]	Study and research land utilisation for policy making on land utilisation and development.
National	PCD	Develop appropriate methods for treatment of wastes, hazardous wastes and water quality.
National	DEQP	Research, study, develop and promote environmental management, including clean technology.

3.3.5 Statutory Bodies

National	DMCR	• Submit the amendment of measures and regulations related to conservation, rehabilitation, management and utilisation of marine and coastal resources for sustainable development. • Oversee, evaluate and monitor the measures and regulations.
National	Department of Fisheries	• Execute the Fisheries Act, the Wildlife Conservation Law and other related laws. • Establish measures of fisheries and aquatic utilisation, as well as control and enforce fisheries in freshwater and sea.
National	PCD	• Suggest environmental quality standards and effluent standards. • Establish measures in control and prevent pollution problems. • Act upon pollution complaints. • Execute the Enhancement and Conservation of National Environmental Quality Act, in particular the pollution issues, and other related laws.
National	Department of Mineral Resources [http://www.dmr.go.th]	• Execute the Mineral Act. • Suggest amendment of measures and regulations related to mineral resources.
National	Royal Forest Department [http://www.forest.go.th/] & National Park, Wildlife and Plant Conservation Department [http://www.dnp.go.th]	Enforce the forest laws, indirectly impacting seagrass beds.
National	Marine Police Division [http://www.police.go.th/]	Enforce the Fisheries Act and Navigation in Thai Waterways Act.
National	Royal Thai Navy [http://www.navy.mi.th/]	Enforce: • the Minerals Act B.E. 2510 • the Fisheries Act B.E. 2490 • the Navigation in Thai Waterways Act B.E. 2456 • the National Park Act B.E. 2504 • the Petroleum Act B.E. 2514 etc.
Province	PAO	Promulgate own regulations.
Local Administration	Pattaya	Promulgate own regulations.
Local Administration	Municipality	Promulgate own regulations.
Local Administration	Tambon (Sub-District) Administration Organisation	Promulgate own regulations.

3.3.6 Bodies Responsible to Promulgate Reserved Areas

National	ONEP	Study, analyse, coordinate and establish measures for promulgation of conservation and environmental protected areas.
	DMCR	Suggest areas that should be conserved for marine and coastal resources management.

3.3.7 *Public Participation*

National	DMCR	Encourage public participation in conservation and rehabilitation of marine and coastal resources.
	DEQP	Encourage public participation in conservation and utilisation of natural resources in sustainable way, including being a centre for dispute resolution on environmental matters.

3.3.8 *Information Centre*

National	DMCR	Research Centre for national marine and coastal resources.
National	Department of Fisheries	Develop fisheries data system.
National	DEQP	• Promote and distribute environmental matters. • Be an information centre on the environment.
National	Department of Agricultural Extension [http://www.doae.go.th/]	Develop, encourage and coordinate fisheries and farming knowledge to farmers.
National	Department of Agriculture [http://www.doa.go.th/]	• Advise on soil, water, fertiliser, plant and agricultural related products. • Transfer agricultural technologies knowledge.

4. MANAGEMENT PERSPECTIVES AND THE DEVELOPMENT OF THE NATIONAL SEAGRASS ACTION PLAN

Rationales

The resolutions and management interventions for the protection, rehabilitation, and sustainable utilisation of Thailand's seagrass ecosystem must proceed in accordance with the notion of solving problems at their roots. The management objectives aim at solving major issues such as the reduction of sedimentation on seagrass beds, which is the result of oceanographic disturbances, i.e., channel dredging, construction of breakwaters and ports, coastal developments, and other activities. Moreover, it is necessary to promote better understanding and recognition of the significance of the seagrass ecosystem. This can be achieved through integrated research and the application of appropriate knowledge. All activities must include public involvement, which begins by listening to problems and comments as well as actual participation in the management processes.

Vision

"Thailand's seagrass ecosystem is protected and rehabilitated to maintain ecological abundance alongside traditional utilisation and sustainable development."

Mission

1) Solve problems related to the degradation of the seagrass ecosystem.
2) Establish protocols for the management of seagrass beds through public involvement.

Main Objectives

Both the government and public sector will systematically manage Thailand's major seagrass areas. The objectives are to:

1) Establish a widely accepted and efficient system for the protection and management of seagrass beds.
2) Conduct scientific research in order to support systematic management of the seagrass ecosystem.
3) Provide accurate knowledge and proper understanding regarding the seagrass ecosystem to the general public though effective media.
4) Promote public awareness regarding the importance and significance of the seagrass ecosystem through effective media.
5) Improve existing law enforcement procedures and establish new regulations in order to successfully protect and manage Thailand's seagrass ecosystem.
6) Rehabilitate degraded seagrass beds and adjacent ecosystems.
7) Promote alternate fishing methods and occupations in order to reduce the impact of fishery activities on seagrass beds.

Strategies of Action Plans

According to the action plans, the major component of the protection of seagrass ecosystems is to solve problems at their root, which will have both direct and indirect impacts, through the involvement of stakeholders, including the local communities. Such involvement begins with preliminary surveys and includes the establishment of organisations and suitable management guidelines. This can be facilitated by providing accurate information on sustainable utilisation and conservation of seagrass resources.

Strategies and Management Interventions

The strategies to achieve the envisioned outcomes are as follows:

1) Encourage community involvement in the management of seagrass beds.
2) Promote knowledge, understanding, and awareness among citizens and officials.
3) Reduce causes of the degradation of the seagrass ecosystem, resulting from various activities.

In compliance with the vision, the necessary management interventions are as follows:

1) Promote local assembly and develop the government's capacity in efficiently managing the seagrass ecosystem.
2) Conduct integrated research to manage the seagrass beds and to evaluate the success of the programme.
3) Provide knowledge and promote public awareness regarding the values and the importance of the seagrass ecosystems among communities, local organisations, and government officials.
4) Apply legal measures for the protection of seagrass beds and environmental quality.
5) Rehabilitate degraded seagrass ecosystems as well as related ecosystems.
6) Promote alternate fishing methods and occupations as sources of income in order to reduce the impact of fishery activities on seagrass beds.

Management Interventions, Plans, and Projects

To achieve the determined objectives, there are 6 management interventions, which include action plans and projects. They are as follows:

Intervention 1. **Promote local assembly and develop the government's efficiency in managing the seagrass ecosystem.**

1. Integrated promotion of seagrass resource management.
   - 1.1 Establish national and local seagrass committees.
   - 1.2 Organise public meetings among local residents and officials to provide proper knowledge and understanding regarding the seagrass ecosystem and to assess and update information on current conditions.
   - 1.3 Organise annual meeting on the status and management of seagrass beds to revise, adapt, and determine suitable resource management guidelines, which are consistent with current conditions.
   - 1.4 Organise training and workshops in order to allow exchange of ideas and experiences among related personnel from the Andaman Sea, Gulf of Thailand, and South China Sea.
2. Developing efficient human resources for the management of seagrass beds.
   - 2.1 Organise workshops and training on seagrasses and their management, for government officials, local organisations, and stakeholders.
   - 2.2 Facilitate the involvement of Local Administration Organisations in the management of seagrass beds.
   - 2.3 Develop and improve seagrass-related knowledge among personnel working on seagrass.
3. Thailand's National Master Plan for the Management of Seagrass Ecosystems 2007 to 2012.
   - 3.1 Prepare the National Master Plan for the Management of Seagrass Ecosystems 2007 to 2012.

Intervention 2. Conduct integrated research to properly manage seagrass beds.

1. Research into the management of seagrass beds.
   - 1.1 Study the distribution of seagrass and biodiversity on seagrass beds.
   - 1.2 Study the potential of using seagrass in the wastewater treatment processes, both inside and outside the natural areas.
   - 1.3 Conduct surveys on the number of fishers, fishing gears, and the economy of the fishing communities in areas with seagrass beds.
   - 1.4 Investigate the impacts of fishery activities on seagrass beds.
   - 1.5 Study the currents and sedimentation rates in areas with seagrass beds.
   - 1.6 Investigate the impacts of aquaculture activities on the seagrass ecosystem.
   - 1.7 Investigate the impacts of coastal developments on the seagrass ecosystem.
   - 1.8 Study the aquaculture of economic species on seagrass beds.
   - 1.9 Investigate the impacts of environmental changes on seagrass.
   - 1.10 Assess the economic values of seagrass resources.
   - 1.11 Conduct research related to the rehabilitation of seagrass beds.
   - 1.12 Conduct surveys on the perceptions and economy of the surrounding communities adjacent to the seagrass beds.
2. Monitoring environmental quality and problems in areas with seagrass beds.
   - 2.1 Monitor the contamination of heavy metals in the water, sediments, and economically important species at risk.
   - 2.2 Introduce nutrient and phytoplankton monitoring programmes.
3. Construction and development of seagrass geographical information systems.
   - 3.1 Create a seagrass database using geographical information system and remote sensing.
   - 3.2 Modify seagrass database.
   - 3.3 Launch a seagrass website with data on seagrass, environmental condition, and other activities.

Intervention 3. **Provide knowledge and promote public awareness regarding the values and the importance of the seagrass ecosystems among communities, local organisations, and government officials.**

1. Provide proper knowledge and understanding of the seagrass ecosystem.
   - 1.1 Publish informative documents to provide knowledge and promote better understanding of the seagrass ecosystem.
   - 1.2 Produce plastic keys to the identification of seagrass and seagrass fauna for students and the public.
   - 1.3 Produce seagrass maps and posters conveying knowledge on seagrass ecosystems.
   - 1.4 Develop teaching aids in seagrass ecology for students and local communities.
   - 1.5 Organise seagrass seminars and workshops for government officials and press personnel.
   - 1.6 Organise seagrass ecology workshops for teachers in schools near seagrass beds.
   - 1.7 Promote knowledge regarding seagrass ecosystems at schools near seagrass beds.
   - 1.8 Organise youth seminars and training courses on the conservation of fishery resources.
   - 1.9 Organise meetings for the marine and coastal resources protection volunteer network.
2. Raise awareness of the value and significance of the seagrass ecosystem.
   - 2.1 Organise brainstorming seminars to gather local knowledge pertaining to seagrass ecology.
   - 2.2 Organise workshops to build positive impressions towards sustainable local fishery practices.
   - 2.3 Organise marine science camps for students.
   - 2.4 Promote and provide information, understanding, and awareness regarding the value and importance of seagrass ecosystems through national and local media.
   - 2.5 Create signs promoting the value of seagrass, to be installed in different communities.

2.6 Create a campaign discouraging the catching and consuming of gravid individuals during their reproductive and egg-laying periods.

2.7 Organise drawing, slogan, and essay competitions to raise awareness of the significance and value of seagrass ecosystems.

Intervention 4. **Apply legal measures for the protection and rehabilitation of seagrass beds and environmental quality.**

1. Improve existing laws, policies, regulations, and rules for the utilisation of seagrass beds.
   1.1 Revise the provincial development plans, which are likely to impose impacts on the environmental qualities of seagrass beds.
   1.2 Reconsider the desire of the communities to be involved in the management of coastal resources.
   1.3 Modify existing laws in order to allow communities to be involved in the management of the seagrass ecosystem.
   1.4 Issue guidelines to all projects in the watershed areas, which relate to the seagrass beds, for the prevention of topsoil erosion and sediment disturbance caused by activities within the areas.
   1.5 Prohibit the use of destructive fishing gears on seagrass beds.
   1.6 Establish wastewater standards for aquaculture practices and enforce regulations regarding wastewater treatment before discharge into the natural environment.
   1.7 Designate seagrass resource utilisation zones.
   1.8 Advocate for the declarations of watersheds connected with seagrass beds, as environmental protected areas.
   1.9 Advocate for the declarations of major seagrass beds as Ramsar Sites.
2. Solving problems related to wastewater discharge onto seagrass beds.
   2.1 Revise the current plans for sewage and treatment systems and propose plans for improvement.
3. Eradication of activities that have environmental impacts on seagrass beds.
   3.1 Monitor all activities, which pose impacts on seagrass beds, through community involvement.

Intervention 5. **Rehabilitate seagrass ecosystems.**

1. Rehabilitation of seagrass beds and seagrass resources.
   1.1 Rehabilitate degraded seagrass beds.
   1.2 Produce aquatic seedlings to replenish the natural stock on seagrass beds.
   1.3 Modify or ban destructive fishing gears.

Intervention 6. **Promote alternate fishing methods and occupations in order to reduce the impact of fishery activities on seagrass beds.**

1. Promotion of aquaculture practices.
   1.1 Promote aquaculture of marine species and algae that do not negatively impact the seagrass beds.
2. Promotion of ecotourism in areas with seagrass beds.
   2.1 Encourage local communities to be guides for ecotourism in areas with seagrass beds.
   2.2 Organise guide training for local residents.
   2.3 Publish handbooks to introduce seagrass ecotourism.
   2.4 Promote shorebird and migrating bird watching.
   2.5 Publish guidebooks of mangrove flora and fauna for tourists.

Executing Period

The proposed action plans will be executed over a period of 5 years. The details of action plans, projects, and activities under the six proposed management interventions are shown in National Action Plan for Thailand Seagrass.

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ANNEX 1

The occurrence of seagrasses in the Gulf of Thailand.

Seagrass Site	Total Area (ha)	Seagrass Species*	Biomass of Each Species (g/m^2)	Density of Each Species (number/m^2)	Percentage Coverage (%)	Productivity ($g/m^2/d$)	Associated Habitat
Chonburi	-	CS [1,3], EA [1,3], HD [1,2], HM [1,2,3], HO [1,2,3], RM [1], HP [1,2,3], HU [2]					
Sattahip Bay	-	HP [2] HM [2]	30.93-47.06 [2] 1.14-1.36 [2]	- -	5-75 [2] 5-45 [2]	- -	-
Toey Ngam Bay	-	HP [2] HM [2]	6.44 [2] 0.0 [2]	- -	2-40 [2] 3-10 [2]	-	-
Northern Part of Pra Island	-	HM [2]	0.42-0.71 [2]	-	2-75 [2]	-	Not Associated [4]
Western Part of Pra Island	-	HO [2] HD [2]	- 1.88 [2]	-	20-70 [2] -	-	Coral [4]
Kram Island	-	HD [2,5] HM [3]	0.78 [2] -	- -	40-50 [2] -	- -	Coral [4]
Samaesarn Island	-	EA [3] HO [3] CS [3]	- - -	- - -	- - -	- - -	Coral [4]
Kham Island	-	HP [3] HU [2]	- 2.41 [2]	-	- 20 [2]	-	Coral [4]
Rayong	1,720	HP [1,6,7], HD [1,7], HM [1,7], HO [1,7], HU [1,7], CS [7]					
Khao Laem Ya	260 [7]	HU [7] HP [7] CS [7]	- - -	- - -	- - -	- - -	Not Associated [4]
Bann Phae-Suan Sonn	490 [7]	HO [7] HM [7] HD [7]	- - -	- - -	- - -	- - -	Not Associated [4]
Makhampom Bay-Prasare River Mouth	970 [7]	HP [6,7,8] HO [7,8] HU [8] HD [8]	- - - -	- - - -	- - - -	- - - -	Mangrove
Pak Klong Hua Hin	-	HP [6]	-	-	-	-	Mangrove

ANNEX 1 *cont.* The occurrence of seagrasses in the Gulf of Thailand.

Seagrass Site	Total Area (ha)	Seagrass Species*	Biomass of Each Species (g/m^2)	Density of Each Species (number/m^2)	Percentage Coverage (%)	Productivity ($g/m^2/d$)	Associated Habitat
Chanthaburi	>700	EA [1,9,10,11], HD [10], HM [10], HO [6], HP [1,6,9,10,11], HU [1,11]					
Pang Rad River Mouth	-	HP [6]	-	-	-	-	Mangrove
Khung Krabane Bay	700	EA [9,10,11] HD [10] HM [10] HO [6] HP [9,10,11]	328.06 [9] - - - 21.77 [9]	- - - - -	45.82 [9] - - - 35.35 [9]	- - - - -	Mangrove/Coral [4]
Trat	>13.7	HB [1], HD [1,12,13], EA [1,12,14], HO [1], HP [1,12], HU [1,12], CS [12]					
Bann Klong Hin-Bann Klong Muang	12 [12]	HD [12] HU [12]	- -	- -	- -	- -	-
Mai Rud Bay	0.5 [12]	CS [8,12] EA [8,12] HP [8,12]	- - -	- - 1,104 [12]	- - -	- - -	-
Thammachat Bay-Pui Island	-	CS [8,12] EA [8,12] HU [8,12]	- - -	192 [12] 40 [12] 24 [12]	- - -	- - -	-
Kluay Bay, Kud Island	-	CS [8,12] HU [8,12]	- -	995 [12] 37 [12]	- -	- -	Coral [4]
Kradad Island	-	HO [8] CS [8] HD [13] EA [8,14]	- - - -	- - - -	- - - -	- - - -	Coral [4]
Khao Lan-Laem Klad	1.2 [12]	HU [8,12] HD [8,12]	- -	- -	- -	- -	-
Koh Rang	-	CS [8]	-	-	-	-	Coral [4]
Koh Rad	-	HP [8] CS [8]	- -	- -	- -	- -	Coral [4]
Sabparod Bay-Bann Nontri, Chang Island	-	HD [8]	-	-	-	-	Coral [4]
Phetchaburi		RM [14]					
Pak Klong Bang Kra Noi-Pak Klong Bang Kra Yai	-	RM [14]	-	-	-	-	Mangrove
Prachuap Khiri Khan		HO [1], HP [1]					
Manao Bay	-	HO [1] HP [1]	- -	- -	- -	- -	Coral [4]
Chumphon	-	EA [12], HB [15,16]					
Mao Bay	1 [12]	EA [12]	-	30-50 [12]	-	-	-

ANNEX 1 *cont.* The occurrence of seagrasses in the Gulf of Thailand.

Seagrass Site	Total Area (ha)	Seagrass Species*	Biomass of Each Species (g/m^2)	Density of Each Species (number/m^2)	Percentage Coverage (%)	Productivity ($g/m^2/d$)	Associated Habitat
Chumphon Island National Park		HB [12,15]					Mangrove/Coral [4]
- Thung Ka Bay	423 [15]	HB [15]	-	-	-	-	
- Pak Klong Wisai	302 [15]	HB [15]	-	-	-	-	
- Sawee Bay	355 [15]	HB [15]	-	-	-	-	
Surat Thani	>1,072	EA [1,12,17], TH [1,12], HB [1], HD [12,17], HB [12,17], HO [1,12,17], HU [1,12,17]					
Samrong Cape, Samui Island	150 [12]	EA [12]	-	-	-	-	Not Associated [4]
		HD [12]	-	-	-	-	
		HM [12]	-	-	-	-	
		HO [12]	-	-	-	-	
		HU [12]	-	-	-	-	
Chon Khram Bay, Samui Island	500 [12]	EA [12]	-	-	-	-	Coral [4]
		HD [12]	-	-	-	-	
		HM [17]	0.053-2.232 [17]	-	5.00-6.67 [17]	-	
		HO [17]	0.144-2.308 [17]	-	5.00-7.50 [17]	-	
		HU [17]	34.733-64.616 [17]	-	41.50-65.00 [17]	-	
Pang Ga Bay, Samui Island	-	EA [12]	-	-	-	-	Coral [4]
		HU [12]	-	-	-	-	
		HD [17]	0.17 [17]	-	10 [17]	-	
		HM [17]	0.012 [17]	-	5 [17]	-	
		HO [17]	0.919 [17]	-	23 [17]	-	
Chaweng Bay-Mad Lang Island, Samui Island	100 [12]	EA [12]	229.83-645.37 [17]	50-70 [12]	40-56.8 [17]	-	Coral [4]
Laem Yai Bay, Samui Island	20	HU [17]	-	4.788-6.326 [17]	-	-	Coral [4]
		HO [17]		0.602-0.935 [17]			
		HM [17]		0.049 [17]			
Nai Wok Bay, Pha Ngan Island	-	EA [12], TH [12]	total 413.36 [12]	total 100 [12]	-	-	Coral [4]
Wok Tum Bay, Pha Ngan Island	300 [12]	EA [12]	-	80-100 [12]	-	-	Coral [4]
		HU [12]	-	-	-	-	
Tok Bay, Tan Island	-	EA [18]	-	-	-	-	Coral [4]
		HO [18]	-	-	-	-	
Tham Island-Thalai Island	2 [12]	HU [12]	-	30-50 [12]	-	-	-
Nakhon Si Thammarat	2.2	EA [1,6], TH [1,6], HO [1], HU [1,6]					
Tha Rai Island	2.2 [6]	EA [6]	-	-	total 15 [6]	-	-
		HU [6]	-	-		-	
		TH [6]	-	-		-	
Phatthalung	-	HP [19], HB [19]					
Tha Yang Bay	-	HP [19]	-	-	-	-	-
Bann Koh Yuan	-	HB [19]	-	-	-	-	-

ANNEX 1 *cont.* The occurrence of seagrasses in the Gulf of Thailand.

Seagrass Site	Total Area (ha)	Seagrass Species*	Biomass of Each Species (g/m^2)	Density of Each Species (number/m^2)	Percentage Coverage (%)	Productivity ($g/m^2/d$)	Associated Habitat
Songkhla	>2.1	HB [1,19], HO [1,19], HP [1,19], HU [19], RM [1]					
Sai Kaew Beach	1.5 [19]	HP [19] HU [19]	- -	- -	total 10 [19]	- -	-
Bann Tai Sor	-	HB [19]	-	-	-	-	-
Chak Cape	-	HB [19]	-	-	-	-	-
Bann Bang Nod	0.1 [19]	HB [19]	-	-	5 [19]	-	-
Coastal Aquaculture Research Station	-	HB [19]	-	-	-	-	-
Pak Klong Na Thab	0.5 [19]	HO [19] HU [19]	- -	- -	- -	- -	-
Pattani	>425.7	HB [1,19,20], HO [1,19,20], HP [19], HU [1,19,20], RM [19,20]					
Pak Klong Ya Moo	150 [19]	HB [19] HO [19] HU [19]	- - -	- - -	total 10 [19]		-
Pattani Bay - Ta Chee Cape - Bann Bang Poo	 total 273.6 [19]	 HU [20] HO [20] HB [19,20] HO [19,20] RM [19,20]	 221.0-254.6 [20] 21.6-86.6 [20] 174.6-212.07 [20] - -	 - - - - -	 - - total 72 [19]	 - - - - -	Mangrove
Chala Lai Beach	2.1 [19]	HP [19] HU [19]	- -	- -	total 16 [19]	- -	-
Narathiwat	3.9 [19]	HB [19], HU [19]					
Manao Bay	0.6 [19]	HU [19]	-	-	39 [19]	-	-
Klong Tak Bai	3.3 [19]	HB [19] HU [19]	- -	- -	total 39 [19]	- -	-

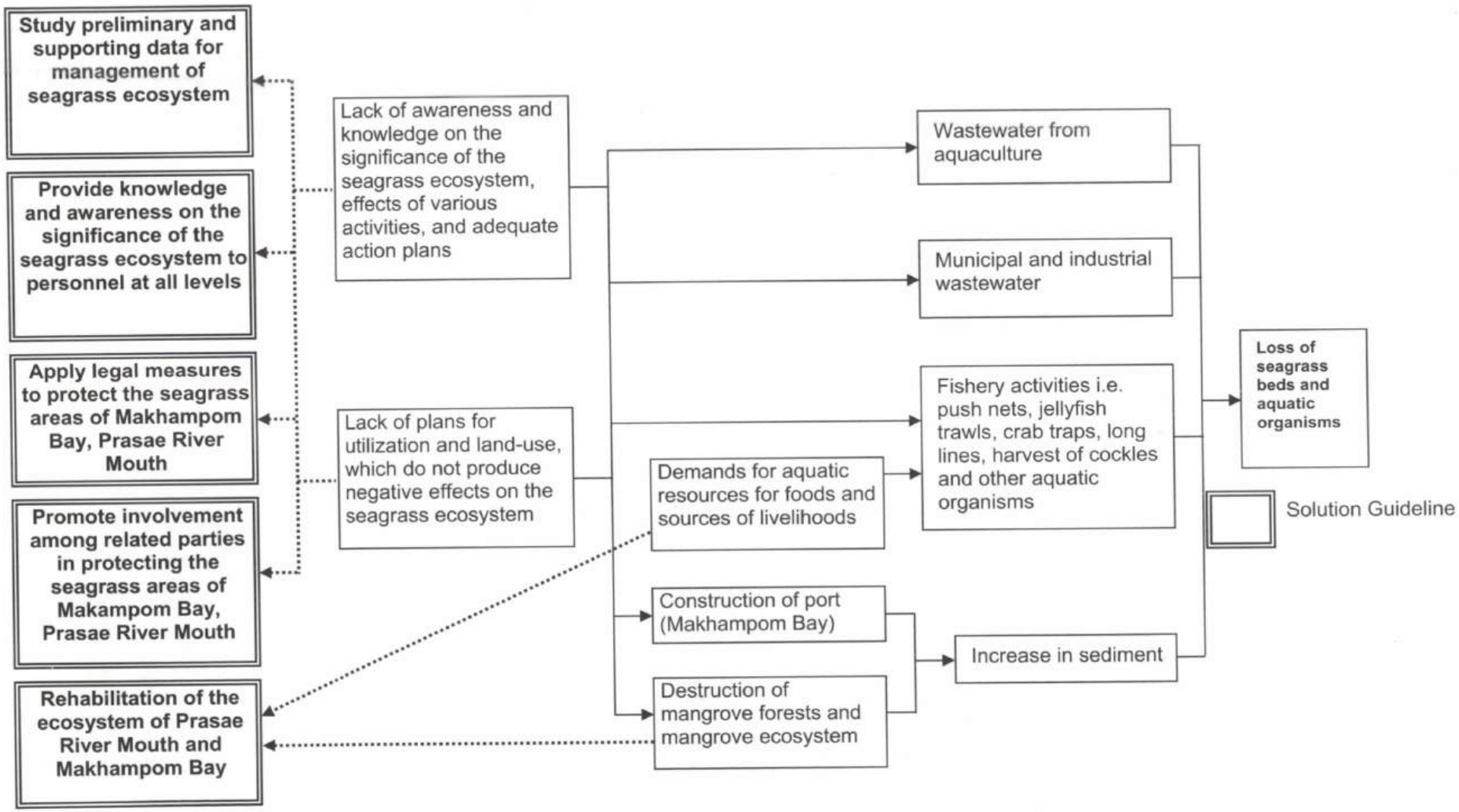
Remark :

* Seagrass Species

- EA: *Enhalus acoroides*
- HB: *Halophila beccarii*
- HD: *Halophila decipiens*
- HM: *Halophila minor*
- HO: *Halophila ovalis*
- HP: *Halodule pinifolia*
- HU: *Halodule uninervis*
- CS: *Cymodocea serrulata*
- RM: *Ruppia maritima*
- TH: *Thalassia hemprichii*

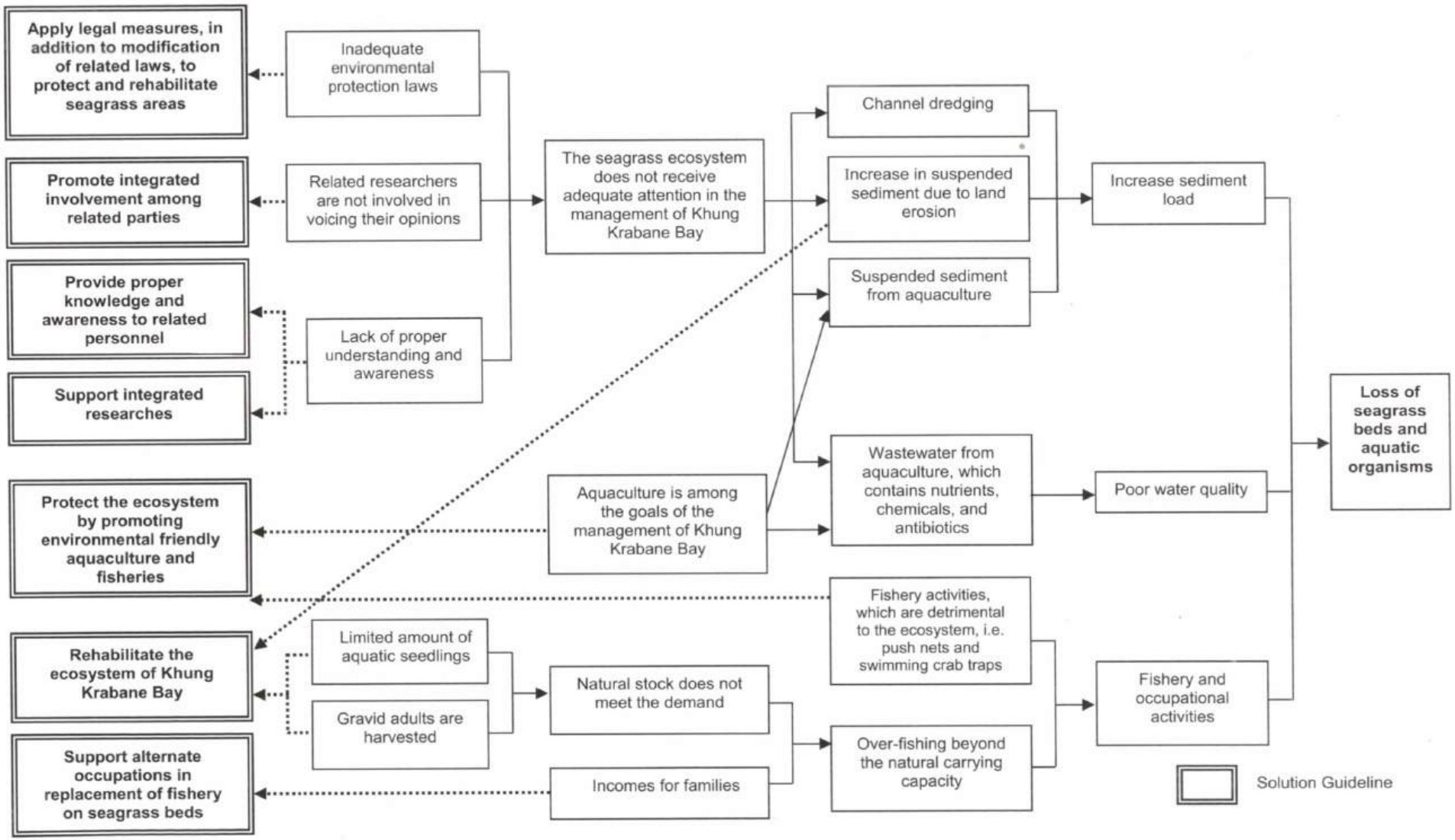
ANNEX 2

Causal chain analysis for Makhampom Bay, Rayong Province.



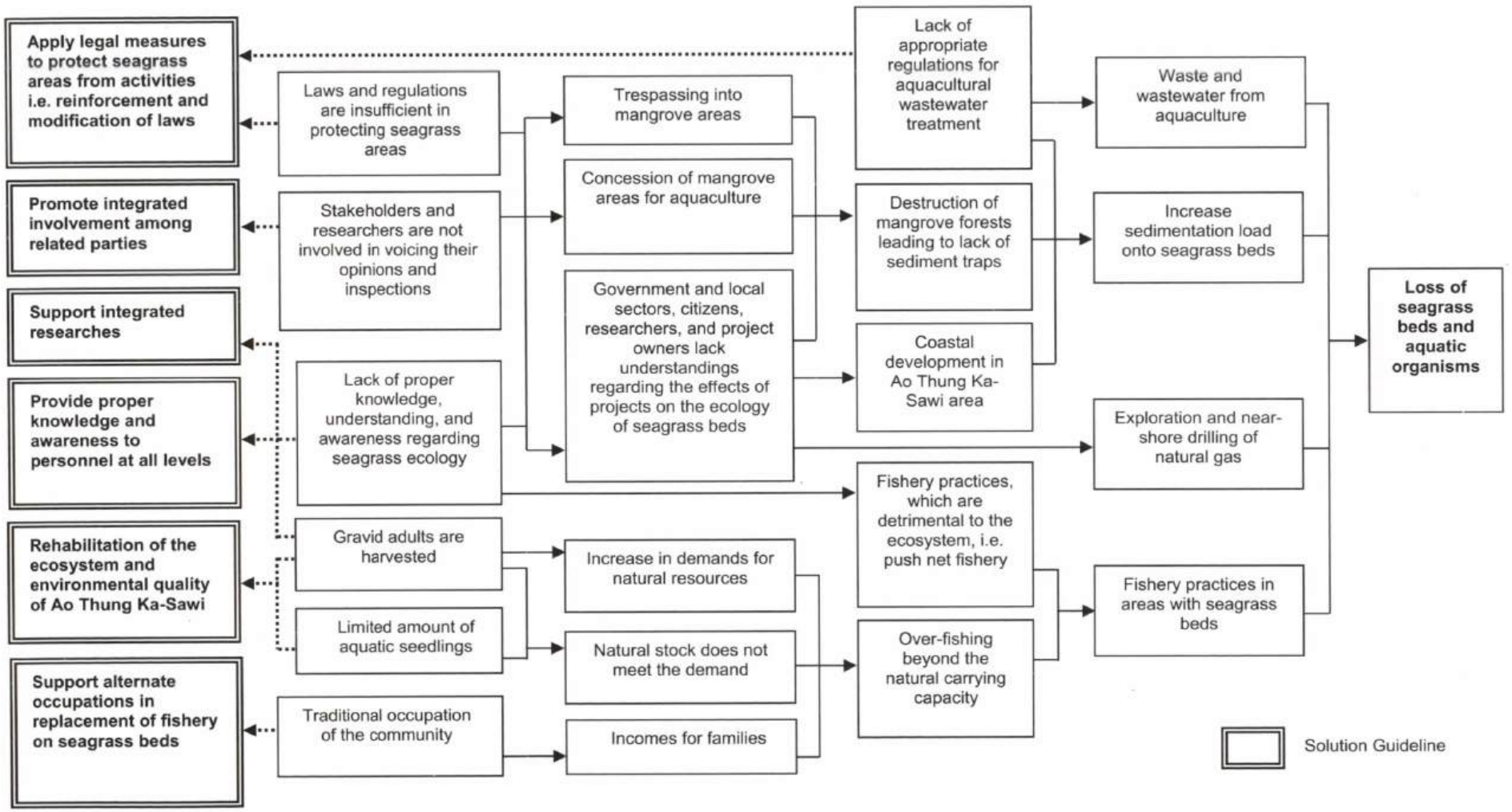
ANNEX 3

Causal chain analysis for Khung Krabane Bay, Chanthaburi Province.



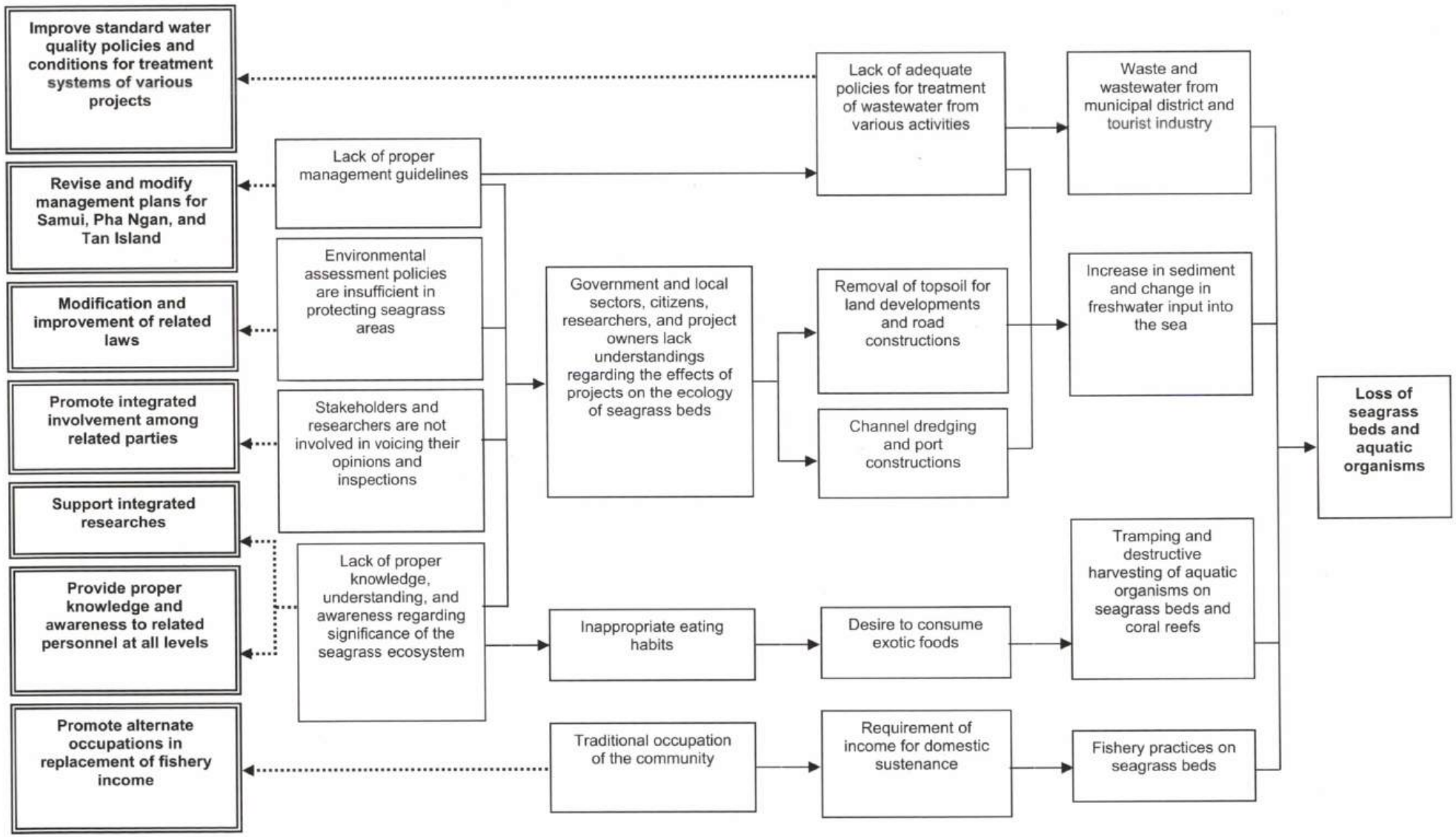
ANNEX 4

Causal chain analysis for Ao Thung Ka-Sawi, Chumphon Province.



ANNEX 5

Causal chain analysis for Samui, Pha Ngan, and Tan Island, Surat Thani Province.



ANNEX 6

Causal chain analysis for Pattani Bay, Pattani Province.