Mangrove forest recovery in Thailand

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Mangroves are a type of tropical and sub-tropical maritime forest found in intertidal areas, especially in and around brackishwater estuaries with saline, waterlogged soils. Mangrove forests typically receive considerable nutrient and sediment influxes from inland areas. Mangrove forests trap and use these materials, thereby supporting growth and land building. Dense mangrove tangles protect inland areas from storm waves and winds while, at the same time, protecting offshore reefs and other areas from terrestrial pollutants, including sediment runoff. Mangroves are ecologically and economically valuable since they provide spawning, nursery and other important habitats for many species of fish and crustaceans found within and beyond mangroves. Mangrove-generated detritus (up to 14,000 kg/ha/yr dry weight) fuels food chains within and beyond the mangroves. Mangroves are also valuable sources of lumber, firewood, charcoal, medicines and food for coastal communities that depend at least partly on mangroves for their livelihood and well being.

		Location of Goods and Services	
		On-site	Off-site
Valuation of Goods and Services	Marketed	**1** Usually included an economic analysis (e.g., poles, charcoal, woodchips, mangrove crabs)	**2** May be included (e.g., fish or shellfish caught in adjacent waters)
	Non-marketed	**3** Seldom included (e.g., medicinal uses of mangrove, domestic fuelwood, food in times of famine, nursery area for juvenile fish, feeding ground for estuarine fish and shrimp, viewing and studying wildlife	**4** Usually ignored (e.g., nutrient flows to estuaries, buffer to storm damage)

Fig. 1. Four categories of goods and services from mangrove areas based on whether the goods and services are marketed or non-marketed (sold for income) and whether the eventual value is realized in the mangroves or beyond. (Figure from Hamilton and Snedaker [1984].)

Mangrove conversions or destruction has occurred over many centuries in many countries. In Indonesia, large-scale mangrove conversions for extensive milkfish ponds, called tambaks, began in the 15th century. Greatly increased mangrove destruction occurred during the past century in many tropical marine countries, although accurate estimates of these losses are lacking. Most losses relate to human population increases and pressures on limited resources; perhaps not unlike deforestation, wetland filling and draining, and other habitat losses in North America following increased immigration and settlement beginning in the 17th century. Several categories of human activities cause mangrove losses (Macintosh 1996):

- Conversions of mangroves to other uses including agriculture such as rice and coconuts, aquaculture ponds for fish and shrimp, salt evaporation ponds, industrial and urban sites, and landfills.
- Over-exploitation of mangroves for lumber, fuel wood and charcoal by local communities.
- Insufficient mangrove recovery or replanting following clear-cutting for wood products.
- Watershed influences such as chemical pollution by industry and agriculture, and freshwater diversions either into or away from mangroves.

Many of these conversions or losses are reversible through appropriate restoration. Losses due to industrial or community development, freshwater diversions and salt production are not easily reversed, inasmuch as they typically cause significant changes in land elevation and/or soil properties. De-watering, compaction and oxidation of organically rich, acid sulfate mangrove soils create unsuitable conditions for mangrove survival.

Until recently, mangroves were undervalued and mostly considered wastelands awaiting conversion to more productive uses. That valuation was based on incomplete appreciation of mangrove's full economic value. Mangrove goods and services values include four categories of marketed or non-marketed (sold products) versus site location where the value is realized (Figure 1). Most earlier valuations considered only one combination, marketed goods and services sold on-site. This valuation was usually limited to wood products and foods produced from mangroves and sold directly for income.

In most, if not all cases, these values are only a small portion of total mangrove economic value. The other values are not always obvious or easily measured, but they are real values in the truest sense. Mangroves are known to be important or even essential for offshore shrimp and fish catch sustainability, but their exact value is difficult to quantify (Baran and Hambrey 1998). Likewise, mangrove protection of offshore coral reefs from silt, and coastal areas from storm damage are not easily measured, perhaps until after substantial damage occurs.

Most recently, resource managers, politicians, business people and the general public became more aware of overall mangrove values. This awareness has resulted in legislation and enforcement for mangrove protection. Emphasis is now on mangrove preservation and sustainable uses rather than on mangrove conversion. Mangrove destruction still occurs, but mangrove loss rates are much less, and in some cases have even reversed. Thailand's experience is an example of such a reversal.

The total mangrove area in Thailand before modern times is unknown, but probably exceeded 500,000 ha. By 1961, 367,900 ha remained (Figure 2). Between 1961 and 1996 mangroves further decreased by 54.5 percent to 167,367 ha, or by an average 5,730 ha/yr (see the table).

By 1993, shrimp ponds were found on 32 percent of converted mangrove lands, community development on 2.4 percent, while other uses accounted for 65.5 percent (Menasveta 1997). Other uses included agriculture, road and port development, salt farms, mining and mangrove lands overharvested for charcoal and other wood products. In some cases, mangroves were converted directly to shrimp ponds, but, in many cases, shrimp ponds were a secondary conversion. In many cases, mangroves were first converted to agriculture or salt production, then later converted to shrimp when the first conversion proved less profitable. Primary and secondary conversion areas for each use are unknown.

What is clear, however, is that most mangrove conversion to shrimp ponds occurred before the major expansion of Thai shrimp farming beginning about 1987. The early pond conversions were mostly for extensive shrimp ponds located within intertidal areas, including mangroves (Menasveta 1997, Menasveta and Fast 1998). Extensive culture ponds are typically large with low yields of, perhaps, 150 kg shrimp/ha/yr (Figures 3 and 4). Starting about 1987, Thai shrimp culture experienced massive increases. Cultured shrimp production increased from less than 20,000 kg/yr before 1987 to 275,543 kg/yr by 1999 (Figure 2). This expansion was made possible by large market demands for shrimp, and by Thailand's adoption of intensive culture technology. By the early 1980s, Thailand had a well-established network of hatcheries and farms for freshwater shrimp (*Macro-brachium rosenbergii*) culture. Technicians and farmers were well versed in larviculture and pond management. About the time intensive marine shrimp culture collapsed in Taiwan during 1988, Taiwan expertise and funds came to Thailand and helped fuel Thailand's culture of black tiger shrimp (*Penaeus monodon*). This contributed to Thailand's very rapid shrimp culture expansion and dominance.

Thailand's ocean caught shrimp production increased from about 70,000 tons in 1971 to a maximum of 150,000 tons in 1982, but decreased and stabilized thereafter between 70,000 and 110,000 tons/yr since 1983 (Figure 2). The decrease and stabilization of ocean caught shrimp was associated with establishment of regional EEZs (Exclusive Economic Zones) during 1981, and maximum exploitation of Thailand's ocean shrimp fishery within its EEZ.

As a result of Thailand's rapid adop-

Table 1. Mangrove areas in Thailand between 1961 and 2000, with changes in respective mangrove areas during each time interval. Changes are shown for both the period of record and on a yearly basis. (Source: Royal Thai Forestry Department 2001).

Year	Mangrove Area (ha)	Change in Mangrove Area		
		For Period (ha)	Percentage (period)	Yearly (ha)
1961	367,900.00			
1975	312,700.00	-55,200.00	-14.81	-3,942.88
1979	287,308.00	-25,392.00	-6.82	-6,348.00
1986[a]	196,435.84	-90,872.16	-24.38	-12,981.76
1989	180,559.04	-15,876.80	-4.27	-5,292.16
1991	173,820.96	-6,738.08	-1.82	-3,368.96
1993	168,682.56	-5,138.40	-1.39	-2,569.12
1996	167,366.88	-1,315.68	-0.78	-438.56
2000	244,159.52	76,792.64	45.88	19,198.08

[a]*The unusually large mangrove area decrease reported this year was possibly due to a change in mangrove survey methods from land/aerial surveys before 1986 to LANDSTAT techniques during 1986 and thereafter.*

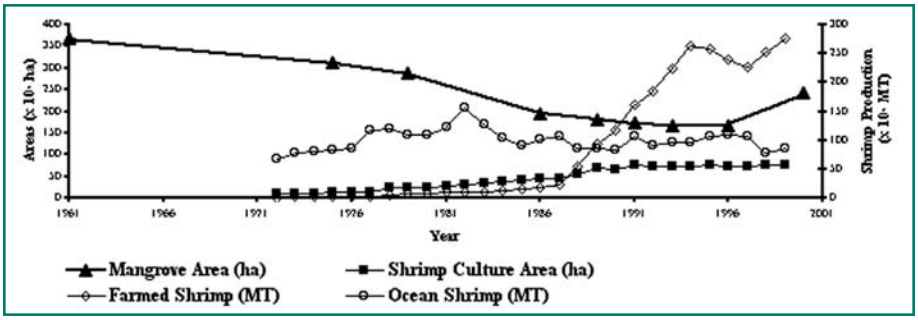

Fig. 2. Total mangrove area, shrimp pond area, ocean-caught shrimp production and farmed shrimp production in Thailand between 1961 and 2000. Data from RTFD (2001) and Thai Department of Fisheries (1997, 2001).

Fig. 3. Extensive shrimp farms circa 1980 located on former mangrove area in Chaophraya River estuary about 20 km south of Bangkok, Thailand. (Photo by Prof. Piamsak Menasveta)

Fig. 4. Extensive shrimp pond in Thailand during early 1980s. (Photo by Prof. Piamsak Menasveta)

tion of intensive shrimp culture technology, few semi-intensive shrimp farms were built in Thailand and many extensive farms were less profitable compared with intensive culture (Fast *et al*. 1995). Furthermore, unlike extensive and semi-intensive culture, intensive culture systems are best located above the tidal range, which means either behind mangroves or in non-mangrove areas. Intensive culture systems that commonly produce more than 5,000 kg/ha/yr also require less than three percent of the land area needed to produce equivalent amounts of shrimp using extensive systems. This combination of intensive culture and relocation outside mangrove areas resulted in only relatively modest increases in total shrimp culture area from 44,770 ha during 1987 to 77,544 ha by 1999 (Figure 2). This 73 percent increase in area supported a greater than 1,000 percent increase in shrimp production during the same time.

The changes in mangrove areas that occurred following cultured shrimp increases are, perhaps, of greater interest. If 1987 is considered the turning point in Thai shrimp culture, we see that mangrove area had decreased by 47 percent between 1961 and 1986 (Figure 2 and the Table). Between 1986 and 1996 there was a further 15 percent decrease in mangrove area of 29,069 ha, while shrimp culture area increased by 56.7 percent or 26,296 ha. More impressively, the mangrove area between 1996 and 2000 increased 46 percent or 76,793 ha, while shrimp production and culture area also increased. The increased shrimp culture area between 1996 and 1999 was seven percent or 4,881 ha, while shrimp production increased about 23,000 tons. Total mangrove area in Thailand during 2000 was about equal to total mangrove area in 1980, well before shrimp culture expansion began.

Mangrove areas increased in all four of Thailand's coastal regions between 1976 and 2000. The largest percentage increases occurred in the North Central and Southern regions of the Gulf of Thailand with 121 percent and 98 percent (Figure 5). Increases of 80 percent and 34 percent occurred in the Eastern Gulf and Andaman Sea regions. However, in absolute terms, the greatest increase was on the Andaman Sea coast with 43,582 ha. Andaman coast mangroves accounted for 72 percent of all of Thailand's 244,160 ha of existing mangroves in 2000, compared with only five percent for the North Central region. The Central and Southern regions accounted for nine percent and 13 percent of total mangroves.

Observed increased mangrove area between 1996 and 2000 begs the questions… What accounts for these increases and will mangrove area increases continue? The reasons for increased mangrove areas include a combination of factors. First, mangrove areas are often neither as productive nor economically competitive with agriculture or aquaculture elsewhere. Extensive shrimp farms in mangrove areas are often much less profitable compared with intensive shrimp farms outside mangrove areas (Fast *et al*. 1995). Many of these shrimp farms have consequently been abandoned and reverted to mangroves. Perhaps more important for mangrove recovery is a heightened public awareness that mangrove values extend beyond the mangroves themselves, and that further mangrove destruction is unacceptable. This public awareness is reflected in Thailand's legislation and enforcement of laws and regulations concerning mangrove uses. Current laws created in 1987 by Thai Cabinet resolution (Piyakarnchana 1988, Tookwinas *et al*. 1999) established three categories for mangroves: *Mangrove Area I* is the conservation and preservation zone without exploitation; *Mangrove Area II* is for economic use on a sustainable and managed basis; while *Mangrove Area III* is for other economic uses such as agriculture, aquaculture, salt production or urban development. The Royal Thai Forestry Department (RTFD) is charged with overall management of mangrove forest areas. As part of their mangrove forest management, the RTFD stopped issuing concessions for all mangrove forest uses starting during the early 1990s. By 2003, all existing concessions will expire and there will be no new concessions issued thereafter.

As an outgrowth of public awareness and legislation, there have been active programs of mangrove reforestation by public and private sectors. Shrimp culture cooperatives in many of Thailand's 24 coastal provinces actively support mangrove reforestation. This support includes sponsoring student groups who replant mangroves as part of their civic and community services (Figure 6). The Royal family strongly supports a variety of environmental issues, including mangrove preservation

and reforestation. The RTFD also has active reforestation and silviculture programs for both increasing mangrove areas and managing existing and future mangrove plantations. In addition to commercial and government support for mangrove restoration, non-government organizations (NGOs) have also made significant contributions. The Yadfon Association, one such NGO, has restored more than 1,000 ha of mangroves on the Andaman Sea (Quarto 1999, Thongtham 2002).

Time will tell whether Thailand's mangrove areas will continue increasing. There are, of course, physical limits as to how much mangrove area can exist in a region. This is determined by such factors as intertidal reach, soil conditions, freshwater inflows, sediment loads and water currents. However, we expect that Thailand's total mangrove area will continue to increase on the strength of the momentum created by the factors mentioned above. Mangrove areas during 2000 had already increased above the 1980 level, well before shrimp culture expansion began in Thailand. Given the strength of this recovery, we see no reason why mangrove areas should not increase even further.

Notes

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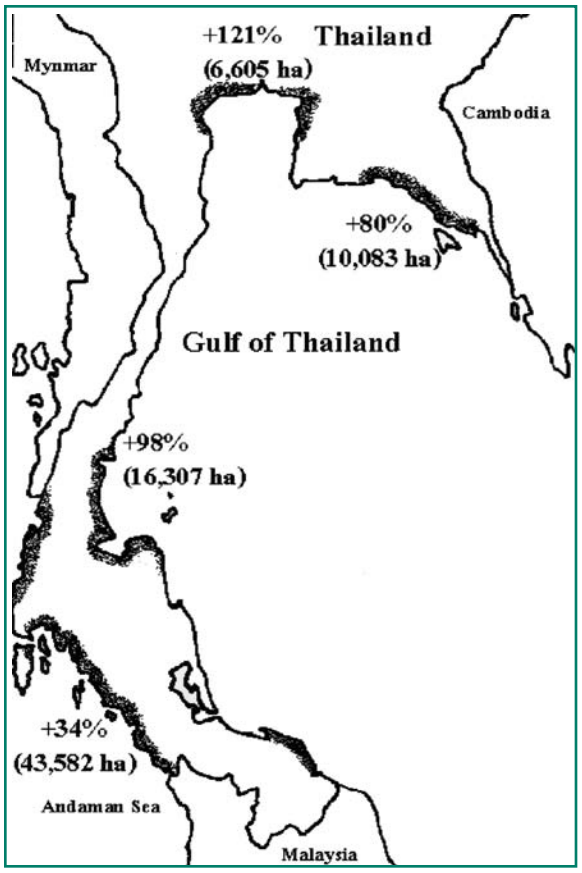

Fig. 5. Changes (percent and ha) in mangrove areas in Thailand's four coastal regions during 2000 compared with 1996. The three Gulf of Thailand regions include the Eastern, North Central and Southern. The fourth region is the Andaman Sea coast. Data from Royal Forestry Department (2001).

Fig. 6. Planting of mangroves by university students in former shrimp farming area, Prachub-kirikhan Province in North Central region during October 1999. (Photo by Mr. Sommai Janekitchakarn)

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