

COUNTRY REPORT

Country: Singapore

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Introduction

The Republic of Singapore consists of a main island and almost 60 small offshore islands. The main island and islets cover an area approximately 647 km², and surrounding territorial waters, an almost equal area of 630km². It has a population of approximately 3 million people, covering a high population density of 4,600 persons per km² in 1995 (Ministry of Information and the Arts, 1996). Founded as a entreport in 1819, the country has seen large scale economic development since the 1960s, and has been transformed from an economic backwater to one of the newly industrialized economies (NIEs), often described as one of the four "dragons" of Asia (Hilton & Manning, 1995). Singapore's marine environment is an important resource, playing a large role in its economic growth and prosperity, supporting the world's busiest harbour and the world's largest oil refining centre. In the early part of the development of Singapore, due to the immediate need for housing the population and aggressive economic growth, much of its natural coastal habitat was destroyed to make way for public housing and industries. It is estimated that only 1% of the original mangrove forests remains in mainland Singapore (Chou *et al.*, 1980), while an estimated 60% of total reef areas have been lost through foreshore reclamation (Chou, 1995).

1. Coastal Management

In Singapore's highly urbanised society, fishing and collecting from the coral reefs and other coastal areas, either for the aquarium trade or for subsistence, has declined steadily since the 1980s with stricter action taken by the Police Coast Guard. For example, in Oct 1991, five men were arrested by the Coast Guard and their cargo of corals confiscated. This arrest was the first of its kind in Singapore (Anon., 1991a). However, no further reports of such arrests have been made.

Coral reefs

In 1991, three NGOs recommended to the Government that some coral reefs in the southern islands be conserved. Four reef areas were selected for conservation after a survey was conducted by over 150 volunteer sport divers, using the transect method described in Dartnall & Jones (1986). Results of this survey indicated the occurrence in these four areas of 197 species of scleractinian corals from 55 genera (Chou, 1993). However, the abundance and diversity of other reef organisms such as fish, spiny lobsters, and molluscs has declined due to habitat degradation and earlier removal by collectors. The Government, through the National Parks Board, carried out a detailed study on the feasibility of protecting and managing the four proposed areas. These were eventually included in the 22 areas identified for conservation under the Green Plan. A Working Group on Nature Conservation was formed by the Government to implement policy directions concerning these areas. The four marine areas have a total extent of 37.25km² (5.9% of the territorial waters). Within these areas, coral reefs occupied 7km² while the islands took up 6.5km². These areas also contain a variety of other coastal habitats such as seagrass beds, mangroves and sand flats. Recommendations for conservation included:

- * making the proposed areas protected areas and imposing restrictions.
- * restrict the issue of permits (by the Land Office, Ministry of Law) for coral collection to research, conservation, and educational purposes only
- * enforce legislation to prevent illegal harvesting of corals
- * prevent dumping of spoils within and around identified coral areas and also prevent pollution from land reclamation activities
- * cultivate appreciation for nature among young Singaporeans
- * raise general public awareness of nature conservation and improve resources to provide its appreciation
- * avoid indiscriminate promotion of ecotourism

The Police Coast Guard was identified as the agency to enforce the laws protecting coral reefs against commercial harvesting within the four areas. However, there has been no progress in the upgrading of these areas to a protected status, except for the 1996 declaration of one of them into a Marine Nature Area to be administered by the Nature Parks Board (Nathan, 1996a).

Mangroves

The only mangrove area that has been designated as a nature reserve is at Sungei Buloh. Other mangrove forests at the Mandai - Sungei Khatib Bongsu - Loyang network of mangroves have been designated as nature areas under the "Green Plan". In addition, there are park areas which include mangroves, eg. Pasir Ris Park (northeastern Singapore).

While no specific laws for the protection of the mangrove forests exist, protection of the wild animals and the natural habitat are covered by the Wild Animals and Birds (WAB) Act (1974), the Parks and Trees Act (1975) and a National Parks (NP) Act (1990). These Acts are administered by the National Parks Board. However, loopholes in the structure of the laws exist (Lye, 1991), which need to be reconciled.

Seagrass

The loss of seagrass beds has had little observable impact, despite its importance to fisheries as nursery grounds (Wood *et al.*, 1969). This is due to the near non-existence of commercial fisheries in Singapore waters. There was a reduction in subsistence fishing (Tham, 1973), but there is no evidence to link this with the degradation of seagrass beds.

No management plans for the conservation of existing seagrass stands or the restoration of denuded beds have been initiated, as the importance of seagrass ecosystems as a sustainable resource has not been fully appreciated. This potential is highlighted by a pilot study in the Singapore River that found artificial seagrass to be effective in increasing the fauna within three months of its implantation (Lee & Low, 1989). The conservation of seagrass beds has so far been incidental: one of the marine conservation areas has an extensive seagrass bed (*Enhalus* sp.) on its reef flat.

Industrial pollutants

There is an ever present risk of pollution from the heavy shipping activity and shipyards along the coastline. The Maritime and Port Authority of Singapore (MPA) monitors for hydrocarbons, utilising technology such as satellite imagery to convict polluters (Teo, 1997). In addition, Singapore is an active participating member in the following programmes:

- * The ASEAN oil spill contingency plan initiated by the ASEAN Expert Group on Environment (AEGE) in 1970, and has developed to include the participation of the International Maritime Organisation (IMO) and the United Nations Environment Programme (UNEP). The ASEAN Senior Officials on the Environment (ASOEN) formed in 1990 is expected to ensure that the regional oil spill contingency plan is implemented successfully.
- * The Oil Spill Preparedness and Response Plan (OSPAR), with Japan providing financial support to ASEAN for equipment to combat oil spills, and also the operation of an information network to document oil spills.
- * The East Asia Response Ltd. (EARL), formed by British Petroleum, Caltex, Exxon, Mobil and Shell, which stocks equipment capable of handling oil spills of between 10,000 and 30,000 tons (Chua, 1994).

International protocols and conventions to control shipping traffic have also been adopted and implemented to minimise the risk of marine pollution. These programmes include:

- * The Traffic Separation Scheme (TSS), developed by the Tripartite Technical Experts Group (TTEG), which was adopted and implemented by Singapore, Malaysia and Indonesia in 1981 to reduce accidents along the heavily used Straits of Malacca and Straits of Singapore. A Vessel Traffic Information Scheme was set up in Singapore to ensure compliance with the TSS.
- * The Asia-Pacific Memorandum of Understanding on Port State Control in the Asia-Pacific Region (1993), which establishes and maintains a system to ensure that all foreign ships visiting ports complied with the regulations set by the international conventions of MARPOL 73/78, the International Convention on Standards for Training, Certification and Watchkeeping for Seafarers (1978), the Convention on the International Regulations for Preventing Collisions at Sea (1972) and the ILO Convention No 147 Concerning Minimum Standards in Merchant Ships (1976) (Koh & Lim, unpublished).

The Pollution Control Department (PCD), Ministry of the Environment is the central agency coordinating and implementing controls on pollution. They are responsible for environmental planning and building development control, air and water pollution control, hazardous substances and toxic wastes management. Industries may be required to conduct environmental impact assessments, including measures to reduce and control discharges of waste water and cooling water, and the disposal of wastes. Industrial effluent and sewage must meet the standards set by the PCD, which is backed by several Acts and Regulations, for example, the Trade Effluent Regulations, 1976 and the Poisons Act (Hazardous Substances Rules, 1986). The collection and disposal of toxic industrial waste is also controlled through

licensing. Monitoring of the inland waterways and coastal waters is carried regularly by the Strategic Planning and Research Department (SRPD) at some 83 points in and around the island. Inspections and checks on industrial premises is also carried out by the Sewerage Department and the Public Utilities Board. Heavy penalties are imposed on offenders.

Reclamation and Development

Reclamation is expected to continue until the year 2000 and will make the country 25% larger than its original size in 1967 (Loo & Chou, 1995). As a result much of the southern islands will be developed and marine life affected as the coral reefs and seagrass beds become affected. High sedimentation levels from these activities have been recorded. Dredging and earth spoils dumping are also partly responsible. Other impacts from the development of the islands include alteration of water flow around the reefs, point sources of pollution from visitor facilities, anchor damage from pleasure craft and disturbances caused by snorkellers and SCUBA divers.

Certain mangrove areas (eg. Sungei Buloh) were developed for prawn and poultry farming in the past. However, such activities on the mainland have ceased, and are now confined to the island of Pulau Ubin in the northeast.

Natural impacts

Coral bleaching, attributed to the El Niño event, did not affect corals in Singapore. Storm-induced damage and *Drupella* infestations are negligible while *Acanthaster* infestations have not been recorded.

Integrated management

While protection of terrestrial habitats is well established with specialised agencies having the appropriate legislative framework, an integrated management strategy for coastal waters does not exist, despite the increasing pressure of multiple use on coastal waters. The lack of an institutional mechanism for coordinated protection of coral reefs and marine life needs to be addressed. Steps are being taken to integrate and update existing laws, including the formulation of an "umbrella" law (Anon., 1994), encompassing four separate Acts that cover the environment (the Water Pollution Act, the Clean Air Act, the Environment Public Health Act and the Poisons Act). A review of current industrial site laws is also underway (Nathan, 1996b). A single agency that has full jurisdiction of both land and sea over the proposed areas is needed. The National Parks Board is seen as the most appropriate agency for these responsibilities. Additionally, many developers are now conducting baseline studies and environmental impact assessments of proposed major projects, even though such studies are not mandatory.

2. Capacity Building

Education

Several organisations are involved in the dissemination of information on conservation issues to the public:

The Nature Society (Singapore) (NSS) is made up of conservation-minded individuals, and is educating the public through talks and books, such as the "The Singapore Red Data Book" (Ng & Wee, 1994). However, the emphasis of the Society is terrestrial.

The Reef Survey and Conservation Project involving three non-governmental organisations (Republic of Singapore Yacht Club, Singapore Institute of Biology and Singapore Underwater Federation) trained 150 volunteer divers to conduct coral reef surveys in the southern islands of Singapore between 1987 and 1991. Based on the information gathered, four areas of coral reefs worthy of being conserved were identified (Chou, 1990; 1991a), and the report submitted to the Government for consideration.

The Singapore Environmental Council (previously the National Council on the Environment), has initiated many projects aimed at increasing the awareness of school students on conservation issues, including the Reefs Insights programme, which is targeted at secondary and pre-university students.

The National University of Singapore, comprising academic staff, research assistants and post-graduate students, supply scientific and technical support to many of the projects and publications on conservation. Posters and publications from the School of Biological Sciences (formerly Department of Zoology), National University of Singapore and the Singapore Science Centre provided an educational value to the public.

Courtesy mooring buoys were deployed by the Singapore Environment Council and Raffles Marina in 1994 (sponsored by Shell Pte Ltd.) around a reef popular with boats and divers in an effort to reduce anchor damage.

The Singapore Underwater Federation (SUF) has also been active in promoting environmental awareness. Activities organised include underwater clean-up of some popular dive sites and a snorkelling programme for school children. They are also spear-heading a re-survey of the coral reefs to ascertain their present state of coral reef health and a mooring buoy adoption scheme.

Programmes for International Year of the Reef

The institutional members of the RSCP and NSS have joined forces, through the formation of the Singapore Reef and Marine Conservation Committee (SRMCC), to coordinate their efforts, pool resources and become stronger in making recommendations to the government. Activities planned for the International Year of the Reef include the deployment of mooring buoys, conducting another broad scale survey of the coral reefs involving volunteer divers and other education and public awareness activities.

3. Research and monitoring

The School of Biological Sciences, National University of Singapore, has been involved in many research initiatives, both local and regional, including:

- * The ASEAN-Australia Marine Science Project: Living Coastal Resources (1985 to 1995).
- * The ASEAN-US Coastal Resources Management Project (1987 to 1992).
- * The ASEAN-Canada Cooperative Programme on Marine Science (since 1987).
- * The United Nations Environment Programme-East Asian Seas Action Plan.
- * The UNDP/IMO Regional Programme on the Prevention and Management of Marine Pollution in the East Asian Seas.
- * The monitoring of artificial reefs as an enhancement tool in the rehabilitation of degraded reefs, which was initiated in 1989.
- * The monitoring of soft-bottom benthic communities of major rivers of Singapore in a 5-year programme. This project is a joint project involving the School of Biological Sciences, National University of Singapore and the Ministry of the Environment, and began in 1993.
- * The Reef Survey and Conservation Project (1987 to 1990).

Publications from these and other projects include:

Coral reefs

- Community structure (Teo, 1982; Chou, 1985, Chou & Teo, 1985; Chou & Wong, 1985; Chou, 1986a; Chou & Koh, 1986; Chou & Wong, 1986; Chong, 1986; Chou & Lim, 1988; Chou, 1988a; Lim *et al.*, 1990; Chua & Chou, 1991; Goh & Chou, 1991; Chua & Chou, 1992; Goh & Chou, 1994a);
- Distribution and systematics of the crinoids (Lim, 1987) and hard coral associates (Goh *et al.*, 1989);
- Biology of the gorgonians (Goh, 1991; Goh & Chou, 1994b), tunicates (Lane, 1987) and sea urchins (Lee, 1968; Hori *et al.*, 1987);
- Bioactive compounds from corals (Ding *et al.*, 1994);
- Inter- and intra-specific interaction between coral colonies (Wong & Chou, 1993)
- Productivity of coral organisms (Tun *et al.*, 1994 [a]; [b]);
- The enhancement of degraded reefs through the use of artificial substrata (Chou, 1986b; Chou & Hsu, 1988; Chou, 1988b; Chou, 1991b; Chua & Chou, 1994).
- Community structure of reef fish (Lim *et al.*, 1990; Lim & Chou, 1991; Low & Chou, 1992).
- Population dynamics of the pomacentrid community (Leng, 1990);
- A pilot study on the recruitment of fish was conducted (Low & Chou, 1994a).
- Sedimentation rates (Chan, 1980; Lane, 1991; Low & Chou, 1994b).

Seagrass

- Research on the associate shrimp *Periclimenes indicus* and molluscs of *Enhalus* beds at Pulau

Hantu (Itoggi, 1971; Low, 1973)

- Quantitative and qualitative assessment of seagrass distribution and associated fauna during the ASEAN-Australia LCR project (Hsu & Chou, 1989a & b).
- Loo *et al.* (1990) conducted a qualitative study on the seagrass-associated fish community.
- Preliminary *in situ* primary productivity work on *Enhalus acoroides* using an automated respirometer (Tun *et al.*, 1994a).

Mangroves

- A summary of the state of Singapore mangroves compiled by Chou *et al.* (1980) provided an inventory of 1200 taxa.
- An updated list of brachyuran crabs was reported by Tan & Ng (1994).
- Fish fauna in some mangrove areas were reported at Low & Chou (1993; 1994c) and Lim & Larson (1994).
- Murphy (1992) on the natural history of insect herbivory on mangrove trees.
- The benthic soft-bottom community of mangrove habitats has also been examined by Goh & Chou (1993) at Sungei Buloh and Chung & Goh (1990) at Pulau Tekong.
- Faunal zonation at Pandan mangroves (in the south of Singapore) was studied by Berry (1963).
- Murphy & Lee (1991) attempted to elucidate zonal patterns of mangrove trees from stem count data and measurement of tidal ranges in the Mandai mangroves (in the north of Singapore).

Future research activities

The School has enhanced its capacity for marine science monitoring since 1984 with better equipment and facilities. In addition to monitoring programmes to detect temporal change in the coral reef community, seagrass beds and mangrove forests, emphasis on *in situ* studies on the effects of pollutants on the coral reefs and *in situ* coral reef productivity studies to further our understanding of coral biology must be initiated. Research capacity will be further enhanced with the recent establishment of a Tropical Marine Science Initiative by the National University of Singapore.

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