INTRODUCTION

The oceans and coastal resources of the Asian and Pacific Region are currently facing three separate, but interactive threats. The first is pollution from both land and sea based sources, which causes direct damage to specialized ecosystems (such as mangroves, coral reefs and seagrasses), whilst weakening the ability of marine plants and animals to survive fluctuations in their environmental conditions. The second is a direct threat to the biomass and ecological balance of the marine environment through overfishing and unsustainable extraction of resources and, the third, direct physical damage to coastal and marine ecosystems from urban and tourist related development.

This chapter examines the major environmental issues facing the coastal and marine environment of the region and highlights the current and planned response to these challenges.

STATE OF THE COASTAL AND MARINE ENVIRONMENT

A. Damage to Coastal Zones and Habitat

Direct physical loss of, or damage to, coastal habitats arise from a range of development activities. Dredging of harbours and shipping channels, the construction of embayment (harbours) and marinas, and the reclamation of coastal wetlands for development purposes have each had a profound effect upon the ecological resources of the estuarine and coastal systems of the region. For example, New Zealand has reclaimed more than 85 per cent of its wetlands, mostly to create new pastureland, but also for housing and industrial sites. Many of the remaining wetlands have been degraded by drainage, pollution, animal grazing and the introduction of new plant species (Government of New Zealand 1996).

In addition to the direct physical damage to a range of in-shore, littoral and shoreline habitats, development within the coastal zone has also affected the geomorphological processes associated with accretion and deposition of coastal sediments. In order to guard against local coastal erosion, high cost sea walls and groynes have been constructed with significant impacts on the wider patterns of erosion and deposition. For example, a government quarantine facility, built in the 1940s on Makaluva Island in Fiji, now lies beneath the sea, some 100 metres offshore. The construction of the coastal defences around the quarantine facility accelerated the erosional processes such that the island has shrunk in size (United Nations 1995).

Coastal erosion triggered by human activity is also evident in many other countries of the region. In Malaysia, for example, coastal erosion has affected every state of the country and by 1998, of a total shoreline of 4,809 km², some 1,400 km² or 29 per cent was eroded.

B. Pollution of Coastal and Marine Environment

1. Marine Pollution: Status and Trends

Coastal and marine water pollution has increased throughout the region, mainly due to domestic and industrial effluent discharges, atmospheric deposition, oil spills and other wastes and contaminants from shipping. Most of the pollutants entering the marine environment come from land based sources and comprise sand/silt, nutrients, toxic chemicals and oil. The suspended load (primarily silt) per km² of drainage basin in the region is three to eight times higher than the world average and contributes to the high turbidity of coastal waters. Two thirds of the world’s total sediment transport to oceans occurs in South and East-Asia, due to a combination of active tectonics, heavy rainfall, steep slopes and erodible soils, disturbed by unsound agricultural and logging practices (UNEP 1999). These sediments impact upon not only the shallow inshore water habitats, but also on the wider oceanic ecosystem.

The urban and agricultural areas of the region produce significant quantities of organic wastes in such concentrations that the nutrient filtering mechanisms of the coastal zone are unable to neutralize their effects. Rivers running through Cambodia, People’s Republic of China, Malaysia, Thailand and Viet Nam deliver at least 636,840 tonnes of nitrogen to coastal waters overlying the Sunda Shelf. Of these, People’s Republic of China contributes at least 55 per cent, Viet Nam and Thailand, contribute 21 and 20 per cent, respectively (Talaue-McManus, L. 2000). The issues associated with the discharge of pollutants to inland waters are discussed in greater detail in Chapter 4.

Industry, and commercial agriculture, contaminates the flow of natural wastes with a wide range of materials that include persistent organic pesticides, heavy metals like mercury and lead, plastics of all kinds, and a cocktail of hazardous industrial chemicals. The relative contribution of various sources of oil pollution varies and comprehensive and strategic management initiatives are necessary in its monitoring and control (Box 5.1). The factors affecting oil pollution include population density, extent of shipping and mineral exploration, and the degree of industrialization of littoral...
Box 5.1 Australia’s National Plan to Combat Pollution of the Sea by Oil

Australia’s National Plan to Combat Pollution of the Sea by Oil is managed by the Australian Maritime Safety Authority (AMSA) and funded by a levy on the shipping industry. The National Plan is a collaborative arrangement between AMSA, the States and Northern Territory governments, the shipping, oil and exploration industries and the Australian Marine Oil Spill Centre, at Corio Quay, Victoria. The Centre was established by the oil industry to assist in responding to major oil spills around the Australian coast and in adjacent areas where Australian-based companies operate.

Under the Plan, pollution-response equipment is stockpiled at strategic ports and oil terminals, with a response capability for an oil spill of up to 10,000 tonnes. Whilst fully laden tankers typically carry 60,000 tonnes of oil, the result of most collisions is the rupturing of only one or two internal tanks, such that any oil spill is typically much less than the tankers’ fully laden capacity. Furthermore, in most cases oil is lost progressively such that the amount of oil that needs to be managed in a spill increases over time. The Kirkki oil spill, for example, happened over a two-week period. If a spill larger than 10,000 tonnes occurs, Australia may need to seek international assistance through arrangements under the international Oil Pollution Response and Cooperation Convention. Australia has concluded a memorandum of understanding with New Zealand under this Convention, by which assistance will be provided to each other in cases of pollution incidents in either country. Similar agreements are currently being negotiated with Papua New Guinea and Indonesia.

Australia has been at the forefront of regional initiatives to protect the marine environment through the regulation of international navigation. In 1990, the Great Barrier Reef was the first area in the world designated as a ‘Particularly Sensitive Area’ by the International Maritime Organization requiring all vessels of more than 70 metres in length or those carrying oil, chemicals or liquefied gas to carry Australian-licensed pilots when using the designated routes within the Great Barrier Reef Marine Park (Zann 1995). In addition, Australia and Papua New Guinea are co-operating in the development and provision of specific preventive and response measures to protect the Torres Strait area from oil spills. In support of these two specific initiatives, Australia is currently upgrading existing navigational aids and charts and establishing protocols for the management of ship passages through the Torres Strait and the Great Barrier Reef areas.

Source: CSIRO 1996 and Zann, L. 1995

countries. In the South China Sea, with the intensification of these factors absolute oil inputs are likely to increase. A study of the South China Sea (Talaue-McManus 2000) identified pollution hotspots; the locations of these are shown in Figure 5.1.

The quality of marine water is not monitored in many countries of the Asian and Pacific Region. Where monitored, the results are far from satisfactory. For example in People’s Republic of China, a 1997 study found that only 19 per cent of China’s coastal waters met Grade I water quality standards, and by 1999, this had reduced to 15 per cent, with the most severe sewage and agricultural pollution in coastal areas of the Pearl River Estuary. Of China’s four major sea areas, the East China Sea was the most polluted, followed by the Bohai Sea, the Yellow Sea and the South China Sea. (Government of China 1997 and 1999).

As pollution intensifies, the destabilized coastal and estuarine systems undergo wild gyrations in population densities – some species dying off while others bloom in huge numbers.

2. Blooms and Diebacks

Over the last twenty years, toxic blooms (or “red tides”) have become increasingly common, with major outbreaks in Australia, People’s Republic of China, Japan, the Philippines, New Zealand and the Republic of Korea. Since 1986, for example, China’s State Oceanographic Administration reported five major episodes (with two in 1998), each affecting more than 500 square kilometres of coastal waters.

In 1992, red tides, caused by outbreaks of massive numbers of toxic dinoflagellates, occurred in New Zealand and caused massive contamination of seafood resources. Over 200 cases of food poisoning were reported with symptoms ranging from diarrhoea, nausea, vomiting, muscular aches and weakness to dizziness, loss of memory, tingling, numbness and respiratory problems. (Government of New Zealand 1996). In addition to the human health impacts, toxic blooms have caused tremendous economic losses to countries in the region. For example, in 1997, a red tide outbreak in Kerala, India forced the closure of shellfish beds, leaving nearly 1,000 families without work. In Hong Kong, China, toxic blooms wiped out US$10 million worth of fish in 1997 and another US$32 million worth of high value fish in 1998 from its mariculture industry. In the Republic of Korea, 126 incidences of red tides were reported in 1996 alone, with losses to aquaculture estimated at US$10 million (Table 5.1).

It may also be noted that when the blooms of algae use all available nutrients and die, the organic enrichment of sediments cause long-term changes in benthic habitats, populations, and community structure. Increased sedimentation and nutrients from catchments have been linked with massive
dieback of seagrasses in many areas. New South Wales, for example, lost half of the *Zostera* seagrass in its estuaries and the seagrass die-off in Queensland resulted in mortalities of endangered dugongs (Zann 1995).

![Figure 5.1 Distribution of Pollution “Hot Spots” In South China Sea](image)

**Figure 5.1 Distribution of Pollution “Hot Spots” In South China Sea**

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Species</th>
<th>Loss (million US dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>1972</td>
<td>Yellowtail</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>1977</td>
<td>Yellowtail</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>1978</td>
<td>Yellowtail</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>1987</td>
<td>Yellowtail</td>
<td>15</td>
</tr>
<tr>
<td>Rep. of Korea</td>
<td>1978</td>
<td>Oyster</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>Oyster</td>
<td>&gt;60</td>
</tr>
<tr>
<td></td>
<td>1991-92</td>
<td>Oyster</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>1998</td>
<td>Farmed fish</td>
<td>32</td>
</tr>
</tbody>
</table>

**Table 5.1 Economic Losses from Red Tides in Fisheries and Aquaculture Facilities in Selected Countries of the Region**

Source: Talaue-McManus 2000

3. **Increased Dissolved Carbon Dioxide**

Observations showed that levels of dissolved carbon dioxide were abnormally elevated in seawater in the early 1970’s, although no ill effects were detected. However, in 1998, researchers found that elevated dissolved CO$_2$ was slowing down calcium carbonate deposition in coral communities and possibly, by inference, in other marine organisms that secrete calcium carbonate in the formation of shells and exoskeletons. Elevated dissolved CO$_2$ was raising the acidity of seawater and thereby making carbonate formation more difficult.

Currently, the oceans absorb about two billion tonnes of carbon dioxide a year, about one third of the carbon dioxide produced by the burning of fossil fuels. If the normal process of binding carbon into calcium carbonate is impaired, less carbon dioxide will be removed from the atmosphere causing an even faster rise in both atmospheric and dissolved CO$_2$ (Langdon et al 1999).

C. **Specialized Ecosystem and Resources Status and Trends**

1. **Mangroves**

More than 40 per cent of the world’s currently estimated 18 million hectares of mangrove forest occur in South and Southeast Asia. These subregions also have the highest diversity of mangrove species in the world. The South Pacific subregion provide a further 2 million ha of mangroves or some 10 per cent of the total mangrove areas in the world.

The resource needs of the region’s growing population have exerted considerable pressure on the mangrove ecosystems. Large areas of mangrove have been removed for industrial, residential and leisure developments and, in particular, for the establishment of ponds for fish and prawns aquaculture. It is estimated that over 60 per cent of Asia’s mangrove forests have already been converted to aquaculture (Figure 5.2) equivalent to losses of 11 million ha. More than 3 million ha of mangroves have been converted to aquaculture ponds in Southeast Asia alone.

Agriculture has also affected mangroves both directly through landtake and indirectly through freshwater diversion for irrigation and through the addition of agricultural residues in the run-off. Freshwater interceptions for agricultural schemes have severely affected mangroves in the Indus delta of Pakistan and Ganges delta in the western part of Sunderbans.

2. **Coral Reefs**

Although coral reefs occupy less than one quarter of one per cent of the marine environment, they are home to more than a quarter of all known
Coral reef systems also provide a useful indicator of marine biodiversity and ecological health (Box 5.2). About four fifths of the world coral reefs are in the Asian and Pacific Region, approximately half of these are in the Pacific, one third in Southeast Asia and the remainder in South Asia (Figure 5.3). Coral reefs and their associated plants and animals provide human populations with seafood, medicine and other products. In developing countries, coral reefs contribute about one quarter of the total fish catch and provide food, according to one estimate, for one billion people in Asia alone (Jameson S.C. et al 1995 and Hinrichsen D. 1997). Coral reefs also act as buffer zone to break the intensity of wave action and impact of storms and provide recreational resources to the tourism industry.

However, in the Asian and Pacific Region, coral reefs are threatened by a range of human activities including coastal development, over exploitation and destructive fishing practices, as well as land and marine based pollution. An extensive study by the WRI has categorized the threat to the coral reefs of the region (Table 5.2). In 1998, coral bleaching, which is a phenomenon associated with global warming killed large areas of coral reef within the region (see Chapter 16, Box 16.2).

The coral reefs of Indonesia and the Philippines are noted for their extraordinarily high levels of diversity, each containing at least 2 500 species of fish, although, at present, only 30 per cent of these reefs are in good or excellent condition. Due to the richness of these reef areas, the coastal zone policy and management decisions made by these two countries will have a major impact on the global heritage of coral reef diversity (Bryant, D. et al 1998).

In comparative terms, the reefs of the South Pacific subregion are under less immediate threat than those of Southeast Asia (WRI 1999). Forty-one per cent of the Pacific reefs are classified as threatened, and just 10 per cent face a high risk. Those near population centres face significant human pressures including the reef communities off southeastern Papua New Guinea, the Solomon Islands, Vanuatu, and Fiji. Fiji’s reefs are an important tourist draw and, according to a 1992 estimate, a major source of food for local people, generating close to $200 million annually in fisheries and tourism revenues alone (Bryant, D. et al 1998).

3. Seagrasses

Seagrasses are common throughout the tropical and temperate coastal waters of the Asian and the Pacific Region. Often associated with mangrove habitats in coastal waters and with coral reefs in deeper waters, seagrasses perform the crucial ecological function of trapping fine sediments that remain suspended after passing through estuarine and mangrove areas. Typically, therefore, seagrass beds are depositional areas, providing a mechanism for clearing waters of sediment – particularly important to the survival of sun-loving corals.

Seagrasses provide important habitats and food sources for a range of marine fauna including commercially important species, such as the tiger prawns of Northeast Australia. The generic richness of seagrass beds is centred in the Indo-West Pacific Region (Heck and McCoy 1978), whilst species diversity is highest in the area defined by Indonesia, Borneo, Papua New Guinea and northern Australia. Northeast and Southeast Asia harbours the second highest number of sea grass species at 20 of the 50-recorded species worldwide (Fortes 1994 and 1995; Sudara et al 1994).
Table 5.2 Status of the Coral Reef in the Asian and Pacific Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Total</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>(pp/km²)</th>
<th>Number</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean</td>
<td>36 100</td>
<td>16 600</td>
<td>10 500</td>
<td>9 000</td>
<td>46</td>
<td>29</td>
<td>25</td>
<td>135</td>
<td>66</td>
<td>15 100</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>68 100</td>
<td>12 300</td>
<td>18 000</td>
<td>37 800</td>
<td>18</td>
<td>26</td>
<td>56</td>
<td>128</td>
<td>57</td>
<td>36 263</td>
</tr>
<tr>
<td>Pacific</td>
<td>108 000</td>
<td>63 500</td>
<td>33 900</td>
<td>10 600</td>
<td>59</td>
<td>31</td>
<td>10</td>
<td>98</td>
<td>92</td>
<td>372 809</td>
</tr>
<tr>
<td>Global Total</td>
<td>255 300</td>
<td>108 400</td>
<td>79 000</td>
<td>67 900</td>
<td>42</td>
<td>31</td>
<td>27</td>
<td>101</td>
<td>367</td>
<td>475 298</td>
</tr>
</tbody>
</table>

Selected Country and Geographic Grouping Statistics

<table>
<thead>
<tr>
<th>Region</th>
<th>Total</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>(pp/km²)</th>
<th>Number</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>48 000</td>
<td>33 700</td>
<td>13 700</td>
<td>600</td>
<td>70</td>
<td>29</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>374 967</td>
</tr>
<tr>
<td>Fiji</td>
<td>10 000</td>
<td>3 300</td>
<td>4 800</td>
<td>1 900</td>
<td>33</td>
<td>48</td>
<td>19</td>
<td>91</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>6 000</td>
<td>4 900</td>
<td>1 100</td>
<td>0</td>
<td>82</td>
<td>18</td>
<td>0</td>
<td>38</td>
<td>1</td>
<td>124</td>
</tr>
<tr>
<td>India</td>
<td>6 000</td>
<td>1 400</td>
<td>500</td>
<td>4 100</td>
<td>23</td>
<td>8</td>
<td>68</td>
<td>412</td>
<td>2</td>
<td>288</td>
</tr>
<tr>
<td>Indonesia</td>
<td>42 000</td>
<td>7 000</td>
<td>14 000</td>
<td>21 000</td>
<td>17</td>
<td>33</td>
<td>50</td>
<td>93</td>
<td>26</td>
<td>30 405</td>
</tr>
<tr>
<td>Lesser Antilles</td>
<td>1 500</td>
<td>0</td>
<td>300</td>
<td>1 200</td>
<td>0</td>
<td>20</td>
<td>80</td>
<td>159</td>
<td>2</td>
<td>253</td>
</tr>
<tr>
<td>Maldives</td>
<td>9 000</td>
<td>7 900</td>
<td>1 100</td>
<td>0</td>
<td>88</td>
<td>12</td>
<td>0</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>6 000</td>
<td>5 800</td>
<td>200</td>
<td>0</td>
<td>97</td>
<td>3</td>
<td>0</td>
<td>n.a.</td>
<td>2</td>
<td>163</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>6 000</td>
<td>5 000</td>
<td>800</td>
<td>200</td>
<td>83</td>
<td>13</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>530</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>12 000</td>
<td>6 000</td>
<td>4 500</td>
<td>1 500</td>
<td>50</td>
<td>38</td>
<td>13</td>
<td>7</td>
<td>8</td>
<td>2 149</td>
</tr>
<tr>
<td>Philippines</td>
<td>13 000</td>
<td>50</td>
<td>1 900</td>
<td>11 050</td>
<td>0</td>
<td>15</td>
<td>85</td>
<td>174</td>
<td>12</td>
<td>458</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>6 000</td>
<td>3 000</td>
<td>2 500</td>
<td>500</td>
<td>50</td>
<td>42</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Bryant, D. et al 1998

* Reef Area Estimates by Region and Threat Category (sq km) and percentages
  Reef area estimates are based on WCMC’s dataset Shallow Coral Reefs of the World and Spaiding and Grenfell (1997).
  Estimates of shallow reef area for Australia, Indonesia and the Philippines are significantly smaller than other published estimates.

* Average Coastal Population Density (pp/sq km), Statistics are for populated areas within 60 kilometres of the coastline. Population data come from Gridded Population of the World data set from the National Centre for Geographic Information and Analysis-GLOBAL Demography Project.
  Data are unavailable for some small island areas.

* Marine Protected Areas (Number and Area Estimates)
  Marine protected area counts and area estimates are summaries of the WCMC dataset Marine Protected Areas of the World, and are incomllete for some countries.
  Area statistics for protected sites are for the entire protected area, which include non-reef.

Box 5.2 REEF CHECK – A Global Coral Reef Monitoring System

In 1997-1998, the Institute for Environment and Sustainable Development of the Hong Kong University of Science and Technology, designed and implemented the REEF CHECK programme as a means of gaining a global assessment of the health of surviving coral reef systems.

Co-ordinating the efforts of marine scientists from more than 40 countries, REEF CHECK was able to derive snapshot assessments of the biodiversity and state of health of over 400 reef systems. The results also provided a basis for tracking changes to coral reef systems (at the individual reef level or at national, regional and global scales) in response to specific events, such as the 1998 coral bleaching (see Chapter 16, Box 16.2), or processes, such as overfishing or coral mining. REEF CHECK was very effective in building up community support for the conservation and management of reefs and many user groups, including SCUBA diving clubs and dedicated REEF CHECK associates, are requesting advice on how to use the method for repeated monitoring of reef health.

The methods employed proved to be flexible and robust, allowing modification for specific local circumstances, such as the addition of specific indicator organisms of local economic or social significance. For many areas of the world, the ideal monitoring programme will include a large number of broad-brush surveys carried out by the local community and using standardized methods, such as those developed for REEF CHECK, as well as a smaller number of more focused, specialized surveys using methods such as those in GCRMN’s Survey Manual for Tropical Marine Resources.

Participants in the REEF CHECK/GCRMN network can compare their results locally, regionally and globally via the Internet. By increasing the number of sites surveyed using a standard methodology, there is a proportional increase in the chance of detecting subtle changes in the health of reef systems at the local, regional and international levels.

Source: Hodgson, G. 1999
It has been estimated that between 20 and 25 per cent of seagrass areas in Indonesia, Malaysia, Philippines and Thailand have been damaged by a combination of coastal development, elevated sedimentation, destructive fishing methods and land based pollution, thermal discharge, petroleum product spills, dredge and fill operations.

D. Food Resources

1. Fisheries

Fish catches in the Asian and Pacific Region continue to increase. The scale and range of the region’s fisheries vary significantly with countries, such as People’s Republic of China, Japan, Thailand, Indonesia, Democratic People’s Republic of Korea and the Republic of Korea, engaged in large-scale industrial fishing, often venturing to distant waters to catch fish, whilst the small island states and the highly populated, least developed Asian states, concentrate on local food production from small (but numerous) coastal fisheries.

The comparison between estimated potential and average landing from various fishing grounds in the region by FAO is given in Table 5.3. Of all the fisheries in the world, the Indian Ocean fishery is believed to have the most potential for future development, but the data are unreliable and may not have taken into account natural population fluctuations (FAO 1997).

(a) The Eastern Indian Ocean

The Eastern Indian Ocean extends from the Bay of Bengal in the north, the Andaman Sea and northern part of the Malacca Straits in the east, to the waters around the west and south of Australia. The main fishing areas are on the continental shelves of the Bays of Bengal and Martaban and the narrower shelf areas on the western and southern sides of Indonesia and Australia. Knowledge of fish stocks is generally poor and management actions taken have usually been on an ad hoc basis, in most cases with little or no scientific rationale. India, Indonesia, Malaysia, Myanmar and Thailand accounted for some 90 per cent of the total catch in 1994. Whilst Australia caught only 3 per cent of the total by weight, the economic value of the Australian catch represented a much higher proportion.

Most of the catch from the coastal fisheries was used for local consumption, whilst shrimp and tuna were the main export commodities. Over exploitation of shrimp resources in coastal waters reduced the amount of exports from capture fisheries, although there is a continuing trend towards the exporting of shrimp from the aquaculture sector in almost all countries in the region. While the majority of tuna catches were from coastal fisheries, these were supplemented by offshore catches of skipjack and yellowfin tuna.

(b) The Western Indian Ocean

The Western Indian Ocean offers considerable potential for fisheries development, although lack of data on fish stocks and on the current levels of fishery activity are hampering the management of the sector. Rapid shifts in productivity (in part associated with the cycles of the monsoon seasons) and fluctuations in phytoplankton productivity are other factors that hinder a clear understanding of the long term potential of the fishery industry.

However, given the scarcity of alternative employment, fishing intensity is expected to remain high, increasing whenever the catch rates and economic conditions will allow.

(c) Northwest Pacific Fisheries

The Northwest Pacific is the second most productive fishery area in the world and is endowed with a broad continental shelf and high natural levels

<table>
<thead>
<tr>
<th>Marine Areas</th>
<th>Estimated Potential (A)</th>
<th>Year Potential Reached</th>
<th>Subjective Degree of Reliability(^1)</th>
<th>Landings 1990-94 (B)</th>
<th>Difference (A-B)</th>
<th>Status(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Indian</td>
<td>10</td>
<td>2037</td>
<td>Unreliable</td>
<td>3</td>
<td>7</td>
<td>I</td>
</tr>
<tr>
<td>West Indian</td>
<td>13</td>
<td>2051</td>
<td>Unreliable</td>
<td>4</td>
<td>9</td>
<td>I</td>
</tr>
<tr>
<td>Northwest Pacific</td>
<td>26</td>
<td>1998</td>
<td>**</td>
<td>24</td>
<td>2</td>
<td>I</td>
</tr>
<tr>
<td>Southwest Pacific</td>
<td>1</td>
<td>1991</td>
<td>**</td>
<td>1</td>
<td>0</td>
<td>O</td>
</tr>
<tr>
<td>Central-Western Pacific</td>
<td>11</td>
<td>2003</td>
<td>**</td>
<td>8</td>
<td>3</td>
<td>I</td>
</tr>
<tr>
<td>WORLD</td>
<td>82</td>
<td>1999</td>
<td>**</td>
<td>83</td>
<td>-1</td>
<td></td>
</tr>
</tbody>
</table>

Source: FAO 1997a

\(^1\) **Reasonably reliable regression

\(^2\) Overfished, Increasing (when rate of increase = zero)
of nutrients. Although the sector has been heavily fished for many centuries, modern industrial fishing has had a significant impact on the marine resources of the area.

Currently, the largest fish catches in the Northwest Pacific are Alaskan pollock, with the largest portion being taken by the Russian fishery, which landed 1.75 million tonnes in 1994. All the major stocks are believed to be currently at substantially lower biomass levels than existed in the 1980s and there are forecasts of catch trends continuing downwards for several years into the future.

The fishing capacity of the Northwest Pacific fleets continued to rise, despite falling catches. China’s fishery capacity grew rapidly between 1980 and 1997, with their fleet of decked fishing vessels increasing from about 60 000 to 460 000 vessels and the numbers of full time fishermen increasing from 2.9 million to 5.3 million. The amount of fish caught per unit of effort declined over the same period by a factor of 3. Other indications of overfishing, especially in coastal areas of the East China and Yellow Seas, was a shift in catches from large high-valued fish to lower-valued smaller fishes, from demersal and pelagic predator fishes to pelagic plankton-feeding fishes and from mature fish to immature fish (FAO 1997a).

(d) Central Western Pacific

The Central Western Pacific extends from the coast of Southeast Asia down to north and east Australia and further eastwards to the smaller island countries of the South Pacific. Much of the continental shelf in this area lies within the Exclusive Economic Zones of Southeast Asian countries and is rich in demersal resources, including penaeid shrimps, and small pelagic resources, while the oceanic waters have rich tuna resources.

Total catches in the area have increased almost continuously since 1950, although the rate of increase slowed in the 1990s. Unlike temperate fisheries where single species dominated the catch, tropical fisheries were a composite of many species. In 1994 seven species groups accounted for 87 per cent of the total: miscellaneous fishes, tunas, jacks, herrings, redfishes, mackerels, shrimps. The multispecies nature of tropical coastal resources is reflected by the high proportion of the miscellaneous group and the relatively even spread of catches between the other groups.

Two studies in the South China Sea indicate that most of the conventional small pelagic species are already fully exploited. The first study (Table 5.5), on a habitat division basis, showed that only a few sections of the shelf can sustain further expansion.

Countries in the region have introduced various conventional management measures such as closed seasons, closed areas or zoning, mesh-size

Table 5.4 Small Pelagic Fisheries in the South China Sea, 1978-1993

<table>
<thead>
<tr>
<th>Group</th>
<th>Peak landings (mt)</th>
<th>Peak year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round scads</td>
<td>596 000</td>
<td>1991</td>
</tr>
<tr>
<td>Selar scads</td>
<td>229 000</td>
<td>1990</td>
</tr>
<tr>
<td>Jacks, cavalla and trevallies</td>
<td>147 000</td>
<td>1993</td>
</tr>
<tr>
<td>Indian mackerel</td>
<td>357 000</td>
<td>1992</td>
</tr>
<tr>
<td>Indo-Pacific mackerel</td>
<td>212 000</td>
<td>1993</td>
</tr>
<tr>
<td>Spanish mackerel</td>
<td>114 000</td>
<td>1993</td>
</tr>
<tr>
<td>Kawakawa</td>
<td>283 000</td>
<td>1992</td>
</tr>
<tr>
<td>Frigate and bullet tunas</td>
<td>128 000</td>
<td>1992</td>
</tr>
<tr>
<td>Sardines</td>
<td>716 000</td>
<td>1993</td>
</tr>
<tr>
<td>Anchovies</td>
<td>419 000</td>
<td>1993</td>
</tr>
</tbody>
</table>

Source: Yanagawa, H. 1997

Table 5.5 Fisheries Potential of the South China Sea

<table>
<thead>
<tr>
<th>Subdivision</th>
<th>Area (10^3/km^2)</th>
<th>Primary Production (tonnes/km^2/year)</th>
<th>Potential catch 10^3/tonne/year</th>
<th>Actual catch 10^3/tonne/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow areas to 10 m</td>
<td>172</td>
<td>3 650</td>
<td>No estimate but fully exploited</td>
<td>1 046</td>
</tr>
<tr>
<td>Reef flats and seagrasses to 10 m</td>
<td>21</td>
<td>4 023</td>
<td>No estimate but fully exploited</td>
<td>275</td>
</tr>
<tr>
<td>Gulf of Thailand to 50 m</td>
<td>133</td>
<td>3 650</td>
<td>No estimate but fully exploited</td>
<td>1 242</td>
</tr>
<tr>
<td>Viet Nam &amp; PR China shelf to 50 m</td>
<td>280</td>
<td>3 003</td>
<td>1 860</td>
<td>453</td>
</tr>
<tr>
<td>Northwest Philippines. to 10 m</td>
<td>28</td>
<td>913</td>
<td>No estimate</td>
<td>315</td>
</tr>
<tr>
<td>Bornean shelf to 10 m</td>
<td>144</td>
<td>913</td>
<td>257</td>
<td>105</td>
</tr>
<tr>
<td>Southwest shelf to 10 m</td>
<td>112</td>
<td>2 433</td>
<td>No estimate but fully exploited</td>
<td>962</td>
</tr>
<tr>
<td>Coral reefs, 10-50 m</td>
<td>77</td>
<td>2 766</td>
<td>295</td>
<td>291</td>
</tr>
<tr>
<td>Deep shelf 50-200 m</td>
<td>928</td>
<td>730</td>
<td>1 688</td>
<td>176</td>
</tr>
<tr>
<td>Open ocean 200-400 m</td>
<td>1 605</td>
<td>400</td>
<td>1 686</td>
<td>80</td>
</tr>
<tr>
<td>Total South China Sea</td>
<td>3 500</td>
<td>Mean = 1 143</td>
<td>5 786</td>
<td>4 945</td>
</tr>
</tbody>
</table>

Source: Pauly, D. and V. Christensen 1993
regulations etc. to control fish decline. However, fishing pressure kept increasing despite attempts by some countries to reduce fishing pressure in coastal areas. The use of explosives to capture fish caused widespread damage to coral reefs. Fishing with cyanide for live food fish from the coral reefs resulted in severe reductions of juvenile and prey fish on coral reefs as well as over exploitation of target species.

(e) The Pacific Islands

There are three main types of fisheries in the Pacific islands: industrial fisheries (mainly tuna); coastal fisheries for export, mother-of-pearl shells; and coastal fisheries for domestic consumption.

Tuna is the target of the only significant industrial fisheries (purse seine, longline, pole and line, and troll) off small islands in the South Pacific. They are especially abundant in the Exclusive Economic Zones (EEZs) of Papua New Guinea, the Solomon Islands and Kiribati, but are also taken off the other Pacific island nations. Large-scale fishing is carried out by distant water fishing nations like People’s Republic of China, Indonesia, Japan, Republic of Korea, Philippines, and the USA, which pay fees to gain access to South Pacific islands' EEZs. In the 1970s and 1980s, few Pacific island nations were fishing for canny-quantity skipjack and albacore. Recently, their participation in tuna fishing has increased with the advent of small-scale longline fisheries for sashimi-quality yellowfin and bigeye tuna. These fisheries operate mainly off Federated States of Micronesia, Fiji, French Polynesia, Guam, Marshall Islands, New Caledonia, Palau, Samoa and Tonga, although these island fleets still take only 6.5 per cent of the weight of tuna caught in the sector.

About 80 per cent of fish captured in the Pacific islands, estimated at around 100 000 tonnes annually, is consumed or bartered locally. Some remote atolls have a per-capita fishery product consumption of over 250 kg annually. Most Pacific islanders live within the coastal zone and in rural areas, and many people fish, mostly for subsistence purposes. A great variety of marine organisms are consumed. For example, over 100 species of finfish and 50 species of invertebrates are included in the fish market statistics in Fiji, and the number of species consumed in the subsistence fishery is nearly twice this.

(f) Southwest Pacific

The fisheries area of the Southwest Pacific, including New Zealand and Southern Australian waters, has been heavily fished since the 1970s and the stocks declined fairly rapidly in response. Thirty-seven species were under quota management in the 1995/96 fishery season, which has been success in curbing some of the overfishing of the past.

The orange roughly fishery provides a typical example: in 1979, the first catches of orange roughly (5 000 tonnes) were reported in New Zealand and by the early 1980s catches had climbed to around 40 000 tonnes before peaking, in 1990, at around 90 000 tonnes. Since this peak, catches have declined by over 50 per cent and catches in 1993/94 were back at around the 40 000 tonnes level. Stocks of orange roughly continue to decline, but this decline has been offset to some extent by the continuing discovery of new stocks.

Other species have shown similar drastic declines. For example, landings of greenback horse mackerel dropped by 90 per cent between 1991 and 1992 and catches of snoek declined by 40 per cent from their 1993 peak and by 1996 had declined to their lowest level since 1979. Harvests of squid started in 1972, and catches of Wellington flying squid collapsed in 1981 (from 63 000 to 1 000 tonnes) before picking up again and increasing, albeit with large variability, reaching a new peak of 58 000 tonnes in 1994.

E. Aquaculture

The Asian and Pacific Region accounts for 87 per cent of the total world production of marine aquaculture. The top 10 Asian aquaculture producers are People’s Republic of China, India, Japan, Republic of Korea, the Philippines, Indonesia, Thailand (also the top seven producers in the world), Bangladesh, Viet Nam and Democratic Peoples Republic of Korea. In 1997, the production of 22 Asian countries and territories alone was 30.7 million metric tonnes (mt) valued at US$ 37.7 billion, an increase of 11.2 per cent and 10.6 per cent in weight and value respectively compared to 1995 when Asia accounted for 90 per cent of world aquaculture production. By comparison, figures for the whole of Asia show that aquaculture production in the region has been growing more than 4 times faster than landing from capture fisheries with aquaculture’s share of total fisheries landing in the region increasing by nearly two fold from 20.7 per cent in 1984 to 38 per cent in 1995 (FAO 1997).

In terms of species, freshwater finfish, in particular Chinese and Indian carp, account for the greatest share (42 per cent) of total aquaculture production. Aquatic plants production is valued at nearly US$ 5 billion, 70 per cent of which comes from People’s Republic of China. Successful hatchery operations is key factor in the rapid production growth of aquaculture.

While finfish make up almost the total volume of freshwater aquaculture, they represent less than 10 per cent of salt-water aquaculture. Seaweed, especially kelp, was the most commonly grown
marine organism, followed by oysters, carp, and scallops. Oysters were grown on wooden or net structures in shallow, estuarine tidal flats and were most valuable in temperate climates. Australia and New Zealand have extensive oyster farms and have also been increasingly successful in farming finfish, especially salmon.

In terms of value, the most important aquaculture species was the giant tiger prawn, worth nearly US$ 4 billion in 1996, followed by oysters at slightly over US$ 3 billion. Prawns and shrimps are especially important to Asian countries, as they are tropical species and are grown in large tidal ponds, generally excavated in mangrove areas. With a 1997 output of some 175 000 tonnes, Thailand continued to be the world’s main supplier of cultured shrimp.

Mangrove clearance for shrimp culture development has been discussed earlier. The additional environmental concern associated with aquaculture is the potential hazard posed by the accidental release of exotic species (particularly predator species) or the spread of diseases from the aquaculture facility to the surrounding natural environment.

F. Other Marine Resources
1. Mineral

More than 4 billion tonnes of oil and 5.8 trillion cubic metres of natural gas reserves have been found on the continental shelves of the Asian and Pacific Region. Offshore oil and gas production is developing rapidly on the west coast of India, the Gulf of Tongking, the Gulf of Thailand, East of Malaysia, West of Borneo and Palawan, West of Japan, in the Celebes Sea, off the North West and the South coast of Australia, the West coast of New Zealand and Papua New Guinea. Mining activities in the coastal zone include the extraction of sands, gravel and rock, whilst each year more than 6 millions tonnes of salt is extracted from seawater in the region.

The vast quantities of sand, gravel and rock quarried from the region’s coastal areas are used for infilling, road building and as aggregate in construction concrete. Coral mining represents one of the few sources of building materials in the smaller islands of the region. In Tahiti (French Polynesia), for example, 3.2 million tonnes of coral were taken from the fringing reef during dredging and filling operations for the airport and the port (Gabriel et al, 1995). Elsewhere, corals are mined for the manufacture of agricultural and construction lime.

2. Tourism

The region’s coastal areas are one of the major attractions of the tourism industry, which is the fastest growing sector in the regional economy. Many countries in the region have sought to exploit the tourist potential of their coastal areas through the development of seaside resorts, sport fishing and scuba diving capacity, sailing, whale watching and other ocean recreational activities. Tourism developers and governments have been quick to recognize the importance of preserving the major attractions of the coastal areas, including beautiful beaches, vibrant coral reefs, lively fisheries and natural scenic splendour. Concepts of “eco-tourism” and “environmentally sustainable tourism” have been the focus of much debate within the international tourism industry and, in a number of cases, have led to formal partnerships between tourism and conservation interests to protect ecologically valuable and interesting sites. Tourism, for example, is often cited as a justification for the creation of parks and reserves, compensating local people and fishing communities for the loss of potential earnings and promoting sustainable management practices.

However, “eco-tourism” remains a relatively small, niche market (albeit one with significant growth potential) and the demands of the mass tourism market within the region (which primarily comprises intra-regional holidaymakers) remains driven by cost and by a demand for comfort levels that can only be provided through significant resource consumption and infrastructure provision.
greatest threat to the biological diversity of marine and other aquatic organisms and can have significant consequences on the production of species that depend on these habitats for shelter or food at critical life stages.

2. **Hydrologic and Hydrodynamic Disruption**

The hydrology of watersheds draining to the coast has been significantly altered as a result of landscape changes, dredging and damming, consumptive water uses and diversion to other drainage basins. Such hydrological changes can alter salinity patterns and circulation within coastal systems and the delivery of nutrients, toxicants, and sediment to the coast by enhancing their concentrations.

The consequences of such changes may be profound. For example, an increase in the supply of fluvial sediments as a result of land clearing, mining or agricultural practices caused decreased light availability and the smothering or shoaling of benthic habitats in Papua New Guinea, Fiji, New Caledonia, New Zealand, Australia, and the Philippines.

**B. Land and Sea Based Pollutants**

1. **Land Based Sources**

   Much of the pollution affecting the marine environment derives from land-based human activities and enters the oceans and coastal zones of the region as either direct discharge, via the outflow of the region’s rivers or through atmospheric deposition. Table 5.6 shows fluxes from rivers in seven selected countries bordering the South China Sea. Fluxes, obtained by multiplying average concentrations with annual discharge rates, indicate the amount of material conveyed by river systems to the sea, as a combination of load from all sources (agricultural, domestic and industrial).

   Land based sources also contribute litter, plastics pathogens and hazardous waters including pesticides to the coastal and marine water. For example, the increased use of chemicals in agriculture is leading to the transport of an estimated 1 800 tonnes of pesticides into the Bay of Bengal where they reappear as toxic residues in finfish and shellfish (Holmgren 1994). The liberal use of agricultural fertilizers, on the other hand, enhances the productivity of coastal waters, favouring nuisance organisms such as phytoplankton species that cause red tides and other similar problems.

   Litter, especially plastics, is also a major problem in the coastal and marine environment and may endure for decades once submerged. Pathogens enter the natural environment, both from inappropriately managed hospital wastes and from aquaculture. Surface pollutants from atmospheric deposits are also impacting fish eggs and plankton species which occupy surface waters, in addition to increasing the level of UV-B penetration. Aquaculture has also contributed to the discharge of nutrients and other wastes, introduction of exotic species, the use of chemicals such as pesticides, antibiotics and

### Table 5.6 Pollutant Fluxes from Rivers of Selected Countries to the South China Sea

<table>
<thead>
<tr>
<th>Country/River</th>
<th>Catchment Area (km²)</th>
<th>Annual discharge (km³)</th>
<th>Biological Oxygen Demand (BOD) (t/y)</th>
<th>Total Nitrogen (IP) (t/y)</th>
<th>Total Phosphorus (t/y)</th>
<th>Total Suspended Solid (t/y)</th>
<th>Oil (t/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonle Sap Lake-River System</td>
<td>69 355</td>
<td>36.45</td>
<td>6 022</td>
<td>1 084</td>
<td>303</td>
<td>13 250</td>
<td>No data</td>
</tr>
<tr>
<td>Coastal rivers</td>
<td>13 406</td>
<td>21.79</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
</tr>
<tr>
<td>Mekong River, Cambodia Section</td>
<td>72 060</td>
<td>128.38</td>
<td>4 964</td>
<td>894</td>
<td>255</td>
<td>10 950</td>
<td>No data</td>
</tr>
<tr>
<td>PR China</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guangdong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Han, Rong, Pearl, Moyang, Jian</td>
<td>488 802</td>
<td>422.2</td>
<td>566 385</td>
<td>(340 050)</td>
<td>(3 768)</td>
<td>(58 531 000)</td>
<td>9 698</td>
</tr>
<tr>
<td>Quanxi</td>
<td>14 051</td>
<td>24.9</td>
<td>57 668</td>
<td>(8 602)</td>
<td>(507)</td>
<td>No data</td>
<td>823</td>
</tr>
<tr>
<td>Nandu, Changhua, Wanquanhe</td>
<td>15 865</td>
<td>31</td>
<td>140</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>368</td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central, Eastern, Southern rivers</td>
<td>320 553</td>
<td>144.2</td>
<td>299 224</td>
<td>130 044</td>
<td>7 137</td>
<td>12 587</td>
<td>No data</td>
</tr>
<tr>
<td>Total South China Sea for continental countries</td>
<td></td>
<td></td>
<td>1 015 936</td>
<td>636 840</td>
<td>58 202</td>
<td>58 642 827</td>
<td></td>
</tr>
</tbody>
</table>
hormones. In addition, there has been an overall deterioration of water quality and hindrance to access posed by extensive pond systems (Barg 1992).

2. **Pollution from sea based activities**

   The sources of marine pollution from sea-based activities are related to fishing, recreational boating, marine transportation and offshore mineral exploration and production activities. Accidental oil spills have been frequently reported along oil transport routes or at the points of discharge and loading for oil carriers. In the Straits of Malacca alone, 490 shipping accidents were reported during the period from 1988 to 1992, resulting in a considerable amount of oil spillage (*Straits Times* 1993). Although accurate data for the total amount of oil spills are not available, their frequency and distribution has led to the development of strict control regulations in many countries of the region (see Figure 5.4).

   Organotin antifouling, which is used for the keels of ocean-going vessels, is especially toxic to marine molluscs and their larvae. Unlike copper antifouling, organotin toxins become trapped in biological food chains and cause cumulative pollution of harbours and marinas. In consequence, organotin was banned by the IMO in 1998. Vessels also require regular painting and utilize a wide range of highly toxic paints, paint removers, solvents, degreasers, and other compounds.

C. **Global Climate Change**

   A rise in sea temperature has already been linked to the extensive bleaching of coral reefs in the Pacific and Indian Oceans. A more detailed discussion on global climate change, and its implications for the ecosystems of the region, is provided in Chapter 6.

D. **Unsustainable Exploitation of Resources**

1. **Overfishing:**

   Overfishing can cause serious, long-term damage to fish resources and the targeting of particular species can disrupt the ecological balance, depleting the prey of other species and reducing populations of top predators.

   Attempts to control overfishing result in considerable economic conflict as livelihoods are at stake. In New Zealand, for example, government attempts to reduce inshore commercial snapper fisheries were immediately challenged in court-leading to prolonged discussions and high legal costs for the government (Box 5.3). An FAO investigation (FAO 1998) revealed that in spite of the overexploitation of fisheries resources, most marine capture fisheries remain economically viable, generating sufficient income to cover costs-including allowances for depreciation as well as the opportunity cost of capital, with adequate levels of remuneration to the owners and crews and a surplus remaining for reinvestment.

   Subsidies provided by governments have sometimes contributed to overfishing. Diesel fuel tax exemptions are common fishing subsidies in the Region. In Australia, and Japan, diesel fuel used in fishing and shipping is exempt from standard fuel taxes. However, a FAO study (1998) found that the number of subsidies in developing countries has been greatly reduced in recent years and the remaining subsidies are for offshore fishing, artisanal fisheries and fisheries co-operatives as well as for fishing operations in remote and underdeveloped areas.

2. **Poor Integration and Coordination of Stakeholders**

   Government sectors that interact with fisheries were (and remain) largely excluded from the fisheries development process. There is, for example little, if any, communication between fisheries agencies and tourism (sport fishing, diving, resorts, parks), environment (parks and habitat protection), planning (macroeconomics and finance), agriculture and forestry (responsible for water siltation and

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**Figure 5.4 High Risk Areas for Oil Pollution in the South China Sea**

Source: Talaeu-McManus 2000
subsequent damage to inshore fishery habitats), lands and survey (responsible for filling of mangrove and coastal areas) or public works (responsible for building waste dumps, coastal roads and causeways that diminish fish nursery areas, cut off fish migration routes, and disturb water flows in bays and estuaries).

3. **Damaging and Destructive Fishing Techniques**

Commercial fishing gear and practices are not always selective for the species and sizes being targeted and fishermen discard a wide range of species with little or no commercial value. Annual discards from the world’s fisheries were estimated to be about 20 million tonnes, or about 25 per cent of the annual production from marine fisheries.

Catch quotas increase the incentive to discard, especially in mixed species fisheries where several of the species are subject to a quota. Fishermen, required to discard that proportion of the catch taken in excess of the quota, sort the most valuable specimens and discard the smaller or damaged specimens of the quota species as well as lower value species. Discarding by-catch has long been recognized as a wasteful, but inevitable feature of commercial fishing.

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**Box 5.3 The Evolution of Fisheries Management in New Zealand**

Capacity problems in New Zealand’s inshore fisheries began to manifest themselves in the 1960s. Local fishermen complained that the government was licensing foreign offshore fishing vessels, whilst restricting access to domestic vessels. Consequently, in 1963 the government removed the restrictions on fishing effort applied to local fishermen and, in 1965, provided guarantees on loans for fishing vessel purchases. Through these measures the government established both an open access policy with regard to fishery resources and provided mechanisms to aid a marked increase in the capacity of the country’s fishing fleet.

While the intention was to base fisheries development on the offshore resources, the fishing effort in the prime inshore fisheries also expanded rapidly. By the early 1980s, overfishing of species in these zones and overcapitalization within the inshore fleets were rapidly depleting fish stocks. In response, the government (i) set up controlled inshore fishing zones, a new licensing regime that limited vessel numbers and prohibited new entrants to the inshore fisheries; (ii) removed “part-time” fishermen from the inshore fisheries; (iii) enabled regulation of fisheries using management plans formulated after extensive public consultation on the resources to be managed and the regulatory controls (on fisheries inputs) to be applied.

During the lengthy consultation and planning process, overfishing and overcapitalization intensified. By 1984, the inshore harvesting sector was over capitalized by an estimated NZ$28 million and correction would mean the retirement of 44 per cent of the existing fishing capacity. Ultimately, Government and industry agreed to introduce total allowable catches (TACs) to ensure stock conservation, and individual transferable quotas (ITQs) to facilitate industry restructuring. Both parties agreed the initial TACs and ITQs would be set so as to effect a reduction in fishing activity. The main elements of the scheme were: (i) the allocation of a case history to each fisherman, on a national basis (with case history defined as the fisherman’s catch in two of the three years between 1981 and 1983); and (ii) the buy-back of case histories to a level that is equivalent to the TAC for each fishery.

The government ultimately spent over NZ$45 million in legal fees and in buying out 15 800 tonnes of fishermen’s case histories. The important outcome was that a viable and more sustainable future was secured for the affected fisheries and the industry in general. The remaining fishermen could buy, sell or lease their entitlements without undue government restrictions or the requirement of consent. In addition, they could shift their vessels throughout the year between different fisheries for which they had quotas. The government benefited by being able to purchase case histories at prices that did not reflect their full value, owing to the absence of an established ITQ market at the time.

The extensive consultation with fishing industry representatives in the planning, development and implementation of the quota management system was an important element in the successful introduction of ITQs. ITQ management was established for 29 species, including 21 inshore and eight deep-water species. By 1996, 33 species were managed under ITQs, representing some 80 per cent of the total commercial catch from New Zealand’s EEZ.

There are approximately 117 species currently outside the quota management system and these are being managed by a system of permits and regulations. The government intends to bring additional species into the quota system and, at present, a moratorium has been placed on the issuance of new permits for non-ITQ species as a means of controlling the fishing effort prior to these species’ inclusion in the quota management system.

The introduction of ITQs, together with the financial assistance in restructuring, retired 15 800 tonnes of catch from New Zealand fisheries. The reduction in the size of the fleet, whether it was due to this assistance scheme or to the subsequent introduction of ITQs, was dramatic. The number of vessels dropped by 22 per cent between 1983/84 and 1986/87 and there was a further 53 per cent reduction resulting from the use of ITQs between 1986/87 and 1994/95. However, as this rationalization primarily occurred in the country’s inshore fisheries, it helped their conservation and redirected investment to harvest deep-water fisheries.

**Source:** Ministry of Fisheries, New Zealand
as it constitutes a loss of valuable food, has negative consequences for the environment and biodiversity and can be aesthetically offensive. By-catch attracted considerable public and political attention in reaction to the incidental capture of dolphins in tuna purse seine nets, turtles in shrimp trawls and marine mammals, birds, turtles and fish in high seas squid driftnets. However, most measures aimed at reducing the quantities being discarded carry substantial implementation costs.

In the subsistence fisheries that dominate much of Asia and the Pacific islands, especially in highly populated, undeveloped and rural areas, almost everything caught is either consumed or used as feed or fertilizer and little is discarded.

Physical damage to marine ecosystems from fishing derive from three activities: (i) damage from fish capture gear, such as trawls; (ii) damage by fishers during capture of sea foods such as walking on corals, breaking coral or rocks using iron bars or explosives; (iii) damage by anchors, ship groundings, propeller washes, and dredging and filling associated with vessel movements and construction of port facilities. Some forms of fishing also disrupt the physical habitat. For example, bottom trawling can change the physical habitat and biological structure of ecosystems and accidentally capture and destroy a large number of non-target species. Trawl fishing inshore of the Great Barrier Reef in Australia is reported to have changed the physical character of the seafloor, increased turbidity, and removed key microhabitats for coral reef juvenile fish (Zann 1995).

In the last decade, the live fish industry has expanded throughout Asia and the Pacific. Wide use of chemical toxins, such as cyanide, has had serious impacts on juvenile fish and other reef creatures. Collection of tropical fish and other marine creatures for the aquarium trade is common in the tropical areas of the region and the recent phenomenon of the “live rock” trade involves the taking of coral rock from reefs to be used as decorative and biologically active components of salt water aquaria.

**POLICIES AND PROGRAMMES**

A. National Initiatives

1. **Country Experiences in Coastal Zone Management**

   While some countries, such as Sri Lanka (Box 5.4) began active coastal zone management in the late seventies, most started in the mid to late eighties with the formation of committees and the preparation of reports, recommendations and legislation. In recent years, significant progress has been made in the development of coastal zone management plans for Bangladesh, Sri Lanka, Pakistan, Philippines, Tonga, Indonesia, Singapore, Thailand and Malaysia.

   A key factor in the successful implementation of such management plans has been the extent of community participation as demonstrated by the experience of the Philippines, which was one of the first countries to experiment with community partnerships (Box 5.5).

   In Malaysia, the most recent initiative towards integrated coastal zone management is the pilot project being undertaken in Sabah, Sarawak and Pulau Pinang to formulate integrated coastal zone management plans at the State level.

   The core of an Australian initiative is a programme to develop integrated coastal area management strategies and programmes (referred to as Coastcare) based on partnerships (and shared funding) between the Commonwealth, State and Local governments, the community and industry. Coastcare provides opportunities and resources (including federal grants of about US$ 82 million per year) for community, business and interest groups to become actively involved in coastal management and decision-making (Australia Department of Environment 1997).

   New Zealand completely revolutionized the process of decentralization of government with its Resource Management Act of 1991, which required the formation of a New Zealand Coastal Policy Statement 1994 to provide a policy framework for the sustainable management of the natural and physical resources of the coastal environment (NZMFE 1996).

   Remote sensing and GIS databases for marine resource and coastal zone management are becoming more important in the region. India and Japan both have ocean satellites that provide data to fishers showing likely spots for fishing. Satellites provide enforcement of fishing agreements in offshore waters. Remote sensing techniques provided important base-line information of ecosystem conditions in the coastal zone and marine environment. In New Caledonia, for example, satellite images were used to detect changes in coral reefs over a ten-year interval, proving the effectiveness of a marine park in the territory and the vulnerability of coral reefs to local development activities (Bour 1990). In 1998, satellite images tracked the movement of hot surface water in the Indian Ocean to predict where coral reefs would dieback and thus provide conclusive proof that coral bleaching was associated with localized increases in sea level temperatures.
Box 5.4 Coastal Zone Management in Sri Lanka

Sri Lanka’s 18 million people share 1,562 km of coastline and increased migration to coastal areas since Sri Lanka’s independence in 1948 has created a range of consequences including coastal erosion, degradation of valuable coastal habitats and resource use conflicts. A realization of the conflicts and challenges associated with the management of coastal resources in the late 1970s led to the establishment of the Coast Conservation Department (CCD) within the Ministry of Fisheries and the enactment of the 1981 Coast Conservation Act.

In 1986, the CCD began a programme focused on the management of four key issues in the narrowly defined coastal strip: shorefront development, coastal erosion, habitat loss and the decline of recreational and cultural sites. The first outcome was a regulatory programme designed to reduce coastal erosion through a coastal permit applications system (primarily for house construction and sand mining), an extensive programme of public education and the construction of some specific coastal protection works. The second outcome was the development of provincial-level Coastal Zone Management (CZM) Implementation Plans and, in 1995, a series of local-level Special Area Management Plans. Local communities were encouraged to become actively involved in the formulation and implementation of the coastal zone management programme and this bottom-up approach enabled the local community to be “fully aware of and integrated into the planning effort so that it is truly participatory.”

The strategic Coastal 2000 Plan recommended a second-generation coastal resources management programme with a “twin-track” approach, in which plans are implemented simultaneously at both the national and local levels. One of the initiatives of Coastal 2000 was the Special Area Management (SAM) Plan; in the early 1990s, two locations were chosen for the development of SAM Plans: Hikkaduwa, a small town on the west coast known for its coastal tourism and marine sanctuary; and Rekawa Lagoon, important for its local fisheries, mangroves, beaches and agriculture.

In 1992, CCD staff and representatives from the Coastal Resources Management Programme (CRMP) began the process of SAM planning at both locations. Government officials in selected agencies at the national level were contacted, and their interest and support was solicited. At the same time, CCD and CRMP staff began to work with community organizations to identify appropriate groups to be consulted in identifying community perceptions of resource management problems and priorities. Over the next three years, government officials, community groups and interest group representatives identified priority resource management issues and technical questions. Special Area Co-ordinating Committees, comprising both community representatives and government officials, were established and technical studies were commissioned, including environmental profiles for each Plan area. Resource management issues and strategies were identified and compiled. The SAM Plans for Hikkaduwa and Rekawa Lagoon were adopted by their respective co-ordinating committees in 1996.

The SAM planning process at Hikkaduwa facilitated the effective management of the Hikkaduwa Marine Sanctuary, heightened awareness amongst tourists and residents of the need to protect and manage the coastal environment, initiated a waste management strategy and encouraged a glass-bottom boat owner association. In management of Rekawa Lagoon, habitat, fishery and livelihood issues have taken highest priority.

In late 1996, the SAM planning and management processes were evaluated to determine the degree to which coastal management efforts integrated multiple agencies and programmes, levels of government and technical analysis. The evaluation indicated that as the two plans were developed by multidisciplinary teams working with community groups and national, provincial and local government officials, overall integration was excellent. The plans are based on regulatory activities, coastal development projects, research, monitoring and organizational efforts undertaken by both government agencies and community groups. Coordinating committees at both sites are working to maintain a comprehensive approach to improving resource conditions.

SAM plans are a bottom-up strategy for managing coastal resources that complements the existing top-down regulatory approach in Sri Lanka. They allow for intensive, comprehensive management of coastal resources in a well-defined geographic setting (as contrasted with a use-by-use regulation-by-permit approach). Participation by community residents or stakeholders in planning and management is central to the SAM concept. Government agencies serve as catalysts or facilitators to help organize communities for resource management. Government provides technical support, and acts as mediators to help balance competing demands in resource management and as partners of communities engaging in co-management with community groups.

Source: Dr Ampai Harakunarak, Centre for the Study of Marine Policy

2. Pollution Abatement and Control

(a) Land Based Sources

Pollution abatement and control varies considerably within the region. A number of developed countries have enacted and enforced regulations for point source discharges into rivers and harbours, particularly from large industrial sources. These regulations have been effective in reducing industrial wastes in Australia, People’s Republic of China, Republic of Korea, Japan, and New Zealand. Pollution from smaller, more scattered industries has proven more difficult to control as such industries often lack the capital or expertise to achieve pollution abatement and under such circumstances, enforcement of regulations is often arbitrary and ineffective.
A number of countries have implemented comprehensive programmes and subregional policies aimed at reducing pollution entering inland waterways in addition to addressing the impacts to inland and marine habitats caused by transboundary pollution (see Chapter 4).

(b) Sea Based Sources

Australia and New Zealand have developed impressive oil spill response capabilities. For example, oil from a break in a coastal oil transfer site in South Australia in June 1999 was sprayed with oil surfactants by air within hours and oil protection booms set in place to protect nearby beaches well before any oil washed ashore.

As with control of industries, pollution control agreements and legislation is effective for large ships, but in many Asia and Pacific countries, smaller fishing vessels and houseboats are difficult to control or monitor. In Australia and New Zealand, legislation controlling recreational and fishing boats is more effective. For example, organotin antifouling is prohibited and most marine repair yards now incorporate catch basins to prevent paint scrapings washing into the coastal water. Sewage pump-out stations have been set up in many marinas and in some ports, such as Sydney, it is illegal for people to live aboard their boats for more than three days.

Within the region, a number of steps have also been taken to prevent the introduction of marine exotic species. These include increased training and regulations for quarantine officers, research into potential routes of entry, voluntary controls on shipping and promotion of international action through the International Maritime Organization. Two major strategies being used are: to encourage ships to exchange ballast water in the ocean or flush it en route; and to set up quarantine inspection of ballast water prior to discharge. Scientists at CSIRO’s recently established Centre for Research on Introduced Marine Pests (CRIMP) are investigating various options to reduce and manage marine pests. The recently formed Australian Ballast Water Management Council will coordinate these activities and implement principles to ensure adequate quarantine and to reduce the risk of the accidental displacement of species.

3. National Experiences with Restricting Fishing Capacity

Fisheries governance has traditionally been based on command and control, with a variety of regulations based on catch limits, seasons, closed areas and size limits for individual species. While this is marginally effective for commercial fisheries and in countries with strong enforcement capability, it is ineffective for subsistence fishing, particularly in countries with poor enforcement capabilities. All too often, command and control of ocean fishing generated increasing levels of conflict and non-cooperation. Starting in the early 1980’s some governments began a new approach to resource management that incorporated the views of the stakeholders in management decisions and conferred rights to the resource users. In New Zealand, control of industrial fisheries at the national level was based

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**Box 5.5 The Bantay Puerto Programme in the Philippines**

Community participation has played an important part in coastal zone management in the Philippines. The City of Puerto Princesa on the island of Palawan provides a representative example of the Philippines’ approach to resource management. The forests and coastal resources of Palawan had become severely degraded by both commercial activities and the rapid increase in both population and poverty. The City government developed and implemented the *Bantay Puerto Programme* in an effort to protect, conserve and rehabilitate the city’s forest and marine resources so as to improve the residents’ quality of life and to increase the city’s economic contribution to the country by utilising its resources in ways that are ecologically sustainable, socially equitable and economically viable.

Through the mobilization of the local community action groups, the *Bantay Dagat* (dubbed “Baywatch”) and *Bantay Gabat* (“Forest Watch”) programmes proved extremely successful in curbing forest destruction and coastal resource degradation.

The Programme’s key management concept is simple: protect what is there, rehabilitate what has been destroyed or damaged and plan for the management of resource utilization that is environmentally sustainable. Rehabilitation included replanting mangrove trees and setting aside marine conservation areas.

The success of the project was noted by the national government and the 1987-1992 National Development Plan adopted a community-based approach to resource management. Under this approach, local communities were empowered to manage the resources, whilst government provided the necessary enabling conditions, including the provision of appropriate incentives and expertise to properly manage resources. The efficacy of the community-based approach to resource management may be seen from the success of a number of subsequent initiatives anchored to such an approach.

*Source:* Piedad S. Geron 1998
on conferring rights to trade (buy, sell or lease) the entitlement to fish in a particular managed fishery. The rights were generally provided in the form of individual transferable quotas (ITQs) or as a limited number of licences to fish. Internationally, institutions such as the World Bank are also encouraging the adoption of rights-based management.

In subsistence, recreational, and small-scale artisanal fisheries, rights are based on recognition of community control over particular territories. For example, in the Pacific Islands, governments formed partnerships between national fisheries institutions and community stakeholders. Traditional marine tenure and resource allocation mechanisms have been legally and politically recognized in Fiji, Samoa, Vanuatu, the Solomon Islands, and other Pacific island nations. Participatory fisheries governance has proven successful, especially in the small states where community ties remain strong (see Chapter 18). There is an emerging consensus that establishment of specific use or property rights will improve community interest in sustainable management. This has proved difficult after long standing open access approach to sea resources, but early indications from Sri Lanka were that the formal allocation of user rights that give communities greater control over the factors affecting their well-being is a successful solution (UNDP/Government of Sri Lanka 1991).

4. Conservation of Coastal and Marine Resources

Throughout the region, scientists and resource managers have recognized the importance of including key coastal and marine habitats within designated conservation areas. Ideally, the protected zones within a particular area should enable representative habitats to be preserved and should focus, in particular, on habitats that play a key role in the early life stages of marine, estuarine and coastal species. As the vast majority of these species begin their life-cycle as free-swimming larvae and/or spend their juvenile life stages in “nursery” areas, the conservation strategy should provide protected areas that support and maintain the replenishment of populations in the wider marine and coastal environment.

The most successful conservation strategies for preserving key marine and coastal habitats are those that have been implemented as partnerships between resource managers and local communities. The Philippines played a leading role in establishing the principle of community involvement in the management and maintenance of with marine reserves. By the late 1970s, marine reserves established and managed by villagers were demonstrating their effectiveness not only in achieving their conservation objectives, but also in improving the long-term productivity and sustainability of the local fishery, even though the area available for fishing was reduced (Russ and Alcala 1988). This partnership principle has now been applied elsewhere and small-protected marine areas managed by the local community are becoming increasingly common in the region (Box 5.6).

In the late 1990s, the World Bank, in association with the IUCN’s Commission on National Parks and Protected Areas (CNPPA), prepared a database containing the location of every marine protected area in the world, including those in the Asian and Pacific Region (Table 5.7). The database included background information on site characteristics, biodiversity, key species, etc. as a basis for determining future priorities for conservation investment.

Amongst the countries of the region, about four per cent of the coastal waters of New Zealand are included within marine reserves where no fishing activities are allowed. The remote Kermadec Islands Reserve, with 748 000 ha makes up nearly 75 per cent of the total area, with the rest scattered in six smaller reserves and two marine parks. The Department of Conservation and other groups are considering some 24 additional sites to provide protection for a selection of New Zealand’s marine habitats.

Australia’s Marine Policy includes plans to expand the existing network of coastal and marine parks and reserves to provide protection for a cross-section of habitats around the entire Australian coastline. Unlike New Zealand’s marine reserves, Australian marine parks and reserves allow a range of activities, including commercial fishing, in some or all parts of the reserves. Zoning is a prime management tool for the Great Barrier Reef Marine Park Authority, and parts of the World Heritage Site are closed to everyone, even scientists, while other areas are essentially open to all use, except mining and drilling for oil.

The countries of the South Pacific subregion have actively promoted the establishment of parks, reserves and conservation areas and collectively established the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP Convention) (Noumea 1986). Since 1992, when the SPREP focus for conservation shifted to community involvement, the SPREP South Pacific Biodiversity Conservation Programme (SPBCP) has assisted 12 Pacific island countries with the development of 17 conservation areas, almost all of which have a coastal or marine component (see Chapter 18).
5. Harmonizing Aquaculture and Environment

Some progress is being made in the establishment of appropriate legal and regulatory frameworks for aquaculture in a number of the region’s countries, including Malaysia, Papua New Guinea, India, Sri Lanka, the Republic of Korea (Box 5.7) and Thailand.

The Government of India has set up an Aquaculture Authority to regulate the adoption of new technology and the establishment of new farms within and outside the Coastal Regulation Zone. At the State level, the Tamil Nadu Aquaculture (Regulation) Act of 1995 sets out conditions to improve the siting and management of aquaculture facilities and establishes an Ecotourism Fund, supported by deposits from aquaculturists, to remedy environmental damage caused by aquaculture farms. In mid 1998, Thailand’s Ministry of Agriculture, recognizing the accelerated loss of valuable agricultural land to aquaculture, has banned the conversion of rice paddies to shrimp farms.

<table>
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<th>Country/Area</th>
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<td>477</td>
</tr>
</tbody>
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Source: WRI and United Nations Earthwatch website 1999
* Statistics provided by the Government of Malaysia

Box 5.6 The Funafuti Conservation Area Project in Tuvalu

Since Tuvalu separated from Kiribati as an independent nation, the population tripled and unregulated use of the atoll environment led to a marked decline in the quantity of avifauna and marine life on the atoll. Commercial over exploitation of lagoon fisheries undermined the sustainability of important subsistence and local artisanal fisheries. The abandonment of traditional taboos, marine tenure systems and fishing regulations, which were responsible for relatively sustained-yield production over thousands of years, coupled with widespread use of dynamite, pesticides and small mesh gillnets degraded important fisheries resources. By 1992, species of particular nutritional and cultural importance showing evidence of over exploitation included a range of groupers and snappers, emperors and rabbitfish, giant clams, spider conch, lobsters and crabs.

In October 1995, the people of Funafuti, the capital island of Tuvalu, launched the Funafuti Conservation Area Project (FCA). The Government of Tuvalu and the South Pacific Regional Environment Programme (SPREP) supported the people’s initiative through the provision of the technical assistance and material resources that the project needed. The project objective was to conserve the biodiversity of Funafuti atoll through the sustainable use of natural resources for the benefit of the community and their descendants.

The project conception was developed in the traditional government manapā after lengthy discussions between the community elders and officials from the national and regional environment organizations. The designated conservation area covers an oblong shaped area of 150 square kilometres or one-third of the total lagoon-fringed island. The conservation vision of the manapā was based upon the elders’ recollection of the abundance of marine and bird life on Funafuti in the 1950s and 1960s.

Three years after the project was launched, there was a marked increase in the abundance of marine and bird life in the conservation area. The area was patrolled daily and scientific assessments were carried out by visiting conservation scientists from SPREP. Offenders of the conservation rules have been dealt with and according to manapā rules and also mentioned in parliamentary exchanges.

In 1997 a Tuvalu Tourism Marketing and Development Action Plan offered the Marine Conservation Area as the cornerstone for the development of a small-scale eco-tourism business. The project funded SCUBA diving courses with certification to provide the human resources and interest for a Dive Operation. A Tourist information centre, the Funafuti Interpretative Centre, was constructed in 1998 and buoys were deployed marking the boundary of the marine reserve. Community workshops discussed community involvement in resource management, the role of protected areas, and the results of the coral reef baseline survey. A pamphlet on management practices for the Funafuti Conservation Area was produced in Tuvaluan and English and several radio talk shows were aired.

The FCA is a success story to the extent that the community has been fully involved in all stages of the project’s planning and implementation. The conspicuous return to the abundance of marine and bird life that existed thirty years ago has served to heighten interest and awareness in the benefits and value of conservation. The project is being replicated in other islands in Tuvalu.

Source: 1. SILIGA A. KOFE, ESCAP POC, Port Vila, and Vanuatu  
2. UNCED 1992
Box 5.7 Aquaculture and the Environment in the Republic of Korea

In the Republic of Korea, marine aquaculture expanded rapidly from its start in the mid-1960s such that by 1996 the country’s aquaculturists produced 538,990 tonnes of seaweed, 306,738 tonnes of molluscs, 11,402 tonnes of finfish and 382 tonnes of crustaceans. The laver culture is carried out by means of a pole and floating net system, while sea mustard and kelp are cultured by long-line systems. Molluscs are farmed using a long-line system for oysters and mussels and a bottom planting system for clams and arkshells. Most of the culture of finfish is carried out in floating net cages, while the culture of prawns is done in embanked ponds.

All aquaculture farms in the country require licensing by municipal authorities. Additionally, all cage culture and other aquaculture involving more than 1,000 m² in surface area must be registered with the Ministry of Environment and operated according to the Aquatic Environment Protection Law. Provisions seeking to minimize the pollution from cage culture include: the use of low-phosphate foods with a sinking rate that does not exceed 10 per cent within a two-hour period and the installation of feed fences with a height of 10 cm above the sea surface to prevent the dispersal of food outside the cages. Aquaculturists are also required to prevent the difference in oxygen levels within and outside the cages exceeding 20 per cent and to remove dead fish immediately and report incidences of diseased fish to the local fisheries administrations. The use of antibiotics and drugs for the control of fish diseases is regulated under the Aquatic Environment Protection Law, whilst licensing provisions require that the seabed under and immediately adjacent to farms is cleaned of debris with dredges more than once every three years.

The Regulations Governing Sanitary Control of Shellfish and their Growing Areas, administered by the Ministry of Maritime Affairs and Fisheries, provide for the administration of water quality standards and the control of water pollution from aquaculture. The National Fisheries Research and Development Institute monitors water quality within the shellfish culture areas as well as the incidence of contaminants in the flesh of the aquaculture products. This entails routine sampling of sanitary indicator bacteria, nutrient salts (to assess eutrophication levels), pesticides and heavy metals. The median coliform most probable number (MPN) of the water should be less than 70/100 cm³, and not more than 10 per cent of the samples taken should have an MPN greater than 230/100 cm³ during the most unfavourable hydrographic and pollutant conditions. The incidence of red tides is also monitored in association with the early warning of aquaculturists when toxic species are identified.

The Environment Impact Assessment Law requires the preparation of an environmental impact assessment (EIA) prior to the construction of city and industrial complexes, port development, land reclamation and water resource development. The establishment of aquaculture ventures is not currently subject to EIA, although this is planned in the near future. The transport of aquatic animals and plants, including the introduction of new species, the quarantining of imported species and the prevention of infected or recessive exotic species into Korean waters, are all subject to regulation by the Ministry of Maritime Affairs and Fisheries. Regulations under the Marine Pollution Control Law provide for government compensation to aquaculturists in the event of economic loss owing to abnormal environmental changes such as harmful algae blooms. Compensation may also be sought from private entities and public utilities arising from pollution (including oil spills), reclamation and industrial activities.

Major pollution control and abatement measures under way or planned since 1991 include: the classification of coastal areas according to intended use (fisheries, recreational, agricultural and industrial); the strengthening of water quality standards and the control of industrial and municipal effluent into coastal waters; a national seawater quality monitoring system (for which 280 sampling sites were designated in 1996); investment in treatment facilities for sewage, industrial wastewater and excretion (for the equivalent of US$3.1 billion during the period 1992-1996); the requirement to undertake EIA for all coastal development activities; and the designation of special conservation areas in which most development activities would be prohibited.

These efforts in the Republic of Korea have greatly helped in the promotion of sustainable aquaculture in the country.

Source: Hak Gyoon Kim 1995

Elsewhere within the region, certain states and some NGO’s, including producer groups, have developed and implemented codes of conduct and practice for particular aspects of aquaculture. Examples include the Code of Practice for Mangrove Protection by the Global Aquaculture Alliance (GAA); the Code of Practice for Australian Prawn Farmers; the codes of practice for cage culture of finfish and pond culture of shrimp in Malaysia; and guidelines for sustainable industrial fish farming (Anon 1997).

B. International Initiatives


Amongst its various provisions, UNCLOS provides a legal foundation for the sustainable development of coastal and marine resources. Most coastal countries have signed the Convention, primarily in order that they might benefit from the provisions relating to the national ownership of
fishing and mining rights extending 200 nautical miles from their coasts. Through the allocation of exclusive rights for a large portion of the world’s oceans, the Convention has curtailed the “free for all” approach that had previously encouraged maximum capacity exploitation and had prevented individual nations from implementing conservation and resource management strategies.

Although the implementation and maintenance of the UNCLOS provisions has been slow and problematic, the Convention has fostered the development of national policy and legislation for protection of the coastal and marine environment. In 1998, for example, Australia became the first country in the world to establish a national ocean policy and New Zealand is expected to introduce similar provisions in the near future (Michaelis 1999).

To assist with the implementation of the provisions of the Law of the Sea, the twenty-eighth session of the FAO Conference formulated a Code of Conduct for Responsible Fisheries that provided guidelines for sustainable fishing activities. The Code of Conduct also recommended a regional approach to: (i) the strengthening of scientists’ and administrators’ capacities; (ii) the development of timely and reliable fisheries information and statistical data as well as the setting up of a regional network; (iii) research and management considerations for shared or transboundary fish stocks; (iv) the development of methodologies for stock assessments; the prevention and control of degradation; and the monitoring of large ecosystems such as the South China Sea or the Gulf of Thailand (FAO 1999).

2. Regional Seas Programme The action-oriented Regional Seas Programme was established more than 20 years ago and now encompasses a large number of discrete regions worldwide, including five regions that include ESCAP member countries of Asia and the Pacific; the East Asian Seas; the North West Pacific; the South Pacific; the Kuwait region (including the Islamic Republic of Iran); and the Mediterranean Seas Region (including Turkey).

The activities of the individual Regional Seas Programme are endorsed by each of the member countries and have typically included joint approaches to environmental assessment and management, legislation and institutional and financial arrangements. National institutions within each of the regions are responsible for implementing agreed actions with the main funding being provided through trust funds provided collectively by the region’s governments. The long-term goal is the implementation of relevant global environmental conventions and other agreements, including the Law of the Sea, the London Convention and International Maritime Organization regulations.

3. Support to Coastal Zone Management In the Asian and Pacific Region, ESCAP, the International Centre for Living Aquatic Resources Management (ICLARM) and SPREP have been actively involved in the promotion of sustainable coastal management and have prepared a range of management guidelines and studies including EIA tools for industrial and urban development in coastal areas, port infrastructures, tourism development, hazardous waste management and industrial pollution control. In addition, UNCED’s Agenda 21 and the FAO (Clark 1992) have provided guidelines on the integrated management of coastal resources, including coastal fisheries (Scura 1994).

The 1996 International Workshop on Integrated Coastal Management in Tropical Countries reviewed regional progress in the formulation, design, implementation and extension of integrated coastal management (ICM) and produced a set of Good ICM Practices (IWICM 1996). In addition, there has been recent assessment of the current objectives and methods for evaluating internationally funded coastal management projects (Sorensen 1997).

In its efforts to strengthen the capacity of governments, NGO’s and the private sector in coastal zone management, the FAO has collaborated with a range of institutions, including ICLARM, NACA, the United Nations Statistics Division, IUCN and other United Nations agencies sponsoring ICM activities. These international efforts have included pilot project to test alternative management approaches and the publication of guidelines on managing the environmental impact of aquaculture. Table 5.8 illustrates the range of regional organizations that provide support to the sustainable management of coastal and marine resources within the South Pacific subregion.

4. Control of Pollution from Ships The control of maritime pollution is primarily founded on three international agreements: (i) the International Convention on Civil Liability for Oil Pollution Damages; (ii) the International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties; and (iii) The International Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention). The United Nations International Maritime Organization (IMO) administers these agreements and was responsible for introducing subsequent safety and environmental regulations for the oil tanker industry to prevent ocean dumping, ship-based discharges and accidental spills. The new
rules required double-hulled construction, improved cargo handling procedures and more cautious operations in port and at sea. As a result, the volume of oil spilled into the oceans has dropped by 60 per cent since 1981, even though the amount of oil shipped has almost doubled (Zann 1995).

IMO also works closely with a range of other international and regional organizations in the development and implementation of new maritime pollution control initiatives including the Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas, a programme to raise the safety standards of small ships, craft and passenger ferries which are not within “Convention size” and, in conjunction with the ESCAP and with funding from the Netherlands, IMO has been conducting workshops on the adoption of the Convention on the Facilitation of International Maritime Traffic.

IMO’s Pacific programme assists with legal, port and safety issues related to maritime transport and has been focussed on upgrading the South Pacific Maritime Code and on the implementation of the 1993 Strategy for the Protection of the Marine Environment prepared jointly with the South Pacific Regional Environment Programme (SPREP) and the Marine Division of the South Pacific Forum.

5. Regulating By-catch
The 1995 United Nations Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks seeks to minimize pollution, waste, discards, catch by lost or abandoned gear and catch of non-target fish and non-fish species. These objectives were reiterated in the Plan of Action produced by the International Conference on the Sustainable Contribution of Fisheries to Food Security, held in Kyoto, Japan, in 1995 (FAO 1999).

The FAO’s Code of Conduct for Responsible Fisheries requires: “States, with relevant groups from industry, should encourage the development and implementation of technologies and operational methods that reduce discards. The use of fishing gear and practices that lead to the discarding of catch should be discouraged and the use of fishing gear and practices that increase survival rates of escaping fish should be promoted. Where selective and environmentally safe fishing gear and practices are used, they should be recognized and accorded priority in establishing conservation and management measures for fisheries.” (FAO 1999).

The Technical Consultation on the Reduction of Wastage in Fisheries, held in Japan in October 1996, concluded that there had been significant improvements in reducing discarded by-catch in the previous decade. This had come about as a result of less fishing effort, time and area closures of fishing grounds, the use of more selective gear, the utilization of previously discarded by-catch, enforced prohibitions on discarding and consumer-led actions.

Some types of fishing gear, especially long drift nets, had such extensive and damaging effects on target and non-target species that they were banned, either nationally or regionally. For example, the countries of the South Pacific joined together to successfully ban long drift nets from the entire South Pacific subregion, even on the high seas beyond national EEZs (see Chapter 18).

Public concern over by-catch of marine mammals, especially dolphins, resulted in public boycotts of tuna and the initiation of a “dolphin safe” labelling programme. This, in turn, resulted in the development of purse seines and fishing techniques that minimized by-catch of dolphins.

6. International Conventions on Marine Wetland
The only international convention to focus specifically on wetlands is the Convention on Wetlands of International Importance (The RAMSAR Convention 1975) (see Chapter 3). Member governments undertake to; (i) designate at least one wetland for inclusion in the List of Wetlands of International Importance; (ii) promote wise use of wetlands; (iii) consult with each other on implementation obligations arising from the Convention, especially, but not exclusively, in the case of a shared wetland or water system; (iv) create wetland reserves. The Convention fosters international cooperation for shared water resources and shared species and provided for the establishment of a Wetland Conservation Fund to provide assistance to developing countries for wetland conservation activities. To date, 67 countries have signed the Convention and 66 have ratified it.

There are 106 RAMSAR wetlands in the Asian and Pacific Region, totalling some 9 698 000 ha. Australia, a founding member of RAMSAR, has designated 40 wetlands, totalling 4 481 346 ha, under the Convention. Other countries that have designated wetlands under the RAMSAR Convention include the Islamic Republic of Iran (18 designated wetlands), Japan (nine), Pakistan (nine), India (six), People’s Republic of China (six) and New Zealand (five).

The Convention for the Protection of the World Cultural and Natural Heritage (1975) has designated 36 World Heritage Sites within the region. Of these sites, five are coastal or marine areas: (i) The Great Barrier Reef (Australia); (ii) Fjordland National Park (New Zealand); (iii) Sundarbans National Park (India); (iv) Lord Howe Island (Australia); and (v) Henderson Island (United Kingdom).
### Table 5.8 Regional Organizations for the Sustainability of Coastal and Marine Resources in South Pacific

<table>
<thead>
<tr>
<th>Regional Organization and member states</th>
<th>Primary activities related to marine and coastal issues</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Coastal Zone Management</td>
</tr>
<tr>
<td>SOPAC The South Pacific Applied Geoscience Commission</td>
<td>Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu</td>
</tr>
<tr>
<td>SPC – Secretariat of the Pacific Community</td>
<td>Australia, American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Wallis and Futuna</td>
</tr>
<tr>
<td>SPF – South Pacific Forum Fisheries Agency</td>
<td>Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu</td>
</tr>
<tr>
<td>SPREP – South Pacific Regional Environment Programme</td>
<td>Australia, American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Wallis and Futuna</td>
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Source: IWICM 1996

7. Ocean Monitoring

The International Oceanographic Commission (IOC) has established the Global Ocean Observing System (GOOS) to provide information in support of oceanic and atmospheric forecasting, ocean and coastal zone management and research into global environmental change. The system will also serve the needs of the Framework Convention on Climate Change, by underpinning the ability to forecast changes in climate.

The GOOS also includes an integrated, multi-disciplinary, coastal observing system for detecting and predicting change in coastal ecosystems and environments including eutrophication due to nutrient enrichment, toxic contamination, habitat loss, saltwater intrusion, flooding and storm surges, harmful algae blooms and sea level rise.

Databases and sampling methods are gradually becoming standardized for a wide range of coastal and marine ecosystems. More than 230 ichthyologists from 54 countries assembled key information on all species of fish in the world into a single “FishBase” now available on the Internet (www.fishbase.org) and on annually updated CD-ROMs. FishBase eliminates confusion over taxonomic identification of species between scientists from all countries and provides rapid access to the world’s knowledge of the ecology, biology and use of fish resources (Froese and Pauly 1997).

The revolution in ocean monitoring, combined with the facilitation of information exchange over the Internet, assists collaboration between developed and undeveloped nations. For example, the Hong Kong University of Science and Technology initiated and coordinated a global “Reef Check” project over the Internet to ascertain the current state of 400 coral reefs in over 40 countries. The Internet not only helped test and standardize ways to identify and measure important indices of ocean ecology, but also enabled the participation of more scientists, and even non-scientists, in the monitoring process.

### Conclusion

The vulnerable coastal and marine ecosystems of the Asian and Pacific Region provide major resources to the region’s peoples supporting a diverse and stabilizing natural system. However, the pace of coastal development and increasing pollution loads threaten the sustainability of the marine and coastal resources and the continued exploitation of the significant reserves of offshore oil and gas provide...
the potential for both economic prosperity and an increased risk of environmental degradation.

Coastal wetlands, seagrass beds, coral reefs and the sea surface microlayer are key habitats that are especially vulnerable to physical damage and chemical pollution. The reproductive cycles of marine organisms, including finfish, are linked to these key habitats and damage to the habitats reduces the ability of fish and invertebrates to withstand fishing pressure. Many of the region’s major fishing areas are showing signs of overfishing; for example, the key species of the Northwest Pacific fishery, the second largest fishery in the world, are currently fished at maximum capacity, rather than at sustainable levels, and, as a consequence, stocks are declining. Although reducing fishing capacity has proved to be a lengthy and politically unfavourable issue, governments have begun the process by reducing fishing subsidies and regulating fishing access rights. The South Pacific Tuna Fishery offers a model of international cooperation for open sea fishing that may prove to be the first sustainable, multi-national ocean fishery in the world.

International agreements and treaties calling for protection of the marine and coastal environments, such as Agenda 21, the United Nations Convention on the Law of the Sea, the FAO Code of Conduct for Responsible Fisheries, have forged a new international awareness of the need for ocean conservation. Although countries in the region are making progress in meeting their obligations under these international agreements, progress is slow and many countries may find the requirements beyond their economic or political reach.

A new consensus seems to be emerging with regard to institutional approaches to the management of marine and coastal resources involving coordination among national government sectors, ministries and departments (fisheries, forestry, agriculture, environment, etc.) as part of a co-operative network of national, state, and local management with active participation of the civil society. Typically, this involves the national government preparing common guidelines and standards and then supporting implementation through the provision of technical and financial assistance to local state, regional or provincial government. Local government then works directly with community members to design long-term coastal plans and to establish community supported monitoring and enforcement activities. This combines both top-down and bottom-up elements with a willingness to form mutually advantageous partnerships between all levels of governance. As success depends on an understanding of the biological necessities of maintaining coastal and marine ecosystems, this approach to integrated management is typically supported by an open system of education and communication.

The control of marine pollution and the establishment of integrated coastal management programmes are legally and institutionally complex and progress has only been possible through international cooperation and, at the local level, the active involvement of key stakeholders and particularly locally affected communities. Future programme success will require the evolution of new mechanisms of open communication and education to enable partnerships between the civil society and government for the protection and sustainable development of the coastal and marine environment.