

Conservation of our natural heritage: The Singapore experience

Jeffrey Low, Liang Jim Lim

National Biodiversity Centre, National Parks Board, 1 Cluny Road, Singapore 259569

Corresponding author: jeffrey_low@nparks.gov.sg

Abstract. Singapore is a highly urbanised city-state of approximately 710 km² with a population of almost 5 million. While large, contiguous natural habitats are uncommon in Singapore, there remains a large pool of biodiversity to be found in its four Nature Reserves, 20 Nature Areas, its numerous parks, and other pockets of naturally vegetated areas. Traditionally, conservation in Singapore focused on terrestrial flora and fauna; recent emphasis has shifted to marine environments, showcased by the reversal of development works on a unique intertidal shore called Chek Jawa (Dec 2001), the legal protection of Sungei Buloh Wetland Reserve (mangrove and mudflat habitats) and Labrador Nature Reserve (coastal habitat) in 2002, the adoption of a national biodiversity strategy (September 2009) and an integrated coastal management framework (November 2009). Singapore has also adopted the “City in a Garden” concept, a 10-year plan that aims to not only heighten the natural infrastructure of the city, but also to further engage and involve members of the public. The increasing trend of volunteerism, from various sectors of society, has made “citizen-science” an important component in many biodiversity conservation projects, particularly in the marine biodiversity-rich areas. Some of the key outputs from these so-called “3P” (people, public and private) initiatives include confirmation of 12 species of seagrasses in Singapore (out of the Indo-Pacific total of 23), observations of new records of coral reef fish species, long term trends on the state of coral reefs in one of the world's busiest ports, and the initiation of a Comprehensive Marine Biodiversity Survey project.

Key words: Singapore, conservation, marine, natural heritage

Introduction

Singapore is a highly urbanised city-state of approximately 710 km² with a population of almost 5 million. While large, contiguous natural habitats are uncommon in Singapore, our warm tropical climate makes Singapore a haven for rich biodiversity despite our small land mass. Thousands of species occur within the four Nature Reserves, 20 Nature Areas, its numerous parks and pockets of naturally vegetated areas (NParks, 2010).

The Nature Reserves in particular, contain within their boundaries elements of our indigenous habitats: lowland dipterocarp forest, (Bukit Timah Nature Reserve), climax secondary forest, including freshwater swamp forest (the Central Catchment Nature Reserve), mangroves, (Sungei Buloh Wetland Reserve) and coastal hill forest (Labrador Nature Reserve). In addition, one of the reserves, the Sungei Buloh Wetland, holds the distinction of being an ASEAN Heritage Park, as well as an important link in the chain of stop-over sites for migratory birds from as far as Siberia. Together, the four nature reserves cover more than 3,000 hectares or 4.5% of Singapore's land area. A network of green space, parks and park connectors, comprising an additional

4.5% of our land area, supports and buffers these Nature Reserves.

While conservation had focused on terrestrial aspects in the past, recent emphasis has shifted to marine environments, showcased by the reversal of development works on a unique intertidal shore called Chek Jawa (MND, 2002), and the upgrading of Sungei Buloh from a “nature park” to Wetland Reserve (SBWR, undated) and re-designation of Labrador Park to Nature Reserve (NParks, 2009a). These areas are primarily in the north of Singapore (Fig.1). The coral reefs are to the south, scattered among 30 patch reefs and islands.

Conservation work was further enhanced with the adoption of a national biodiversity strategy and action plan (NParks, 2009b) and an integrated coastal management framework (PEMSEA, 2010). Singapore has also initiated the “City in a Garden” programme (NParks, 2009c), a 10-year plan that aims to not only heighten the natural infrastructure of the city, but also to further engage and involve members of the public.

This paper will outline significant marine conservation works in Singapore, and highlight the experiences gained in implementing them.

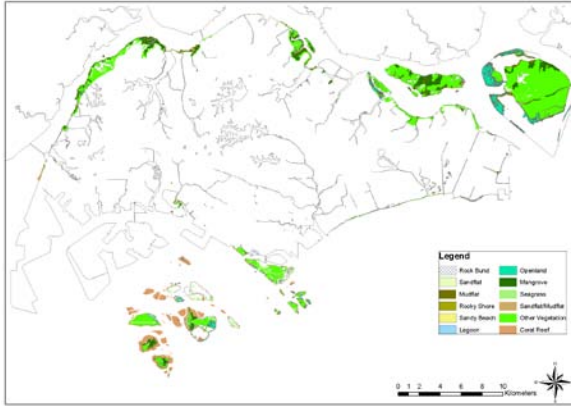


Figure 1: Map of Singapore, showing its biodiversity-significant marine areas.

Marine Conservation Frameworks

Singapore Green Plan 2012 (SGP2012)

The SGP2012 was one of the earliest attempts at consolidating initiatives that showcased Singapore's commitment to environmental sustainability. Launched in 2002 as a 10-year plan, it was formulated with inputs from the People, Private and Public (or 3P) sectors, and comprises six focus areas, namely, Clean Air & Climate Change, Water, Waste Management, Public Health, Conserving Nature, and International Environmental Relations. Primarily terrestrial in focus, it had a few components that covered marine environments, mainly in the habitat monitoring.

National Biodiversity Strategy and Action Plan (NBSAP)

The evidence for the role of biodiversity conservation in improving the quality of life in cities is increasing (Roe, 2010). With this in mind, the NBSAP for Singapore provides a framework that uses an integrated approach for the conservation of our natural heritage. It showcases Singapore's aim to create an urban biodiversity conservation model. It outlines several guiding principles for conservation, broad long-term goals (that mirror the objectives of the Convention on Biological Diversity) and categorises actions into 5 main strategies.

City In A Garden Programme

The vision of a City in a Garden has three components: pervasive greenery, rich biodiversity and a strong sense of community ownership. While mainly focused on terrestrial and horticultural aspects, many of its ideals can be translated to the marine realm; for example, enhancing the habitats and numbers of native marine species and the development of a strong community network, with emphasis on "co-creation" of conservation projects and objectives.

Institutional Frameworks

Technical Committee on Coastal and Marine Environment (TCCME)

The committee was set up in October 2008, to look into the increasing local demand in sea space use, and the potential spill over effects beyond national boundaries. It is one of the few truly multi-agency committees that handles marine biodiversity issues in Singapore. Chaired by the National Parks Board and the National Environment Agency, and comprising members of different government agencies and from academia, they have supported the implementation of research in three focus areas: habitat enhancement and restoration, monitoring and surveys, and anthropogenic impacts on coastal and marine environments. They were also primarily responsible for the adoption of the PEMSEA integrated coastal management framework as the governance framework of choice for Singapore (PEMSEA, 2010).

Singapore Index on Cities' Biodiversity

The Singapore Index or Cities Biodiversity Index (CBD, 2010) was jointly developed by Singapore and the CBD Secretariat. Developed as a self-assessment tool (Chan & Anshari, 2010), it allows cities to monitor the progress of biodiversity conservation efforts against their own individual baselines. The trends between assessments of the index will show either an improvement or decline in the effectiveness of biodiversity. The index comprises three parts: first, the "Profile of the City" provides comprehensive background information on the city; second, a city's self-assessment of the 23 indicators based on the guidelines and methodology provided; and finally, the calculation of the overall score (Chan *et al.*, 2010).

Research Projects

Singapore aims to adopt a "science-inspired" (Goh, 2009), ecosystem-based approach to biodiversity conservation and habitat management. We continue to add to our knowledge about our marine habitats, applying new and multi-disciplinary skills to overcome the conservation challenges for Singapore. The connectivity of Singapore's coral reefs (Tay *et al.*, 2009) for example, was recently established through the use of hydrodynamics, reproductive biology studies and DNA analysis, showing that much of Singapore's reefs are seeded from local sources. This study drives home the vulnerability of our reefs, especially with the increased demand for coastal and sea space.

Studies on long neglected fauna revealed surprising outcomes (Table 1).

Group	No. of species	Reference
Hard corals	256	Huang <i>et al.</i> , 2009
Seagrass	12	Yaakub, <i>pers comm</i> , 2009
Sea anemones	16	Fautin, Tan & Tan, 2009
Mites	40	Bartsch, 2009
Worms	74	Chan, 2009
Echinoderms	90	Lane & Spiegel, 2003
Reef fishes	>100	Low & Chou, 1992
Gobies	149	Larson, Jaafar & Lim, 2008
Sponges	>200	Lim, Voogd & Tan, 2008
Giant clams	4	Neo & Todd, in press

Table 1: Marine flora and fauna of Singapore (from NParks, 2010).

A 3-year study on sponges documented more than 200 different species (Lim *et al.*, 2008) from our inter-tidal and sub-tidal areas. The interest raised from this project partly resulted in the discovery of an internationally threatened species, the Neptune's Cup (*Cliona patera*) (Tun & Goh, 2011), which was thought to be extinct from Singapore, it's type locality. Iconic species such as giant clams were also long thought to be extinct in Singapore, but recent work (Neo & Todd, in press) showed otherwise. Enough evidence was gathered during this study to support research into not only rearing giant clams in local facilities, but also to attempt reintroduction into the wild. Even long-studied organisms throw up new surprises - 256 different species of hard corals (Huang *et al.*, 2009) are now known to exist on our shores.

Active communities

Many of the actions taken (or be carried out) would not be complete without the full and active support of the people. The energy and verge of volunteers drive many of our successful programmes, and these "active citizens" will be crucial to the long-term success in conserving our natural heritage. Some of the examples where the public, private and people sectors work hand-in-hand include monitoring projects on seagrasses (TeamSeagrass) and coral reefs (Reef Friends). These projects are mutually beneficial, providing opportunities for awareness and capacity building between the volunteers, nature groups and government agencies, while gathering much needed data on the state of environment and its biodiversity.

Volunteers and conservationists involved in such programmes should not be viewed as blind followers, however. Because of their varied background - bankers, lawyers, accounts, journalists - they can also drive policy. The best example of this was the development of the Singapore Blue Plan, which resulted in the formation of the Comprehensive Marine Biodiversity Survey.

Singapore Blue Plan

Civil society can also play a role in driving policy. Observing a lack of focus on marine issues, marine nature groups developed the "blue plan" in 1994 to complement the mainly terrestrial-oriented Singapore Green Plan. The current incarnation of the Blue Plan (Hamid *et al.*, 2009), builds on the first two, outlining proposals to protect Singapore's remaining marine habitats. It calls for the protection of 10% of Singapore's marine areas, and enhancing mitigation measures to prevent sedimentation in the waters. The plan was submitted to the government (Chua, 2009).

To show its support for the proposal, the government, through the National Parks Board, initiated a comprehensive survey of Singapore's marine biodiversity.

Comprehensive Marine Biodiversity Survey

Also known as the "Mega-Marine Survey" by its participants, this programme aims to take stock of Singapore's marine ecosystem and species diversity, species distribution and abundance. It is a joint effort between citizens, marine biologists and government to document the amazing biodiversity that still exists on our shores. The survey attempts to integrate the passion of volunteers, the need for sound science, and the support of policy and decision makers. Co-funded by government and private companies, the Survey's first area of focus are the inter-tidal shores, specifically the mudflats.

Team Seagrass

TeamSeagrass is a collaboration between the National Parks Board, local nature groups and Seagrass Watch, and an international monitoring programme that promotes scientific, non-destructive, seagrass assessments. Initiated in 2007, the programme has confirmed the occurrence of 12 seagrass species in Singapore, a 100% increase from the previous 6 (Yaakub, *pers. comm.* 2009), and out of the Indo-Pacific total of 23 (Short *et al.*, 2001). There are currently about 200 volunteers that monitor the seagrasses at 6 locations on Singapore's shores.

Reef Friends

This volunteer-based coral reef survey programme is run by the Blue Water Volunteers and supported by the National Parks Board. It monitors the status of Singapore's coral reefs, using a combination of surveys that documents sessile and mobile benthic organisms and reef fish (English *et al.*, 1997; www.reefcheck.org). Nine sites in the islands south of Singapore are surveyed once every year. Apart from the long term trends on the state of coral reefs in one of the world's busiest ports, the project has also

documented new records of reef fish species (Low *et al.*, 2009).

International Coastal Cleanup Singapore (ICCS)

The International Coastal Cleanup is an annual event conducted in 70-100 countries, coordinated by the US-based non-profit organisation, The Ocean Conservancy. The programme aims to remove and collect data on the debris from the shorelines, waterways and beaches of the world's lakes, rivers and oceans. This information serves to educate the public on marine debris issues and to encourage positive change by submissions to governmental and international organisations that will reduce debris in waterways and enhance aquatic environments. In Singapore, the ICCS is coordinated by volunteers of the Raffles Museum of Biodiversity Research of the National University of Singapore, and supported schools, government agencies, private organisations and corporate entities. For almost 3 decades, the ICCS has mobilised volunteers for this event; in 2009, they mobilised more than 3000 volunteers, picking up over 13,000kg of rubbish over 20km of coastline. This is undoubtedly the largest environmental conservation programme in Singapore.

Conclusion

Singapore continues to strive to create a nature conservation model that champions environmental sustainability in a small urban setting. It has done reasonably well so far for its terrestrial biodiversity and is now focusing on the marine environment. Singapore must capitalize on the solid foundations already laid down in terms of governance frameworks, strong research output and its active communities to achieve the goal of conserving its natural heritage for future generations of Singaporeans.

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