SINGAPORE

4th NATIONAL REPORT TO THE CONVENTION ON BIOLOGICAL DIVERSITY

NATIONAL PARKS BOARD SINGAPORE

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List of Acronyms

3P	People, Public, Private Sectors
ABC	Active, Beautiful and Clean
ACRES	Animal Concerns Research and Education Society
ASEAN	Association of Southeast Asian Nations
AVA	Agri-Food and Veterinary Authority
BCA	Building and Construction Authority
BTNR	Bukit Timah Nature Reserve
BWV	Blue Water Volunteers
CBD	Convention on Biological Diversity
CBI	City Biodiversity Index (also known as the Singapore Index on Cities' Biodiversity)
CCNR	Central Catchment Nature Reserve
CHM	Clearing House Mechanism
CIB	Community In Bloom
CIBS	Community In Bloom Schools
CIP	Community Involvement Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CTFS	Centre for Tropical Forest Science
CUGE	Centre for Urban Greenery and Ecology
ESA	Endangered Species (Import and Export) Act
FA	Fisheries Act
FAO	Food and Agriculture Organization of the United Nations
HDB	Housing Development Board
HSBC	Hongkong and Shanghai Banking Corporation Limited
IMCSD	Inter-Ministerial Committee on Sustainable Development
LNR	Labrador Nature Reserve
MEWR	Ministry of the Environment and Water Resources
MND	Ministry of National Development
MOE	Ministry of Education
NBC	National Biodiversity Centre
NBRC	National Biodiversity Reference Centre
NBSAP	National Biodiversity Strategy and Action Plan
NCE	National Council on the Environment
NEA	National Environment Agency
NGO	Non-governmental Organisations
NIE	National Institute of Education
NParks	National Parks Board
NSS	Nature Society Singapore
NTU	Nanyang Technological University
NUS	National University of Singapore
PCN	Park Connectors Network
PTA	Parks and Trees Act
PUB	Public Utilities Board
RMBR	Raffles Museum of Biodiversity Research
SBG	Singapore Botanic Gardens
SBWR	Sungei Buloh Wetland Reserve
SEC	Singapore Environment Council
SGD	Singapore Dollar
SGP	Singapore Green Plan
SSB	Sustainable Singapore Blueprint
STRI	Smithsonian Tropical Research Institute
SUF	Singapore Underwater Federation
TMSI	Tropical Marine Science Institute
UNFCCC	United Nations Framework Convention on Climate Change
URA	Urban Redevelopment Authority
UWS	Underwater World Singapore
WABA	Wild Animals and Birds Act
WWF	World Wide Fund for Nature

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Box Story

EXECUTIVE SUMMARY

Singapore is a city-state with a land area of about 710 km^2. It is one of the most densely populated countries in the world and yet, harbours rich native biodiversity, both terrestrial and marine.

The wealth of biodiversity can be attributed to Singapore's strategic location within the Malesian region. Favourable climatic conditions also help to account for the rich diversity of flora and fauna found in its varied ecosystems. The 4 legally protected Nature Reserves cover an area of about 33.26 km^2.

In addition to natural ecosystems, managed habitats such as public parks, park connectors, roadside plantings and reservoir parks also support considerable biodiversity, which underscores Singapore's commitment towards creating a clean, green and blue living environment. Over the past 20 years, Singapore's green cover has increased from 36 per cent to 47 per cent of the total land area (National Parks Board, 2008). Chapter I examines the status, trends and threats to Singapore's natural and managed ecosystems.

Singapore signed the Convention on Biological Diversity (CBD) on 12 June 1992 and became a Party on 21 December 1995. The National Biodiversity Strategy and Action Plan (NBSAP) is Singapore's blueprint for biodiversity conservation. Before its launch in September 2009, the Singapore Green Plan (SGP) 2012 served as Singapore's NBSAP. Chapter II provides the current status and progress which Singapore has achieved based on the goals and targets outlined in the SGP 2012.

The Singapore Government takes a pragmatic approach in balancing development with biodiversity conservation. The National Parks Board (NParks) is designated as Singapore's scientific authority on nature conservation and assumes the role of national focal point for the CBD. As the agency responsible for providing and enhancing Singapore's greenery, NParks manages the 4 Nature Reserves, 2 National Parks, a network of over 100 km of park connectors, 24.16 km^2 of roadside plantings and some 320 parks, totalling about 13 per cent of the land area of Singapore (NParks, 2008).

Recognising land, water and energy resource constraints, conserving Singapore's natural heritage requires strong People, Public, Private Sectors (3P) synergy and partnerships. Chapter III highlights the significant contributions from government agencies, academia, non-governmental organisations (NGOs), corporations and the general public. Multi-stakeholder initiatives such as the Plant Conservation Strategy, Hornbill Conservation Project, and Coral Nursery Project are testament to a close-knit 3P approach.

In assessing the effectiveness of our biodiversity conservation strategies and policies, we have adopted a traffic light system to chart our progress towards the 2010 Biodiversity Target. Chapter IV gives an overview of our evaluation in implementing the CBD, identifying strengths and opportunities for future priorities. We have effected the protection of representative ecosystems and incorporated biodiversity

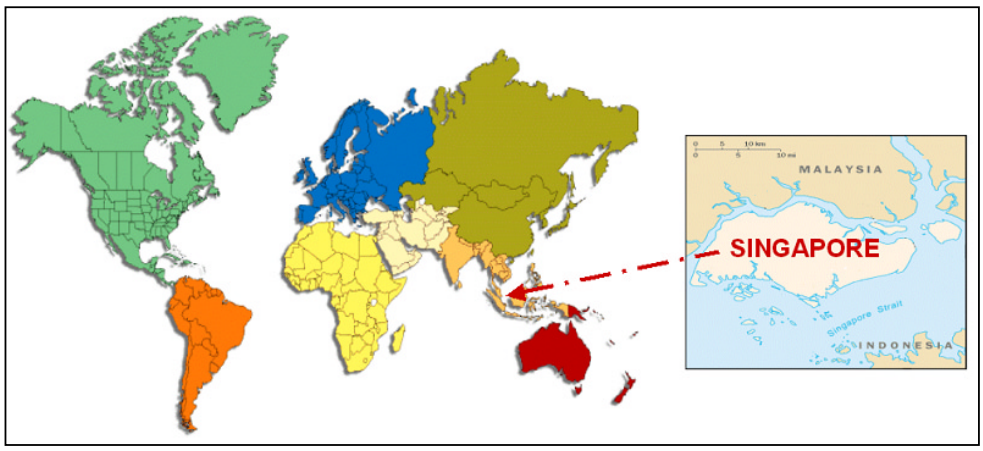
conservation considerations in our master planning process. Additionally, we are seeing our species rehabilitation work bear fruit, e.g. the Oriental Pied Hornbill, a threatened species, has shown increase in the breeding population and distribution in the span of just two years. Future ecosystem and species-specific studies will contribute towards enhancing our monitoring mechanisms for more informed decision-making.

CHAPTER I: SINGAPORE'S BIODIVERSITY

1.1 Introduction

Singapore is a tropical island city-state within the Malesian biogeographical region, consisting of one main island and about 60 smaller offshore islands. Located 137 km north of the equator, Singapore is separated from Peninsular Malaysia by the Straits of Johor and from the Indonesian islands by the Straits of Singapore. The climate is characterised by uniform temperatures between 23 ºC - 34 ºC, with an average daily humidity of 84 per cent, and an average annual rainfall of 2,300 mm. Singapore is densely populated, with a total land area of 710 km^2 and an estimated total population of 4.9 million (as at 2009).

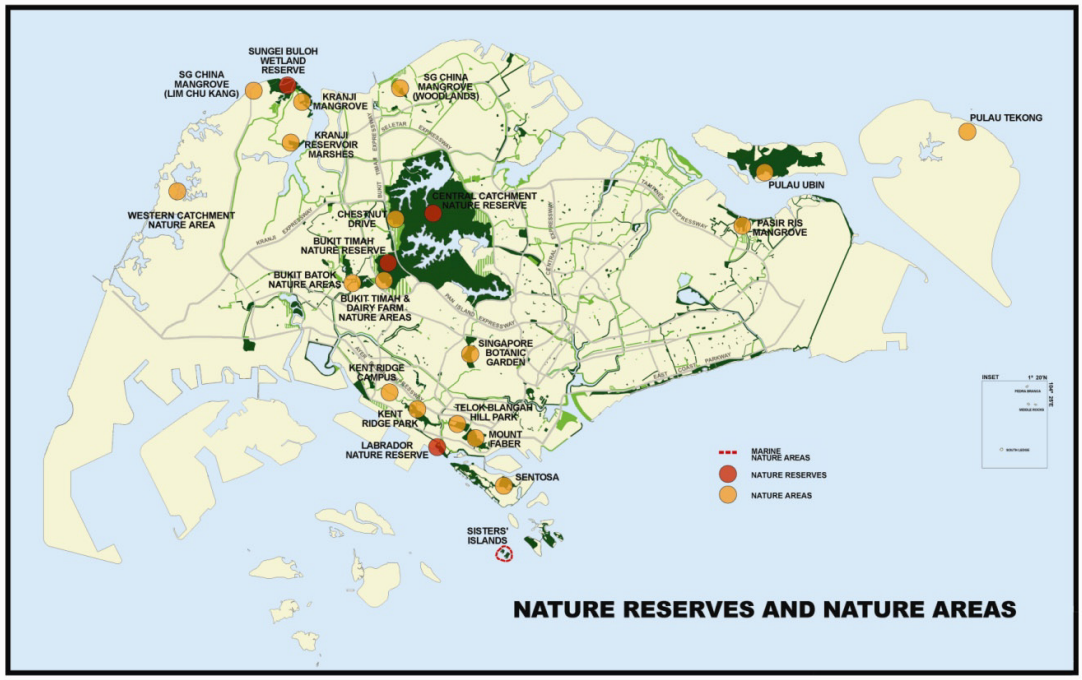
Figure 1: Singapore on the World Map.



Rich biodiversity can be found within Singapore's 22 nature sites, which include 4 Nature Reserves – Bukit Timah Nature Reserve (BTNR), Central Catchment Nature Reserve (CCNR), Labrador Nature Reserve (LNR), and Sungei Buloh Wetland Reserve (SBWR), and 18 Nature Areas. Nature Areas are either terrestrial, marine or coastal areas that support natural ecosystems and have been recognised for their significant biodiversity. They are reflected in the Special and Detailed Controls Plan of the Urban Redevelopment Authority's (URA) Master Plan 2008 (see also Chapter 2.1.3) and are kept for as long as possible. Nature Reserves are legally protected areas with key representative indigenous ecosystems. According to Corlett (1997), the types of forest that cover BTNR are primary dryland forest and tall secondary forest, while CCNR comprises both primary dryland forest, tall secondary forest, as well as primary freshwater swamp forest. SBWR consists of mangrove forest, freshwater and brackish water, and LNR is characterised by coastal hill forest and rocky shore habitat. All 4 Nature Reserves cover 33.26 km^2 or about 4.7 per cent of Singapore's total land area. The forests of Singapore are not exploited commercially for timber, and there is no indigenous people dependant on the forests for subsistence. A large proportion of the current terrestrial vegetation consists of secondary forests, as much of the primary forest cover has already been lost during the 19th century (Corlett, 1992).

Singapore's territorial waters are within a global marine biodiversity hotspot which accounts for the rich species diversity here. Coupled with strong counter-pollution measures, Singapore ensures that her waters meet recreational standards and sustains diverse marine life.

Figure 2: Map of Singapore's 22 Nature Sites (including 4 Nature Reserves and 18 Nature Areas), Park Connectors, and Interim Green Areas
Source: Urban Redevelopment Authority, 2008



Biodiversity is also found in Singapore's managed landscapes, which include reservoirs, ponds, public parks, and roadside greenery. In Singapore's context, parks refer to recreational green areas, which may incorporate both natural and managed green landscapes.

Singapore's Species Richness

Despite being small in size, Singapore retains an impressive variety of flora and fauna. Table 1 below lists known floral and faunal species diversity in Singapore, including new discoveries such as 11 new records of dragonflies.

Table 1: Recorded Species of Known Flora and Fauna in Singapore

Taxonomic group	No. of species	Reference
Vascular Plant	3,971	Kwek, Y. C. & Tan, H.T.W., 2009
Fern and Fern Allies	169	Davison *et al.*, 2008
Fungi	950	Wee, Y.C and Ng. P.K.L. (eds), 1994
Bryophyte	90	T. Benito, pers. comm. 2009
Mammal	52	Baker, N. & Lim, K., 2008
Bird	364	Wang, L. K. & C. J. Hails, 2007
Reptile	98	Baker, N. & Lim, K., 2008
Amphibian	28	Baker, N. & Lim, K., 2008
Freshwater Fish	68	Baker, N. & Lim, K., 2008
Butterfly	295	http://www.butterflycircle.org/sgchecklist.htm
Dragonfly	117	W.J. Ngiam, pers. comm. 2008
Freshwater Fish	68	Baker, N. & Lim, K., 2008
Hard Coral	255	Huang *et al.*, 2009

Surveys and monitoring work by NParks, National University of Singapore (NUS), Nanyang Technological University (NTU), other research scientists and nature enthusiasts have unravelled new discoveries and rediscoveries. During the 1990s, a comprehensive 5-year survey of the CCNR and BTNR was carried out to collect baseline biodiversity information (Corlett, 1997). At the end of the survey in 1997, it yielded 10 discoveries of species (4 mammals, 3 reptiles and 3 amphibians) previously not known to exist in Singapore and 13 rediscoveries of species (9 mammals, 3 reptiles and 1 amphibian) previously thought to be extinct locally. The NParks Natural Areas Surveys Project, conducted in 2006-2007, which surveyed over 20 mangrove, 4 terrestrial and 8 marine sites, charted 30 new records and 11 rediscoveries.

Table 2: New Records and Rediscoveries from NParks Natural Areas Surveys Project (2006-2007)
Source: National Biodiversity Centre, 2008.

New Records	New Records	Rediscoveries
Algae	7 species	-
Annelid or true worm	6 species	-
Mollusc	5 species	1 species
Plant	5 species	8 species
Reptile	-	1 species
Spider	6 species	-
Dragonfly/damselfly	1 species	1 species

Thirty-one out of about 56 species (55 per cent) of 'true'[1] mangrove plants in Asia have been recorded in Singapore (Food and Agriculture Organization of the United Nations, 2007). Mangrove forests in Singapore are dominated by the tree generas *Avicennia*, *Sonneratia*, *Rhizophora* and *Bruguiera*. These mangroves provide sanctuary to estuarine crocodiles, mud-lobsters, mudskippers, archerfish, pipefish, crabs, bivalves and many molluscs species. Mangrove surveys in the past 3 years have revealed new records of 10 species, 6 genera, and 2 subfamilies of marine worms (National Biodiversity Centre, 2007).

About 256 species of the total 800 species (32 per cent) of hard corals in the world, and 12 species out of the 23 seagrass species (52 per cent) in the Indo-Pacific can be found in Singapore. Over 450 species of crustaceans (both marine and freshwater species), 580 species of molluscs, 856 species of marine fishes, and about 500 species of seaweeds (NBC, 2007) were observed. The following sections aim to analyse the status, trends and threats to Singapore's ecosystems.

[1] True mangrove species are found exclusively in the mangrove habitat following the classification in Tomlinson (1986) (Tan *et al.*, 2007a).

1.2 Primary Forest Habitat

Status

The types of primary forests represented today in the Nature Reserves are primary dryland forest, tall secondary forest and primary freshwater swamp forest. Of the 2.8 km^2 of primary forest that still remain, 69 per cent are primary dryland forest while the remaining 31 per cent comprise freshwater swamp forest (Corlett, 1997).

The most extensive patch of primary dryland forest can be found at BTNR which links to smaller patches throughout CCNR. Much of the primary dryland forest consists of hill dipterocarp forest characterised by the dominant key species Seraya (*Shorea curtisii)*. CCNR consists mainly of lowland dipterocarp forest, represented by emergent species such as Melantai (*Shorea macroptera),* Meranti Tembaga (*Shorea leprosula*), and Kempas (*Koompassia malaccensis*). The Nee Soon freshwater swamp forest is also found within CCNR, and is the last remaining natural freshwater habitat of its kind in Singapore (see also Chapter 1.7).

The primary forests in CCNR and BTNR play an important role as a living laboratory for ecological and taxonomic research. Comprehensive surveys of the 2 Nature Reserves have recorded an estimated 1,190 species of vascular plant species in these primary forest fragments, which provide refuge to 44 species of mammals, 207 different species of birds, 72 species of reptiles, 25 species of amphibians, 33 species of freshwater fishes and 156 species of butterflies (Chan & Corlett, 1997).

Trends and Threats

The Centre for Tropical Forest Science (CTFS) has been studying and monitoring the dynamics and health of a 0.02 km^2 plot in BTNR. NParks also has an ongoing Nature Reserves survey of flora and fauna in BTNR and CCNR which will provide important data and updates on the status of the health of the forest. In the last ten years, the fragmented primary forest in BTNR and CCNR appears to be stable with little observable change in tree species composition (La Frankie *et al.*, 2005). The results of such studies are useful in developing appropriate strategies to protect and manage the remaining primary forest fragments.

The primary forest remnant plays a crucial role of being the key source of plant propagules and native fauna. Since 2004, a nursery has been set up at the BTNR. It collects and propagates native plant species for the reforestation efforts in the nature reserves and throughout the island.

1.3 Secondary Forest Habitat

Status

Secondary forest can be generally considered as forest that has undergone a break in its natural existence and now depend on outside influences for its recovery. If left untouched, it will eventually revert to its primary condition. Secondary forest serves as important buffer zones to the existing primary forest, in addition to supporting many species of flora and fauna.

Depending on the maturity of the secondary forest, some key species found include *Resam* Fern (*Dicranopteris linearis*), *Tiup Tiup* (*Adinandra dumosa*), *Dillenia suffruticosa*, and also pitcher plants such as *Nepenthes gracilis* and *Nepenthes ampullaria* (Sim *et al*, 1992). Slightly more mature secondary forest is made up of Silver Back (*Rhodamnia cinerea*), *Bintangor* (*Calophyllum* species), *Cyathocalyx* species, *Xylopia* species and others. Additionally, 57.6 per cent of its basal area seems to be covered by the trees of Mangosteen (Guttiferaceae) Laurel (Lauraceae), Myrtle (Myrtaceae) and Oil-fruit (Elaeocarpaceae) families (Corlett, 1991a).

Secondary forests support important species like drongos, woodpeckers, babblers, bulbuls such as the Cream-vented bulbul (*Pycnonotus simplex*). Other commonly encountered animals include the Plaintain Squirrel (*Callosciurus notatus*), Lesser Dog-faced Fruit Bat (*Cynopterus brachyotis*) and the Reticulated Python (*Python reticulatus*). There are also rare nocturnal species like the Malayan Pangolin (*Manis javanica*) and Horsfield's Flying Squirrel (*Iomys horsfieldii*) (Tan *et al.*, 2007c).

Trends and Threats

It is estimated that about 10 to 30 per cent of the known flora is locally extinct, including an estimated 62 per cent loss of epiphytic species amongst the native orchids (Turner *et al.*, 1994). Along with the decrease in floral diversity, a decline in bird species has been observed (Corlett, 1992). The main threats to birds arise from habitat loss and degradation, pollution, poaching, and competition from alien species. Most of Singapore's natural ecosystems and species loss had occurred by 1920 (Corlett, 1992). NParks has implemented several measures to counter the loss of biodiversity; for example, the Park Connectors Network (PCN) provides an ecological link or green corridors for birds and other animals to move from one forested area to another. Reforestation activities in the Nature Reserves and the removal of alien species (e.g. *Dioscorea sansibarensis*) have helped to sustain viable populations of flora and fauna within the secondary forests.

1.4 Grassland/Open Space Habitat

Status

Grassland and open areas with herbaceous or shrub vegetation are characteristic of highly disturbed ecosystems. These habitats are formed when secondary forests or farmlands are cleared of vegetation, and in the interim period wild plants colonise and repopulate these lands (Corlett, 1991; Tan *et al.*, 2007). The absence of significant tree canopy cover exposes the land to high rainfall, surface runoff, evaporation and direct sunlight, and this contributes to soil degradation that in turn limits the type of plants that can thrive in these habitats. Grassland ecosystems are not likely to be indigenous to Singapore. However, they support a diverse faunal community; bird species e.g. Baya Weavers (*Ploceus philippinus*), Brown Shrike (*Lanius cristatus),* and Paddyfield Pipit *(Anthus rufulus*); butterfly species e.g. Striped Albatross (Appias libythea) and Lemon Emigrant (*Catopsilia pomona*); and dragonfly species, e.g. Common Scarlet (*Crocothemis servilia*), Blue Percher (*Diplacodes trivialis*), and Coastal Glider (*Macrodiplax cora*).

Trends and Threats

Historically, the earliest known areas in Singapore that may have supported grassland habitats would have been the cleared area near the mouth of the Singapore River in the early 1800s (Corlett, 1992). Since then, further development has transformed the surrounding area into a bustling city centre for commercial and banking activities.

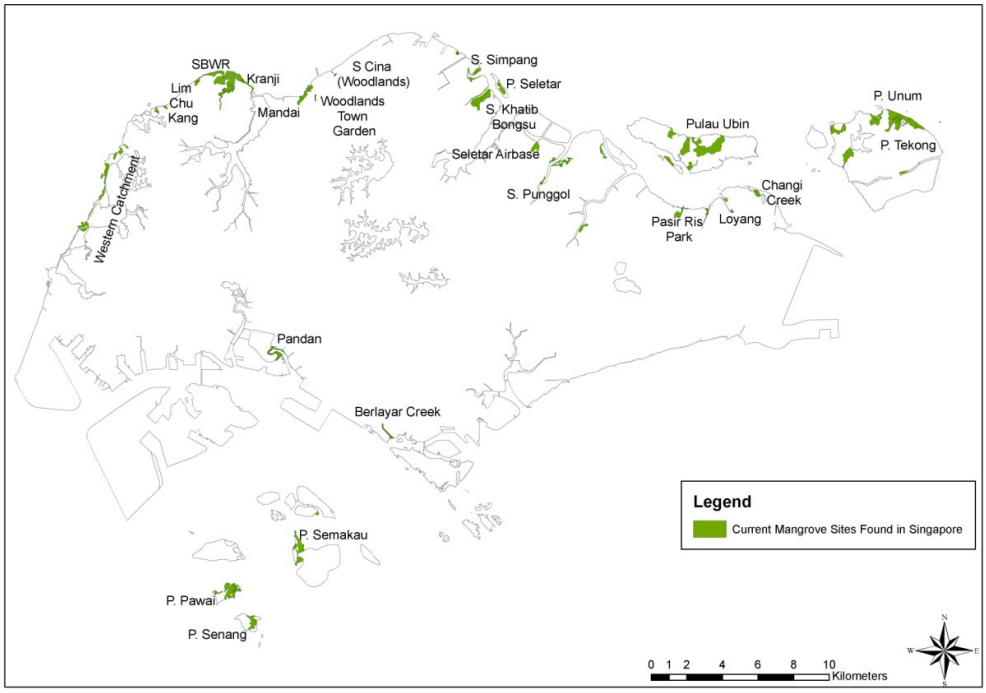
Grassland supports a specialised assemblage of wildlife such as bird and flora species. However, grassland and open country areas are often targeted for development as they are viewed as open land areas that do not serve any purposeful needs.

1.5 Mangrove Forest

Status

Over 4 km^2 of mangrove forest are found in Singapore (Figure 3). The notable mangrove forest sites include Sungei Buloh, Lim Chu Kang, Mandai, Sungei Cina (Woodlands), Pasir Ris and on the offshore islands of Pulau Tekong, Pulau Ubin and Pulau Semakau.

Figure 3: Current Mangrove Forest Sites in Singapore
Source: adapted from Tan *et al*., 2007a. Notes: S. = Sungei; P. = Pulau



Singapore currently has some 31 'true' mangrove plant species, which comprise more than half of the 55 'true' mangrove species found in Asia (FAO, 2007). While mangrove species diversity is high, species diversity is usually represented by small population numbers. Increased surveys and documentation from 2003 to 2007 have enabled better assessments of the conservation status of mangrove species, including several new finds. The mangrove plant Tumu Putih (*Bruguiera sexangula*) previously thought to be locally extinct has been rediscovered recently. In addition, two new records, Berus Mata Buaya, (*Bruguiera hainesii*) and *Ceriops zippeliana* were also discovered in 2003, increasing the overall 'true' mangroves found locally. The young seedlings of these rare finds have been collected for propagation.

There is varied faunal biodiversity found in mangroves. The most conspicuous fauna are the crabs and molluscs. The mangroves contain up to 76 species of crabs, including 8 rare species (Tan & Ng, 1994). Other invertebrates (such as insects and spiders) exist in large numbers. In a 2005 study of a

particular group of invertebrate from the family Dolichopodidae, one hundred and fifty new species of long-legged flies were discovered in Singapore, many of them found within mangroves (Grootaert, 2006).

Fishes, reptiles, birds and mammals are also part of the community of animals found in mangrove habitat. The mangrove is known to support over 150 species of fish, including 40 species of gobies and 5 species of mudskippers (Ng & Sivasothi, 1999). In SBWR alone, over 227 bird species have been recorded since 1988 (Gan, Tan & Li, 2009). A few of these species are adapted only to mangrove forest, such as Ruddy Kingfisher (*Halcyon coromanda*), Mangrove Pitta (*Pitta megarhyncha*), Mangrove Blue Flycatcher (*Cyornis rufigastra*) and Mangrove Whistler (*Pachycephala cinerea*). Other bird species, commonly found in mangrove forest are, Collared Kingfisher (*Halcyon chloris*), Striated Heron (Butorides striatus), Common Iora (*Aegithina tiphia*), and Ashy Tailorbird (*Orthotomus ruficeps*).

Trends and Threats

Development pressures, such as damming up of rivers (to form reservoirs) and canalisation of streams or waterways, land reclamation and natural degradation such as coastal erosion have resulted in the reduction of mangrove forest, which in turn drive out species dependant on mangrove habitats for survival. The threat of rising sea levels may also inundate coastal areas and mangroves.

In recent years, mangrove planting and enrichment planting efforts have been implemented to help recover mangroves at various sites. These include SBWR, Pulau Ubin, Pulau Semakau and Pasir Ris mangrove, For instance, over 400,000 mangrove saplings were planted as part of the efforts to replace loss of mangroves during construction of a landfill at Pulau Semakau (National Environment Agency, 2009).

1.6 Intertidal and Subtidal Habitats

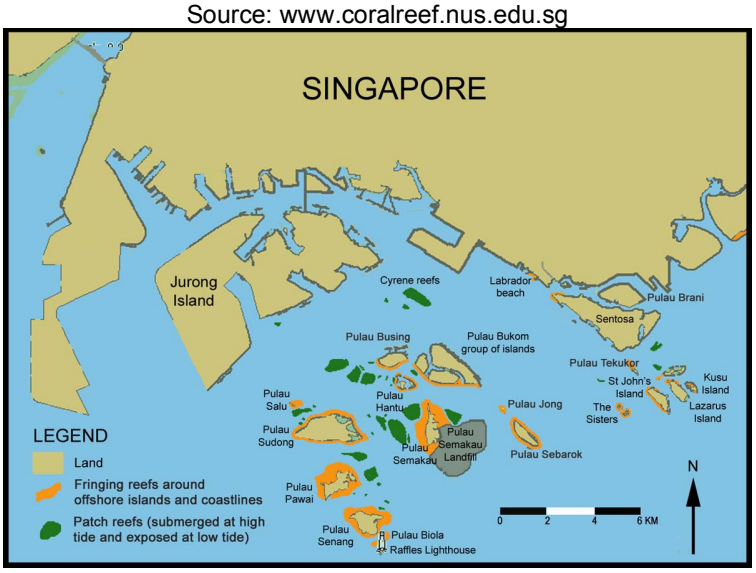
Status

Singapore's seas consist of shallow and sheltered waters in the north along Straits of Johor, and deep open water in the south along Straits of Singapore. The area covers both intertidal and subtidal habitats. Singapore's intertidal habitats comprise of sandy shores, rocky shores, muddy shores, reef flats and seagrass beds (Tan, Chou, Yeo & Ng, 2007) while subtidal habitats comprises of soft-bottom benthic, open sea and coral reefs (Tan *et al.*, 2007).

Despite having constant pressure from reclamation and coastal modifications, Singapore's waters still support a good number of marine biodiversity. Singapore's seagrass species diversity is relatively high with 12 out of the total 23 Indo-Pacific species (Yaakub, pers. comm. 2009). The latest addition to this list, *Halophila decipiens*, was only discovered in Singapore waters in late 2007. Several species of seagrass were thought to have gone extinct when the extensive seagrass meadows on the south eastern shore gave way to reclamation but populations of these species have since been rediscovered on the offshore islands. The larger seagrass meadows are currently found at Chek Jawa on Pulau Ubin, Pulau Semakau and Cyrene Reef, and mapping exercises are being carried out to determine the actual extent of these meadows.

Coral reefs are currently estimated to cover an area of not more than 30 km^2, and are mainly found near the southern islands of Singapore (Tan *et al.*, 2007b). These reefs consist of fringing and patch types, with live coral cover ranging between 10 to 60 per cent of existing reefs (Figure 4). Synchronised mass spawning of corals has been observed at Singapore reefs (Guest *et al.*, 2002), indicating that the reefs are healthy and breeding.

Figure 4: Location of Fringing and Patch Reefs in Singapore
Source: www.coralreef.nus.edu.sg



The range of marine biodiversity that can still be found in Singapore include over 100 reef fish species (Low & Chou, 1992), more than 200 species of sponges (Lim, Voogd & Tan, 2008) and 255 species of hard corals (Huang *et al.*, 2009) which accounts for more than 25 per cent of the world's coral species.

Table 3: Recorded Species of Marine Biodiversity in Singapore

Taxonomic group	No. of species	Reference
Seagrass	12	Yaakub, S.M., pers. comm. 2009
Sea anemone	16	Fautin, Tan & Tan, 2009
Marine mite	40	Bartsch, I., 2009
Marine worm	74	Chan, W.M.F., 2009
Echinoderm	90	Lane & Spiegel, 2003
Reef fish	>100	Low & Chou, 1992
Goby	149	Larson, Jaafar & Lim, 2008
Sponge	>200	Lim, Voogd & Tan, 2008
Hard Corals	255	Huang *et al*., 2009

Trends and Threats

Land reclamation along Singapore's coast has decreased the coral reef cover by about 60 per cent. Development pressures and coastal modifications continue to be the main threats to Singapore's remaining intertidal habitats. Sedimentation and water clarity issues stemming from coastal works also threaten the marine biodiversity in Singapore's waters.

Oil spills, ship groundings and other navigation-related impacts on the reefs have to date been minimal. Other threats such as climate change and ocean acidification are less defined or understood. For example, high sea surface temperatures were the cause of the 1998 mass bleaching event in Singapore (the first known record of such an event locally).

An encouraging trend observed from some reclaimed areas is the recolonisation of marine life. An example can be seen at Changi Beach, where new seagrass habitats recolonised the newly formed beach after reclamation. The area now supports diverse marine life including seahorses, crabs, shrimps, sea cucumbers and urchins. This indicates that where conditions are favourable, given time, new habitats can form on man-made landforms.

1.7 Freshwater Habitats

Status

A variety of freshwater habitats exists in Singapore, both managed and natural. Managed freshwater habitats will be covered in greater detail in the following sub-section 1.9. While many rivers and streams have been canalised, streams in more natural conditions are still found in CCNR and BTNR. Table 4 lists the results of taxonomic surveys done on these freshwater habitats.

Table 4: Floral and Faunal Biodiversity in Singapore's Freshwater Habitats

Flora/Faunal Group	No. of Species	Reference
Freshwater aquatic plant	88	Lim *et al.*, 1991; Turner, 1993; Bastmeijer & Kiew, 2001; Kiew & Turner, 2003
Freshwater decapod crustacean	28	Ng, 1999
Dragonfly and damselfly	110	NBC, 2005
Freshwater aquatic insect	73	Yang *et al.*, 1999, Balke *et al.*, 1999
Freshwater mollusc	23	Clements *et al.*, 2006; Tan & Morton, 2006
Freshwater fish	68	Ng & Lim, 1999
Amphibian	27	Lim & Lim 1992,
Reptile	5	NBC, 2005

The Nee Soon freshwater swamp forest of about 5 km^2 is the last remaining habitat of its kind harbouring about 50 per cent of freshwater fish, 71 per cent of amphibians, 28 per cent of reptiles and 34 per cent of birds in Singapore, as well as the majority of native and threatened freshwater fish and crustaceans (Ng, 1992). Currently, it is within CCNR and legally protected from development and clearing.

Trends and Threats

A large portion of freshwater habitats have been affected by development, and concretised with artificial banks. Changes in water quality due to pollution pose threats to the biodiversity of the freshwater habitats. Additionally, migrating routes of freshwater species are also cut-off due to impoundments.

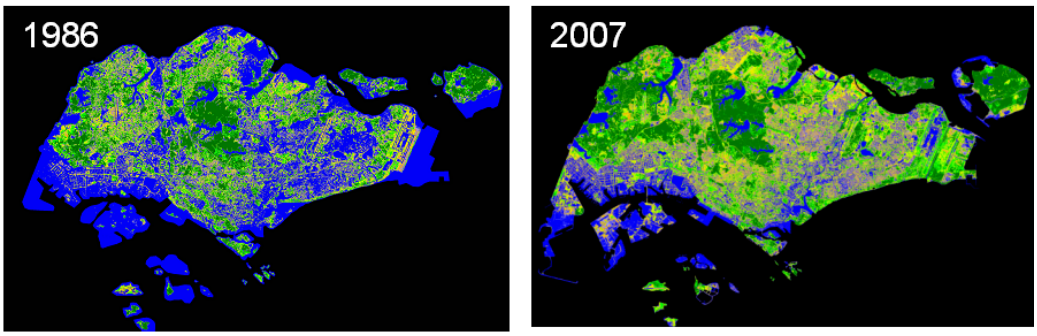
NParks and the Public Utilities Board (PUB) are collaborating on the Active, Beautiful and Clean (ABC) Waters Programme, which includes softening of the landscape of the canals and drains by recreating freshwater ecosystems to the extent possible. One such ongoing project is the recreation of a winding river through Bishan Park, where the existing drainage canal is being re-landscaped into a natural waterway, which will serve to enhance biodiversity and offer recreational options to residents. Please refer to Chapter 3.2.4 for more examples of the ABC Waters Programme.

1.8 Managed Habitats

Status

In creating a "City in a Garden", Singapore has integrated nature/green areas into urban infrastructure, creating more terrestrial and aquatic habitats in built-up areas. Managed habitats have become an increasingly important feature of Singapore's green landscapes, with various uses and benefits. Besides offering ideal recreational and leisure venues for residents and playing an important role in softening urban infrastructure, such areas also provide habitats for biodiversity. Many parks are located within the fringes of pristine Nature Areas, thus increasing their conservation value. Green cover has increased by an estimated 10 per cent over the past 20 years, from 36 per cent in 1986 to 47 per cent in 2007 (Figure 5).

Figure 5: Remote Sensing Images of Greenery Cover in Singapore
Source: Centre for Remote Imaging, Sensing and Processing (CRISP), 2007



Managed aquatic habitats include marine structures like land revetments, concrete piers, and harbour fronts, while freshwater habitats include 15 reservoirs, major rivers, and canals. These reservoirs are mostly surrounded by semi-natural banks, with forests lining the water edge within CCNR and BTNR. They are formed either by the impoundment of inland streams (Upper Peirce, Lower Peirce, MacRitchie, Upper Seletar), marine inlets (Murai, Poyan, Sarimbun, Kranji, Lower Seletar), or *de novo* construction (Bedok). They are primary water sources for the population, and hold significant native and alien species. In a baseline biodiversity study of Singapore's reservoirs conducted by the PUB and the Raffles Museum of Biodiversity Research (RMBR), records for MacRitchie Reservoir currently list 288 species of organisms, of which more than 90 per cent are native species. Upper Peirce Reservoir holds 233 recorded species of organisms, with over 85 per cent native species (PUB, 2008).

Managed terrestrial habitats comprise roadside plantings, public parks, gardens, golf courses and farms. NParks manages 3 types of public parks covering an area of about 18.5 km^2 – 54 regional parks (including 2 national parks[2]), 243 neighbourhood parks, and 23 park connectors. Over 1.3 million trees have been planted on more than 24.16 km^2 of roadsides, including unique tree-scapes along five Heritage Roads totalling about 10km. The trees along these roads, together with 171 trees in the Heritage Tree

[2] Currently, two national parks are listed under the Parks and Trees Act (PTA); Singapore Botanic Gardens and Fort Canning Park. See also chapter 3.1.1.

Scheme are protected and cannot be felled. The Heritage Tree Scheme recognises and conserves trees with historical, aesthetic, cultural, social or educational value.

Singapore Botanic Gardens (SBG) is Singapore's flagship garden with a rich history that can be traced back to the founding years of the country. It is important for recreation, research and forest conservation. About 7,100 species of plants are found within the 0.63 km^2 compound, including 620 native species. A total of 137 species of birds have also been recorded here, some of which include forest birds such as the Crested Goshawk (*Accipiter trivirgatus*) and Crested Serpent-Eagle (*Spilornis cheela*), nesting within a 0.06 km^2 forest compound in the Gardens (Strange, 2008).

The Park Connectors Network (PCN) is designed as green corridors that connect parks, Nature Areas, open spaces and housing centres. By 2020, the current 100 km network of park connectors is envisioned to expand to 360 km. These green corridors also act as ecological links, facilitating movements of birds and other animals between parks and Nature Reserves. In a preliminary study done on one of the established park connectors, the Ulu Pandan Canal, 67 species of birds have been recorded using this stretch of park connectors (Sothi *et al.*, 1999).

Trends and Threats

Singapore's managed habitats comprise relatively high populations of non-native species, including those that have been deliberately introduced. Introductions of exotic flora and fauna have also occurred through escapes and deliberate releases. However, in recent years, NParks has intensified its efforts at enhancing native flora and fauna in parks and roadside planting, creating habitats suitable for native biodiversity including birds, butterflies, dragonflies, etc., and restoring natural ecosystems through the ABC Waters Programme of the PUB. These initiatives have also been applied to the marine environment as indicated by the setting-up of a hard coral nursery to facilitate the growth of hard corals which are used for re-populating degraded coral reefs.

1.9 Implications of Biodiversity Loss

The loss of both plant and animal species will lead to a disruption of ecosystem services. Trees surrounding the reservoirs help to maintain the water quality by filtering and sediment trapping while mangroves buffer the land from erosive weather processes. Natural ecosystems help to moderate and buffer effects of extreme weather conditions by absorbing excess water during flood conditions while releasing moisture during drought conditions. Forests and green areas have also been found to improve physical as well as psychological well-being. These are cost-effective measures considering artificial engineering alternatives have to be implemented to replace these natural buffering systems.

Healthy ecosystems also provide opportunities for research and recreation. Over the years, Singapore residents have increasingly shifted towards a lifestyle that is nature savvy, frequenting parks and Nature Reserves for recreation. Visitors enjoy various outdoor activities at the Nature Reserves and parks. Green landscapes have become an integral feature of Singapore's identity, and therefore it is important that Singapore's natural heritage be retained for current and future generations to enjoy.

The genetic biodiversity resources have potential uses in industrial, biotechnological and medical products. An example of a recent pharmaceutical discovery is the isolation of bioactive compounds with anti-tumour activity from the mucus of the coral *Galaxea fascicularis* (Ding *et al.,* 1994, 1999; Fung *et al.*, 1997). Ensuring the sustainability of terrestrial and aquatic habitats will allow continued research and bioprospecting, which may result in potential commercialisation.

CHAPTER II: CURRENT STATUS OF SINGAPORE'S NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

2.1 The Singapore Green Plan (SGP) 2012

The SGP 2012, adopted in 2002, was the national blueprint for environmental sustainability which charted broad environmental goals for clean air, climate change, water, waste management, conserving nature, public health and international environmental relations (MEWR, 2006). Before the recent launch of the National Biodiversity Strategy and Action Plan (NBSAP) in September 2009, the SGP served as the NBSAP. The SGP 2012 identified 4 targets for nature and biodiversity conservation:

a) Keep Nature Areas for as long as possible
b) Verify and update information on indigenous flora and fauna through biodiversity surveys
c) Establish more parks and green linkages
d) Set up a National Biodiversity Reference Centre

Since the adoption of SGP 2012, significant progress has been made on these targets:

a) Nature Areas are incorporated where possible into new parks and recreational areas
b) The NParks Natural Areas Surveys Project, a 2-year study on biodiversity in Singapore was completed in 2007 (see also Chapter 1.1). Monitoring of the biodiversity in Singapore's nature reserves and marine environment is on-going
c) About 33.26 km^2 (approximately 4.7 per cent) of Singapore's limited land space is devoted to nature reserves, parks, park connectors, and open spaces.
d) The National Biodiversity Reference Centre was established on 22 May 2006 to serve as Singapore's one-stop centre for biodiversity-related information and activities

As many of the SGP 2012 targets were already met, while the others were on track to be met by 2012, the government recognised the need to do more for sustainable development as both the international and domestic contexts have changed. Within Singapore, higher economic and population growth will exert pressures on our limited land resources, environmental quality and biodiversity in the years to come. Climate change has also emerged as a key concern on the international agenda.

In order to ensure that Singapore can achieve sustainable development for future decades beyond 2012, the Inter-Ministerial Committee on Sustainable Development (IMCSD), was set up in January 2008 and released the Sustainable Singapore Blueprint (SSB) in April 2009 to address emerging challenges and to highlight the government's new initiatives towards sustainable development in Singapore through to 2030. Further details on the SSB are provided in Section 3.2.3.

2.1.1 Keep Nature Areas for as Long as Possible

The Urban Redevelopment Authority (URA) Master Plan 2008 is the latest statutory land use plan that guides land use development of Singapore in the medium-term. The Parks and Waterbodies Plan further details the existing and proposed green spaces and waterbodies. The 22 sites that were reflected in the Parks and Waterbodies Plan of the URA Master Plan 2003 (URA, 2003, 2008) were all retained in the 2008 plan. They are recognised as sites with significant biodiversity and will be kept for as long as possible (see also Chapter 1.1, Figure 2 and Chapter 3.2.2.).

2.1.2 Verify and Update Information on Indigenous Flora and Fauna Through Biodiversity Surveys

Access to Singapore's biodiversity information is facilitated through the creation of an interactive web page (http://www.nparks.gov.sg/nbc). This website acts as Singapore's Clearing House Mechanism (CHM) to the Convention on Biological Diversity (CBD). The national CHM ensures that access to information on local biodiversity is readily available for informed decision-making, research and educational purposes. Singapore's CHM also seeks to support the Convention's programme of work by promoting its activities, exchanging information, developing networks of partnerships and raising public awareness on the work of the Convention.

Information available on Singapore's CHM includes listing of local flora and fauna species, scientific literature on biodiversity in Singapore and images of type specimens from the Singapore Herbarium. The CHM also operates as a one-stop centre for the application of biodiversity research and collection permits.

2.1.3 Establish More Parks and Green Linkages

The URA Parks and Waterbodies Plan which is developed in consultation with the Public Utilities Board (PUB) and NParks indicates existing and proposed green spaces and waterbodies such as parks, open spaces, park connectors, Nature Areas (including Nature Reserves) in the next 15 years. Key proposals in the Parks and Waterbodies Plan include:

- Opening up selected areas of natural beauty
- Opening up more waterfronts
- Developing new parks
- Enlarging selected parks
- Linking existing parks
- Creating a variety of streetscapes
- Growing more skyrise gardens

NParks is also linking up parks with Nature Reserves via tree-lined roads and 23 park connectors. NParks maintains about 24.16 km^2 of roadside greenery, 33.26 km^2 of Nature Reserves, and 18.5 km^2 of park connectors, open spaces, neighbourhood and regional parks. Currently, 100 km of park

connectors have been completed, and by 2015 there will be a network of 200 km of park connectors (see also Chapter 1.8).

2.1.4 Set Up a National Biodiversity Reference Centre

The National Biodiversity Reference Centre (NBRC), later renamed as National Biodiversity Centre (NBC) was established on 22 May 2006, and serves as Singapore's one-stop centre for biodiversity related information and activities. A major role of NBC is to develop a national framework for managing biodiversity data. It looks into identifying and prioritising data and information requirements, carrying out needs assessments, identifying information gaps, developing quality standards for data collation, procedures for data exchange, facilitating flow of information, addressing custodianship and access issues and drawing up guidelines for data management standards.

The Centre works towards forming strategic partnerships with individuals, organisations and research institutions in formalising information-sharing agreements. Cooperation with other organisations is an important aspect of the Centre, as it aims to maximise and streamline outputs. NBC also coordinates the conservation of both terrestrial and marine flora and fauna in Singapore. It has also set up a permit system for biodiversity research and collection work done in Nature Areas, which it administers through its CHM (see Chapter 2.1.2).

NBC administers NParks role as Singapore's scientific authority on nature conservation, and represents Singapore in various biodiversity-related international/ regional conventions and fora, including the Convention on Biological Diversity.

2.2 Conservation Programmes

As the scientific authority on nature conservation, NParks works closely with relevant stakeholders in continuing efforts to rehabilitate, enhance and manage indigenous ecosystems. Some of the measures in place include:

2.2.1 In-situ Conservation

Nature Areas and Nature Reserves

As noted in Chapter 1.1, 22 Nature Areas (including 4 legally gazetted Nature Reserves) have been recognised by URA's Master Plan 2008 as areas with significant biodiversity and which support natural ecosystems that are to be kept pristine for as long as possible.

Reforestation Projects

Several measures have been taken to address the problem of fragmentation in Singapore's Nature Reserves. NParks has improved the general condition of the forests through a reforestation programme, which involves volunteers, schools, interest groups and corporate sponsors. Over the years, forest edges and gaps in the forest canopy have been rehabilitated with the planting of more than 17,000 native trees since the 1990s. These reforestation projects are carried out at BTNR, CCNR, SBWR and Pulau Ubin.

Part of NParks strategy is to incorporate conservation of Nature Areas with recreational public parks. Noteworthy examples include the rehabilitation of the mangrove forest patch at Pasir Ris Park, and the planting of 400,000 new mangrove plants over a 0.14 km^2 area in the mudflats at Pulau Semakau.

2.2.2 Ex-situ Conservation

Dipterocarp Arboretum

Singapore's first Dipterocarp Arboretum was launched in 2008 at Yishun Park on a 0.03 km^2 ex-situ conservation site which aims to enhance biodiversity within urban areas. It currently showcases more than 800 trees of over 70 species. It is also used for education and research, specifically in identifying hardy species that are suitable for roadside planting.

Plant Conservation Strategy Project

The Plant Conservation Strategy Project is intended to improve the conservation status of selected rare and endangered plants in Singapore (see also Appendix III). The objective of this project is to improve the conservation status of selected rare and endangered plants through regular in-situ monitoring of rare plant populations, and the ex-situ propagation of these plants.

Conservation of Native Orchids

Current records list 226 species of native orchids in Singapore, 75 per cent of which are epiphytes (plants that grow on another plant), and the remaining 25 per cent are ground species. The aim of this project is to propagate native species by conserving their germplasm, and re-introducing these orchids into parks, streetscapes and Nature Areas. Currently, about 200 plants are being reintroduced each year. Additionally, the Singapore Botanic Gardens (SBG) has developed an orchid seed bank, which aims to store up to 1,000 species by 2015.

Coral Nursery Project

The aim of this collaborative project is to maximise the survival of naturally occurring "corals of opportunity" (corals fragmented by impact). Suitable candidate species for propagation of coral colonies will be grown to sufficient size at the nursery and transplanted to coral reefs off the southern coast of Singapore to enhance the ecological health of these coral reef habitats. To date, a total of 17 nursery tables (each measuring 1m x 1m x 1m) have been deployed and 105 corals of opportunity have been collected from reefs surrounding the southern islands and placed at the nursery.

Seahorse Project

The main aim of the project is to breed the native seahorse species, *Hippocampus kuda*, for eventual repopulation at appropriate marine areas. The breeding is done at the aquaculture facilities at Temasek Polytechnic while population studies are conducted by NParks at selected sites.

2.2.3 Reintroduction/ Rehabilitation

Singapore Hornbill Project

The Singapore Hornbill Project was initiated to study the nesting ecology of the Oriental Pied Hornbill. The key objective was to enhance the population and distribution of this locally endangered bird in Singapore, through the use of modern technology to study behavioural and breeding patterns of the species. Artificial tree holes were provided as makeshift nests for these birds.

A Global Positioning System (GPS) transmitter attached to male birds provided information on its movement, distribution and breeding territory. Infrared video cameras enabled round-the-clock observations even within the nests. The project provided important insights into the nesting ecology of the Oriental Pied Hornbill such as the growth progression of nestlings, food requirements and sensitivity to external disturbances. This project has seen tremendous success, with an observed increase of 20 birds in two years.

Dragonfly Conservation Strategy

The main thrust behind this project is habitat enhancement/ creation for the purpose of boosting dragonfly diversity and abundance in public parks. Dragonflies are important bio-indicators of freshwater ecosystem health, and are also known to be useful in controlling the population of insect pests like

mosquitoes. Surveys have been conducted to obtain baseline biotic as well as abiotic data on ponds in public parks. In some of the well-established ponds in the public parks, as many as 25 species of dragonflies have been recorded (W.J. Ngiam, pers. comm. 2008). This is about a quarter of all dragonfly species currently known to exist in Singapore. Park managers are advised on habitat enhancement/ creation for the benefit of dragonflies and a monitoring process is also set in place to track progress. The project's outreach component includes educational signage, public talks and publications highlighting dragonflies and freshwater conservation.

2.3 The Way Forward

2.3.1 The National Biodiversity Strategy and Action Plan (NBSAP)

In 2008, NParks embarked on an effort to develop a more focused NBSAP for Singapore. The development of the NBSAP went through a consultative process with relevant agencies and NGOs. The NBSAP was launched on 5 September 2009.

The NBSAP is Singapore's master plan for biodiversity, and embodies the balanced approach the government is taking in managing land and marine use, the needs of an increasing population, and economic growth with the conservation of biodiversity. The NBSAP outlines key principles and goals, as well as strategies and actions for sustainable use, management and conservation of biodiversity over the next 10 to 15 years. The 5 key strategies and respective actions of the NBSAP are as follows:

(1) Safeguard our biodiversity

(i) Implement species conservation and recovery programmes
(ii) Rehabilitate areas that have previously been degraded
(iii) Extend green corridors to counter fragmentation
(iv) Utilise parks for ex-situ conservation and to house or re-create ecosystems that have been lost

(2) Consider biodiversity issues in policy and decision-making

(i) Incorporate biodiversity conservation considerations, including integrated coastal management principles, into existing administrative processes
(ii) Enhance biodiversity assessment capabilities
(iii) Strengthen the current processes on access and benefit sharing, to ensure that biodiversity conservation is considered when granting access to Singapore's natural genetic resources

(3) Improve knowledge of our biodiversity and natural environment

(i) Encourage and facilitate research, in particular on ecosystem and species-specific biodiversity conservation, the interactions between the biological components and their physical environment, biodiversity valuation studies and the impact of climate change and biodiversity
(ii) Monitor the health of ecosystems and species as part of the management process
(iii) Develop and maintain a central information portal on biodiversity to facilitate more informed decision-making
(iv) Maintain a list of species with their conservation status (red data list)
(v) Compile case studies on and assess best practices that have been implemented

(4) Enhance education and public awareness

(i) Increase appreciation, awareness and understanding of Singaporeans for nature through public seminars, road shows and events

(ii) Promote volunteerism through biodiversity interest groups

(iii) Incorporate elements of biodiversity conservation into the curricula of all levels of education

(5) Strengthen partnerships with all stakeholders and promote international cooperation

(i) Encourage active participation in the stewardship of the environment for all sectors

(ii) Promote partnerships with regional and international organisations, in particular the ASEAN Centre for Biodiversity and the Secretariat of the Convention on Biological Diversity, as an indication of our commitment to biodiversity conservation at the global level

A monitoring and evaluation mechanism will be set up to track the progress on the implementation of the NBSAP. This will ensure that both national objectives and international commitments are met. A five-yearly review of the NBSAP will be conducted in tandem with the Master Planning process to ensure that the strategies and actions remain relevant and address challenges of the time.

CHAPTER III: MAINSTREAMING BIODIVERSITY

Singapore as a party to the CBD is committed towards integrating conservation and sustainable use of biodiversity into relevant sectors of society (Article 6 of the CBD). Singapore's vision is to be a "City in a Garden", where greenery is incorporated into the city's landscape and in everyday life of the people. Synergies among government agencies, research institutions, and NGOs are the cornerstone towards the success of Singapore's vision and biodiversity conservation strategies.

Chapter III will highlight the key government agencies, tertiary and research institutions, biodiversity interest groups and private sector that are involved in biodiversity related activities. Successful partnerships for biodiversity conservation involving 3P sectors – public, people and private will also be highlighted.

3.1 Stakeholders

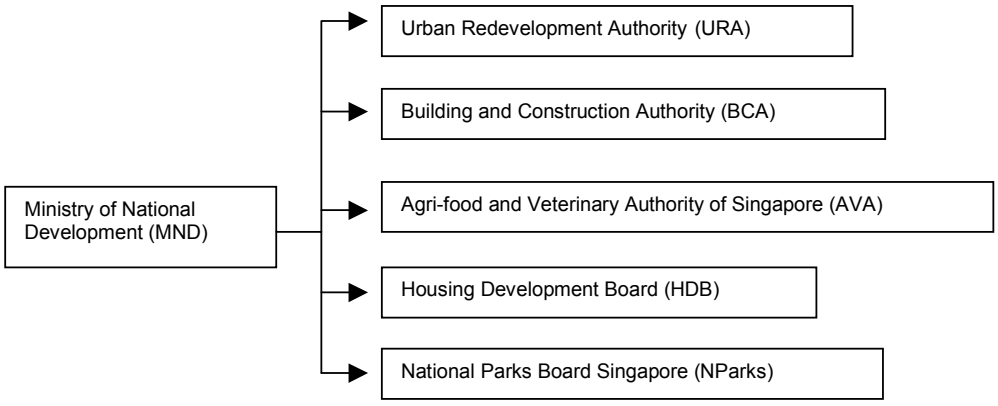
3.1.1 The Public Sector

This section highlights the institutional and legal framework that is in place, in particular the three key ministries and their respective statutory agencies that are relevant to biodiversity conservation. NParks and Agri-food and Veterinary Authority of Singapore (AVA) are statutory boards within the Ministry of National Development (MND) that deal directly with biodiversity related issues. Other statutory boards such as URA, NEA and PUB are responsible for Singapore's land use, environmental infrastructure, and water resources respectively. Inter-agency coordination is well aligned towards Singapore's vision of a "City in a Garden', where biodiversity conservation is taken into account in development projects.

Ministry of National Development (MND)

The mission of MND is to develop world-class infrastructure; create a vibrant and sustainable living environment; and build rooted and cohesive communities. It has played a key role in transforming Singapore into a global city, with green recreational infrastructure and quality affordable public housing. Figure 6 highlights the statutory agencies under the ministry.

Fig. 6: Statutory agencies under the Ministry of National Development (MND)



Urban Redevelopment Authority (URA)

The URA is the national land use planning authority. URA has to cater for the economic, social and environmental needs of the city-state. This is done primarily through the Concept Plan and the Master Plan, which provide integrated planning framework for sustainable development. This will be elaborated in section 3.2.2.

Building and Construction Authority (BCA)

The BCA is responsible for the development of an excellent built environment for Singapore. "Built environment" refers to buildings, structures and infrastructure that provide the setting for the community's activities. Singapore is moving towards a more resource-efficient built environment, and BCA champions the development of green features and sustainable technologies in buildings through the Green Mark Incentive Scheme, for instance, which provides cash incentives to developers and building owners who make efforts to achieve at least a BCA Green Mark Gold rating or higher in the design and construction of new buildings

The Building and Construction Authority (BCA) has also developed a new Green Mark scheme for parks to certify parks for its environmental friendliness, and this will include recognition of conservation features. This new system of certification aims to encourage park managers to build up interest, and learn the necessary skills and management techniques for biodiversity conservation within Singapore's urban green space (BCA, 2008). To help build up competency in this area, NParks' Centre for Urban Greenery and Ecology (CUGE) will be extending its training curricula and research to include the management and conservation of urban ecosystems.

Agri-Food and Veterinary Authority (AVA)

AVA was established on 1 April 2000 with the following core functions:

i. ensure food safety;
ii. ensure resilience in food supply;
iii. safeguard animal and plant health;
iv. safeguard animal welfare;
v. promote agrotechnology;
vi. invest in research and development; and
vii. protect endangered wildlife.

AVA's core functions (iii) and (vii) are directly relevant to biodiversity. It regulates the import of animals and plants, their related products, and also has the jurisdiction to protect wild animals and birds island-wide and is also responsible for controlling the trade in wildlife. AVA is the national authority

responsible for the implementation and enforcement of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). AVA administers and enforces five laws pertaining to biodiversity; Wild Animals and Birds Act 1965, Animals and Birds Act 1965, Control of Plants Act 1994, Endangered Species (Import and Export) Act 2006, and Fisheries Act 1966.

The Wild Animals and Birds Act (WABA) 1965 provides for island-wide protection of almost all fauna, with the exception of 6 common species of birds. Section 5 of the WABA prohibits the "killing, taking or keeping of any wild animal or bird" without a license. The penalty for an offence under section 5 is a fine of SGD 1,000 and the forfeiture of the animal or bird. The Wild Animals and Birds (Bird Sanctuaries) Order provides for certain areas to be set-aside as bird sanctuaries where the killing, taking,netting or snaring of any bird is prohibited. NParks has been administratively empowered by AVA to assist in the enforcement of the WABA.

The Animals and Birds Act 1965 and the Control of Plants Act 1994 empower AVA to safeguard animal and plant health and animal welfare. The Animals and Birds Act 1965 is for preventing the introduction into, and spreading within, of diseases of animals, birds and fish into, within and from Singapore, as prevention of cruelty to animals, and for measures pertaining to the general welfare and improvement of animals, birds or fish in Singapore, and for purposes incidental thereto. The Control of Plants Act 1994 is an Act related to the cultivation, transportation, import and export of plants and plant products and the protection of plants and plant products against pests and diseases by the regulation of the introduction of pests into Singapore and use of pesticides, and for purposes incidental therewith.

The Endangered Species (Import and Export) Act (ESA) 2006 gives effect to CITES by controlling the importation, exportation, re-exportation and introduction from the sea of certain animals and plants, and parts and derivatives of such animals and plants, and for related matters. The prohibition of sale of tiger and rhinoceros parts and derivatives are mentioned specifically in the subsidiary laws. Offences in terms of import and expert of species under this act carries a penalty of SGD 50,000 for each of such scheduled species and cumulatively up to SGD 500,000 and/ or a jail term not exceeding two years.

The Fisheries Act (FA) 1966 is an Act for the protection and conservation of fisheries, the control of fishing, marketing and distribution of fish, the use and control of fishing ports and harbours, and for measures pertaining to the general welfare and improvement of the fishing industry in Singapore and for purposes incidental thereto.

National Parks Board (NParks)

NParks is responsible for providing and enhancing Singapore's green infrastructure, making Singapore a City in a Garden. NParks manages 4 Nature Reserves which cover about 33.26 km^2, 2 National Parks (i.e., Singapore Botanic Gardens and Fort Canning Heritage Park), maintains over 320 parks which occupy, oversees about 24.16 km^2 of roadside planting, and maintains over 100 km of park

connectors. The National Parks Board Act 2005 provides for NParks' establishment as a statutory board, and also accords NParks the mandate in managing national parks, nature reserves and public parks.

As the scientific authority on nature conservation, NParks is Singapore's environmental steward, fostering "an urban conservation model that values the city's rich biodiversity as a strategic asset" (National Parks Board, 2008). In this role, NParks spearheads and coordinates the monitoring of Singapore's native biodiversity. NParks is primarily responsible for biodiversity-related regional and international agreements and conventions. It is Singapore's national focal point for the Convention on Biological Diversity.

NParks administers the Parks and Trees Act (PTA) 2005 which provides for the protection of animals and plants within national parks, nature reserves and public parks. The definition of animal in the PTA is defined as "any mammal (other than man), bird, reptile, amphibian, fish (including shellfish), insect or any other living creature, vertebrate or invertebrate, and includes any egg or young thereof". The PTA makes it an offence to capture, disturb or collect any animal or organism; and to use or possess any instrument or device for the purpose of capturing any animal. It also makes it an offence for a person to carry out an activity, which cause or may cause injury or death of any animal or organism. The Act also prohibits any person to bring or release any animal, including domestic animal into the nature reserve except with prior approval.

In terms of protection for plants which is defined as "any member of the plantae, protosta, monera or fungi kingdom, and includes any angiosperm, gymnosperm, pteridophyte, bryophyte, algae, lichen or fungus", it is an offence to cut, collect, displace any tree or plant or any part thereof within the national park or nature reserve. Additionally, it is also an offence to carry out any activity within any national park or nature reserve, which cause or may cause "alteration, damage or destruction to any property, tree or plant". The penalty for these offences is a fine not exceeding SGD 50,000 or an imprisonment term not exceeding 6 months or both.

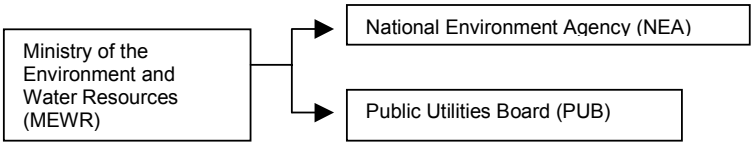
The PTA also provides for the establishment of National Parks and Nature Reserves under Section 7. Currently there are two national parks (Singapore Botanic Gardens and Fort Canning Park) and four Nature Reserves (Central Catchment Nature Reserve; Bukit Timah Nature Reserve; Labrador Nature Reserve; and Sungei Buloh Wetland Reserve) gazetted under the Act.

Ministry of the Environment and Water Resources (MEWR)

MEWR's mission is to deliver and sustain a clean and healthy environment and water resources for all in Singapore. MEWR aims to maintain a quality living environment, and improve Singapore's environmental sustainability. The two key statutory boards under its purview are:

- National Environment Agency (NEA)
- PUB, the National Water Agency

Fig. 7: Statutory Agencies under the Ministry of the Environment and Water Resources (MEWR)



MEWR is also the national focal point for a number of multilateral environmental agreements on climate change, ozone depletion, hazardous waste, hazardous chemicals and persistent organic pollutants. Singapore became a party to the United Nations Framework Convention on Climate Change in 1997 and the Kyoto Protocol in 2006.

National Environment Agency (NEA)

NEA, which was established on 1 July 2002, focuses on the implementation of environmental policies through its divisions on environmental protection, environmental public health and meteorological services. NEA programmes include pollution control; solid waste management; energy efficiency; radiation protection and nuclear safety; prevention and control of vector-borne diseases; public hygiene and cleanliness; management of hawker centres; meteorological services; 3P (People, Public and Private) Partnerships; and environmental training.

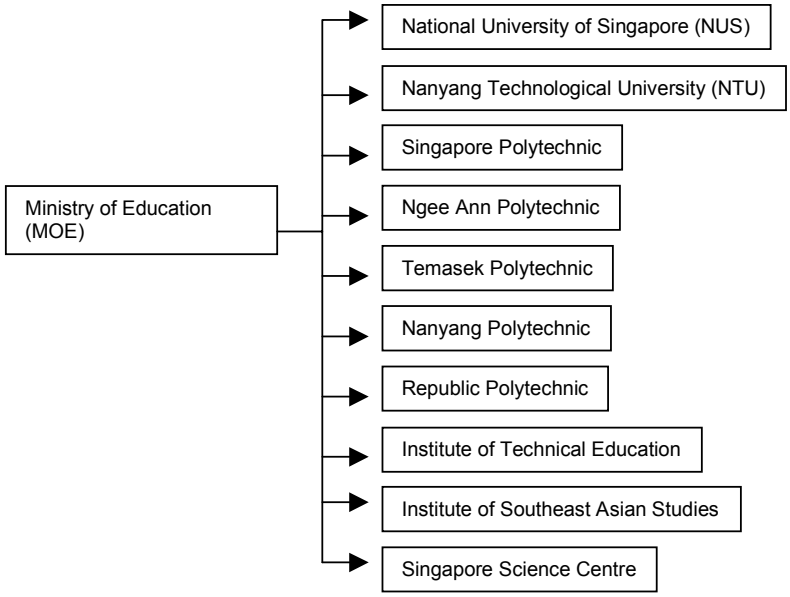
Public Utilities Board (PUB)

PUB, the national water agency, manages water supply, water catchment and used water in an integrated way. PUB's mission is to ensure an efficient, adequate and sustainable supply of water. The Public Utilities (Reservoirs and Catchment Areas) Regulations 2006 regulates activities within the protected central catchments, catchment parks and reservoirs.. Some of the prohibited activities include no damage to any plant, shrub or tree or any part of the same; no killing, hunting, shooting or trapping any animal; or any act, which causes damage to flora or injury to fauna.

Ministry of Education (MOE)

The Ministry of Education (MOE) is responsible for the formulation and implementation of education policies, and administers for example, government and government-aided primary schools, secondary schools, junior colleges and private schools. The Higher Education Division within MOE oversees the provision of tertiary and technical education in Singapore, including three autonomous universities (the National University of Singapore, the Nanyang Technological University and the Singapore Management University). Figure 8 highlights the ministry's relevant statutory boards. Most of these tertiary institutions have programmes related to biodiversity.

Fig. 8: Statutory Agencies under the Ministry of Education (MOE)



3.1.2 Tertiary and Research Institutions

The table below lists some of the major research bodies in Singapore dealing with biodiversity and nature studies. Their work has contributed to better understanding of the nature, status and health of biodiversity that exists in Singapore.

Table 5: List of Research Institutions.

Name	Profile
The Centre for Tropical Forest Science (CTFS)	The CTFS is an administrative unit of the Smithsonian Tropical Research Institute (STRI), and its mission is to promote and coordinate long-term biological and socio-economic research within tropical forests and forest-dependant communities. Currently, National Institute of Education (NIE) and CTFS have a Memorandum of Understanding to undertake collaboration on research and educational activities in Singapore's forests.
National Institute of Education (NIE)	NIE is Singapore's sole teacher training institute and is an integral part of the educational service. Within NIE, Natural Sciences and Science Education Academic Group offers amongst many other graduate programmes, applied plant sciences, chemistry, environmental science, and zoological sciences.

Name	Profile
National University of Singapore (NUS) Raffles Museum of Biodiversity Research (RMBR) Tropical Marine Science Institute (TMSI)	<u>RMBR</u> The Department of Biological Sciences (DBS) at NUS provides courses in Ecology/Biodiversity, Cell/Molecular/Developmental Biology and Biophysical Sciences. The biodiversity programme is centred around the Raffles Museum of Biodiversity Research (RMBR), which hosts the single largest collection of fauna in Southeast Asia, with at least 400,000 catalogued specimens. Staff members and students of the RMBR are engaged in research in conservation biology, ecology and systematics covering the terrestrial, freshwater and marine environments. <u>TMSI</u> The TMSI is a research institute formed within NUS. It is involved in research,development and consultancy in tropical marine science, providing postgraduate level teaching and research opportunities in that field.
Polytechnics	Polytechnics in Singapore offer several tertiary courses in environmental stewardship. Singapore Polytechnic - Diploma in Environmental Management and Water Technology Temasek Polytechnic - Diploma in Environment and Water Technology Nanyang Polytechnic - Diploma in Chemical and Green Technology
Singapore Herbarium	Singapore Herbarium houses about 650,000 herbarium specimens, focusing on those originating from the Malesian region (Peninsular Malaysia, Thailand, Indonesia, Philippines and New Guinea), with the most extensive collections from Singapore and Peninsular Malaysia dating from the 1880s. Current taxonomic research in the Herbarium focuses on bryophytes, *begoniaceae, convolvulaceae, orchidaceae* and *zingerberaceae*.

3.1.3 Biodiversity Interest Groups

NGOs and interest groups form an integral part of Singapore's conservation community, and their contributions are wide-ranging. This includes assisting government agencies in nature surveys, data collection, publication, volunteer projects, education and public awareness. NParks has established a strong network of green volunteers and like-minded individuals who are strong supporters of biodiversity conservation activities. Table 6 highlights some of the NGOs and the roles they play in shaping the future of Singapore's biodiversity.

Table 6: List of Major NGOs and Interest Groups.

Name	NGO/Interest Group	Conservation Profile
The Animal Concerns Research and Education Society (ACRES)	NGO	ACRES works towards improving living conditions and welfare of captive animals, and educating the public on humane animal care. It has conducted road shows and talks to raise awareness of animal welfare, and works closely with schools and students as part of their community involvement project. Website: *http://www.acres.org.sg/*
Blue Water Volunteers (BWV)	NGO	BWV is a marine conservation NGO that supports research activities and promotes awareness of local marine habitats through four main programmes: (1) ReefFriends, (2) ReefWalks, (3) ReefTalks and (4) ReefExhibits Website: *http://www.bluewatervolunteers.org/*
Hantu Blog	Interest Group	Hantu Blog is a non-profit environmental awareness movement for Pulau Hantu, an off-shore island renowned for its reef biodiversity. It also works towards enhancing awareness of Singapore's coastal and marine habitats. Website: *http://www.pulauhantu.org/*
Naked Hermit Crabs	Interest Group	Naked Hermit Crabs comprises volunteers who provide guided walks at Singapore's coastal habitats at Chek Jawa, Pulau Semakau, and Kusu Island. Website: *http://www.nakedhermitcrabs.blogspot.com/*
Nature Society Singapore (NSS)	NGO	NSS is a non-profit NGO committed to the research, appreciation, and conservation of the natural heritage in Singapore. It has partnered NParks on numerous projects, the latest being the 2008 version of the Red Data Book. NSS has also provided various recommendations on policies concerning Singapore's natural heritage. Website: *http://www.nss.org.sg/*
Singapore Environment Council (SEC)	NGO	SEC evolved from the National Council on the Environment (NCE), which was formed in November 1990. SEC is an independently managed, non-profit NGO, and an approved charity. It promotes, coordinates, and organises numerous environmental causes and events in Singapore. Website: *http://www.sec.org.sg/*

Name	NGO/Interest Group	Conservation Profile
Singapore Underwater Federation (SUF)	NGO	SUF centres around scuba diving activities and helps support scientific knowledge of Singapore's natural ecosystem services, and enhancing cooperation with various stakeholders.
TeamSeagrass	Interest Group	TeamSeagrass is part of Seagrass-Watch, the largest scientific, non-destructive seagrass assessment and monitoring programme in the world. They monitor the seagrass population in Singapore, and collect data to better understand and manage Singapore's seagrass meadows. Website: *http://www.teamseagrass.blogspot.com/*
Wild Singapore	Interest Group	Wild Singapore is an online guide on Singapore's wild areas, with constant updates on biodiversity conservation activities and nature guided walks. Website: *http://www.wildsingapore.com/*
World Wide Fund for Nature (WWF) Singapore	NGO	WWF is an international NGO that works towards conserving the biodiversity, ensuring sustainable use of renewable natural resources, and promoting pollution reduction. WWF has recently set up an office in Singapore in 2006, which will implement education and outreach environmental programmes, facilitate dialogue on corporate social responsibility, and explore new ways to finance a sustainable environment. Website: *http://www.wwf.sg/*

3.1.4 Private Sector

Private companies and corporations are also active in Singapore's conservation efforts providing funding and sponsorship for conservation projects. Additionally, some companies provide staff volunteer support for conservation projects, while others contribute scientific expertise. Listed below are some of the private companies that have partnered NParks on conservation projects:

Table 7: Private Companies Involved in Biodiversity Conservation

Name	Conservation Profile
The Hongkong and Shanghai Banking Corporation Limited (HSBC)	HSBC's Care-for-Nature was launched in 1989 as a long term conservation and outreach project. It has funded and supported many community driven environmental activities and infrastructures, which include the construction of boardwalks at Chek Jawa, a treetop walk at MacRitchie Park, and running of the HSBC Volunteer Programme.

Name	Conservation Profile
Keppel Corporation Limited	Keppel Corporation has provided funding support to many conservation efforts, such as the coral nursery project (See also Chapters 2.2.2 and 3.3.1).
Sembawang Shipyard Pte Ltd	A major leader in the international ship-repair and ship-conversion industry, Sembawang Shipyard has started an environmental care and protection project - “Green Wave”, an annual competition open to all students in the primary, secondary and tertiary levels. The objective is to motivate students and develop in them a sense of responsibility for the environment through innovative ideas and projects. It has seen warm reception since it first started in 2003. In 2008, a total of 260 entries were received with participation from about 1,000 students.
Shell Singapore	Shell Singapore has partnered NParks in numerous conservation programmes, including the Shell-NParks Nature Nurtures Programme at SBWR, and provided sponsorship to NSS for the publication of the second edition of The Singapore Red Data Book. Started in January 2007, the Nature Nurtures Programme aims to reach out to teens from challenging backgrounds to build up their skills and self-confidence through nature (see also Chapter 3.3.2).
Toyota Motor Corporation	Toyota has partnered NParks and 5 secondary schools in the “Reforestation and Reach Out Project” to promote environmental education and nature awareness. Students from the schools undertook volunteer reforestation and nature education projects, sharing creative and innovative ideas in environmental education and conservation (see also Chapter 3.3.2).
Underwater World Singapore (UWS)	UWS has embarked on an intensive public awareness initiative, through exhibits, enrichment programmes, outreach talks, and various other marine conservation projects with partners and institutions.
Wildlife Reserves Singapore (WRS)	WRS manages the Singapore Zoo, Night Safari, and Jurong Bird Park. In the areas of conservation and research, WRS is carrying out projects on the oriented pied hornbill and pangolin.

3.2 Sectoral and Cross-sectoral Integration of Biodiversity

In land and resource constrained Singapore, the need to integrate biodiversity and environmental considerations into city planning is all the more important to build a "City in a Garden". Here, mainstreaming of biodiversity is profiled in the education, land-use planning, national development, water and waste management sectors. The blueprints that chart Singapore's development future have incorporated biodiversity conservation where possible, and addressed mitigation of climate change and other environmental issues that will impact biodiversity. Encouragingly, students are increasingly involved in conservation activities, as part or outside school curricula. Singapore's water and waste management infrastructure has also included provisions for the conservation of biodiversity where possible.

3.2.1 Education

Knowledge and awareness are pre-requisites for action, and hence biodiversity is incorporated in the school curriculum at the primary, secondary and tertiary levels. Biodiversity is covered in the formal curriculum across all levels via the Science and Humanities syllabuses. Specifically, it is covered in Primary Science, Lower Secondary Science, Upper Secondary Biology and GCE 'A' level Biology. For the Humanities subjects, the concept of biodiversity is covered in Primary Social Studies, Lower Secondary Normal (Technical) Social Studies, Lower Secondary Geography, Upper Secondary Geography, Upper Secondary Social Studies and GCE 'A' level Geography. Tertiary institutions offer various undergraduate and postgraduate courses in biology, ecology, life sciences, bioengineering, and environmental science (see Table 8). School activities such as the Community Involvement Programme (CIP), Community in Bloom (CIB), and Adopt-a-Park also complement the main curriculum and help to develop in students a sense of awareness and appreciation for the environment.

Community Involvement Programme (CIP)

CIP is aimed at building social cohesion and civic responsibility amongst students. Schools select suitable activities for their pupils at the different levels, including environmental programmes that nurture a sense of responsibility towards nature and the environment. Students maintain an updated logbook of their activities, and in time, cultivate a positive attitude and a sense of ownership in what they have achieved.

Community In Bloom (CIB)

The "Community in Bloom Schools (CIBS)" programme helps pupils discover science and the natural environment through fun, interactive and hands-on gardening activities. Using the school gardens as outdoor classrooms, students can learn through experiential learning. Teacher's resource books (for primary and secondary levels) have been created to assist teachers to run activities, which are crafted to integrate existing curriculum subjects in a fun and creative way. Through these activities, students get to develop science process skills, teamwork, entrepreneurial skills and basic horticultural skills. Since the

inception of CIB in 2005, the number of schools (ranging from preschool to tertiary levels) has increased over the years, from 38 schools in 2005 to 90 schools in 2008.

Adopt-a-Park

The "Adopt-a-Park" programme enables schools, grassroots organisations and the private sector to take ownership in nature outreach and habitat rehabilitation. Parks may be selected for adoption based on their proximity to the adopting organisation. The scheme is for a period of three years, after which a review will be carried out by NParks to assess the possibility of extending the adoption for another 3-year period.

3.2.2 Land Use Planning

The Concept Plan is Singapore's strategic land use and transportation plan which guides the physical development over 40-50 years. The plan is reviewed every 10 years. It takes an integrated approach in considering various land needs and ensures that future development balances economic growth, environmental stewardship and social progress. The mid term review of the Concept Plan that was launched in 2001 was carried out in 2006. One of the broad strategies arising from the review is:

> "Enhancing Quality of Life and Sense of Identity: The quality of life can be enhanced by providing for a greater variety of leisure options. At the same time, there is also a need to selectively retain Singapore's built and natural heritage to foster our sense of belonging."

The Master Plan is the medium-term (10-15 years) statutory land use plan that translates the broad, long-term strategies of the Concept Plan into detailed plans. URA reviews the Master Plan every 5 years, and the latest Master Plan was gazetted at the end of 2008. In recognition of the need to protect Singapore's Natural Heritage, all 22 Nature Areas, including the 4 Nature Reserves were retained. Careful, judicious planning is critical to help keep Nature Areas while Singapore continues to grow. Where possible, Nature Areas are incorporated into parks so that they can be retained and made accessible for public enjoyment. By prioritising developments in urban areas, Nature Areas are kept pristine for as long as possible for future generations to enjoy.

3.2.3 Sustainable Development; Inter-Ministerial Committee on Sustainable Development (IMCSD)

To further consolidate efforts to balance Singapore's economic imperatives with environmental sustainability, an Inter-Ministerial Committee on Sustainable Development (IMCSD) comprising of the following Ministries was established in January 2008 to develop Singapore's sustainable development blueprint:

- Ministry of the Environment and Water Resources (co-chair)
- Ministry of National Development (co-chair)
- Ministry of Finance

- Ministry of Trade and Industry
- Ministry of Transport

Sustainable development for Singapore means, being able to support future economic and population growth while maintaining a quality living environment that is clean, green and healthy so as to achieve our vision for Singapore to be a lively and liveable global city. The blueprint, unveiled in April 2009, details new targets and initiatives to improve resource efficiency, enhance Singapore's urban environment, build capabilities, and foster community action. Key long-term goals aimed at enhancing greenery and achieving a clean, blue and green environment up to 2030 have been identified, for example:

- Increase the green park space by 9 km^2 to 42 km^2 by 2020, and reach a park provision of 0.008 km^2 per 1,000 population by 2030
- Increase the length of park connectors from 100 km in 2007 to 360 km by 2020
- Introduce 0.3 km^2 of skyrise greenery by 2020 and 0.5 km^2 of skyrise greenery by 2030
- Open 8.2 km^2 of reservoirs and 90 km of waterways for recreational activities by 2020 and have 9 km^2 of reservoirs and 100 km of waterways open for recreational activities by 2030

The Sustainable Development Blueprint provides key recommendations to protect and enhance biodiversity. This includes the implementation of a National Biodiversity Strategy and Action Plan, and the development of the City Biodiversity Index, which aims to promote biodiversity conservation among cities globally.

Box Story 1: City Biodiversity Index (CBI), also known as the Singapore Index on Cities' Biodiversity

In 2008, more than half of the world's population lived in cities. Global demographic trends indicate that there will be more cities emerging and the number of megacities will increase. However, biodiversity, which is important for sustaining human health, is disappearing at an unprecedented rate. The key to the success of biodiversity conservation lies in the hands of city dwellers. However, we cannot act appropriately unless we know where we stand in terms of our biodiversity conservation status.

In May 2008, Singapore proposed the establishment of an index to measure biodiversity in cities at the 9th Meeting of the Conference of the Parties to the Convention on Biological Diversity. Later in February 2009, 17 technical experts, comprising representatives from the Global Partnership on Cities and Biodiversity, convened at a workshop in Singapore to design the CBI. The Index, which functions as a self-assessment tool for cities to benchmark their biodiversity conservation efforts, comprises three components: a) Native Biodiversity in the City, b) Ecosystem Services provided by Biodiversity in the City, and c) Governance and Management of Biodiversity in the City.

The global responses from city officials, scientists, conservation managers, academics, etc. have been positive, and various cities are now testing out the draft index to validate its usefulness. The User's Manual for the City Biodiversity Index is posted on the website of the Convention on Biological Diversity, (http://www.cbd.int/doc/groups/cities/cities-draft-user-manual-singapore-index-2009-07-01-en.pdf).

3.2.4 Water Management: Active, Beautiful and Clean (ABC) Waters Programme

Relevant to biodiversity conservation, is PUB's management of water catchment areas and its Active, Beautiful and Clean (ABC) Waters Programme. Currently Singapore has 15 reservoirs, 32 major rivers and 7,000 km of canals and drains. The ABC Waters Programme provides for complementary initiatives in managing catchments and waterways in Singapore. One of the strategies is to soften the landscape of the canals and drains by recreating freshwater ecosystems to the extent possible.

As part of the ABC Waters Programme, PUB and NParks are collaborating to manage 3 catchments in Singapore (Western, Central and Eastern) and to soften the landscape of the canals and drains by recreating freshwater ecosystems to the extent possible. Efforts cover the Nature Reserves and Nature Areas delivering goods and services in terms of climate amelioration, water capture and water quality. Drains, canals and reservoirs are also transformed into recreational and conservation areas. In the upgrading of Sungei Tampines for flood prevention, extra care was taken to preserve and protect the existing mangroves by constructing a diversion canal to channel away the excess floodwaters.

Figure 9: Sungei Tampines with Existing Mangroves and Diversion Canal

3.2.5 Waste Management: Pulau Semakau

Singapore has developed an integrated waste management system that is also environmentally friendly. Pulau Semakau is Singapore's only landfill which is located about 8 km from mainland Singapore. Dubbed as the "Garbage of Eden" by New Scientist in 2007, it also harbours rich biodiversity in a recluse of seven habitats; coastal forest, coral reef, coral rubble, mangrove forest, rocky habitat, sandy shore and seagrass meadow.

3.3 Partnerships

Singapore's efforts to conserve biodiversity can be attributed to a healthy relationship among the people, private and public sectors. This section highlights several success stories of such synergies, and also profiles 3P partnerships (collaboration between all three sectors). Singapore is moving towards enhancing its 3P collaborations, with concerted efforts to make funding available to support the work of NGOs and facilitate networking among the sectors (IMCSD, 2009). For example, organisations from across the people, private and public sectors will be able to tap on a SGD 1.5 million 3P Partnership Fund to explore ideas on environmental sustainability.

3.3.1 Research and Conservation Partnerships

- The Coral Nursery Project: This is collaboration between NParks, NUS, NEA and Keppel Corporation. Officially launched on 31 July 2007, this 2-year SGD 500,000 project focuses on the ex-situ conservation of corals. It aims to enhance the ecological health of these corals by maximising the survival potential of naturally occurring "corals of opportunity" (corals fragmented by impact). See also Chapter 2.2.2.

- Dipterocarp Arboretum at Yishun Park: With funding support of SGD160,000 from Banyan Tree Holdings Limited, NParks has set up Singapore's first Arboretum in Yishun Park. The project started in 2007 with the planting of saplings, and by June 2008, over 800 trees are being showcased, spanning more than 70 Dipterocarp species. This Arboretum serves as a living gallery of trees for education and research. See also Chapter 2.2.2.

- Plant Conservation Strategy: This collaborative effort between NParks, NIE and the NUS aims to improve the conservation status of rare and endangered plants in Singapore through in-situ monitoring and ex-situ propagation. See also Chapter 2.2.2.

- Pulau Ubin Conservation and Management Plans: HSBC has been one of the frontrunner sponsors of conservation projects in Singapore. In line with its long-standing partnership with NParks, HSBC jointly launched the Pulau Ubin Conservation and Management Plans in 2005, which includes amenities such as the Ubin-HSBC Volunteer Hub and visitor facilities at Chek Jawa Wetland. In addition, HSBC made a donation of SGD 800,000 to the Pulau Ubin Conservation Fund, which would be used to enhance biodiversity conservation, outreach and research initiatives on Pulau Ubin.

- Reef Friends Programme: This joint project between NParks and BWV monitors the status of hard corals, mobile invertebrates and reef fish at 9 locations around the islands south of Singapore. The survey methods applied are internationally recognised techniques developed by Reef Check and the Global Coral Reef Monitoring Network. The sites include Pulau Hantu, Pulau Semakau, Pulau Jong, The Sisters and Raffles Lighthouse. The programme began in 2005, and

consists of about 40 active volunteers from different professional backgrounds, including journalists, tertiary students and teachers.

- The Singapore Red Data Book (2008): A 3P collaboration between NParks, NUS, NSS and funded by Shell, follows a previous publication in 1994 which includes contributions from a wide range of experts from governmental agencies, NGOs, tertiary institutions and members of the public. In total, this new edition of the Red Data Book features over 300 flora and fauna species, including a checklist of all the threatened species in Singapore. This book provides a basis for developing long-term strategies for biodiversity conservation.

- The Singapore Hornbill Project: This is a 3P partnership among NParks, Jurong Bird Park, NUS, NTU, and the Bird Ecology Study Group of the Nature Society (BESGroup) to enhance the population and distribution of the Oriental Pied Hornbill, a locally endangered bird in Singapore. Since the project started in 2006, the hornbill population is observed to have increased from 30 to 50 in two years. See also Chapter 2.2.2.

- Sponge taxonomy and distribution: This is a joint study between NParks and NUS on the taxonomy and distribution of intertidal sponges of Singapore. This project has recorded over 100 species of sponges, of which more than 40 are new records, and at least one that is new to science. Research is still ongoing.

- Seahorse project: This project is a collaboration between NParks and Temasek Polytechnic, aimed at breeding native seahorse species within aquaculture facilities at Temasek Polytechnic. See also Chapter 2.2.2.

- TeamSeagrass: TeamSeagrass is a collaborative effort between NParks, private companies, schools and volunteers to monitor the seagrass population in Singapore, and collect data to better understand and manage Singapore's seagrass meadows. The sites include Chek Jawa, Pulau Semakau, Cyrene Reef, Tanjong Rimau (Sentosa), Tuas and Labrador Nature Reserve. The main TeamSeagrass volunteers monitor the former 4 sites, while the site at Tuas is monitored by Schering-Plough Corporation as part of their Corporate Responsibility and Environmental Stewardship Programme. The site at Labrador is monitored by Raffles Girls School, as part of their Science Research Programme.

- West Coast Park Rejuvenation: This 3P collaboration among Shell, NParks and Commonwealth Secondary School aims to rejuvenate a one-hectare mangrove habitat at West Coast park with 200 new saplings. The saplings will be planted in phases, and monitored over time by Commonwealth Secondary School, Shell staff and contractors. The project is fully funded by Shell, with a contribution of SGD 100,000, while NParks has set up a training programme to enhance the volunteers' capacity in areas such as wildlife and environmental management.

3.3.2 Partnerships on Education and Outreach

- Nature Nurtures Programme: The Shell-NParks Nature Nurtures Programme was launched in January 2007 with the aim of motivating teens to contribute positively to society through skills and confidence-building activities in a natural setting. Students participate in teamwork activities that develop interpersonal skills and respect for the environment. Held during weekends at the Sungei Buloh Wetlands Reserve, activities include coastal clean-ups and mangrove salvaging.

- The Seashore Life Programme: This is a joint collaboration between NEA and HSBC under its Care-for-Nature environment conservation and education programme (see also Chapter 3.1.4). It aims to educate students on seashore life and its habitats, harmful effects of litter as well as actions they can do to protect the natural ecosystem.

- Toyota Reforestation and Reach Out Programme: SBWR's "Reforestation and Reach Out" programme started in August 2004, with sponsorship from Toyota Motor Corporation. Five schools participated in the 3P partnership programme, which aims to involve students in reforestation activities in the area around the Outdoor Classroom, which showcased the different habitats of the Wetland Reserve, namely the mangrove, back mangrove, secondary forest and freshwater pond. Their experience was enhanced through a series of workshops conducted by SBWR staff and volunteers. Sessions include plant drawings, public speaking, presentations, resource searching and creation of education materials.

- Wireless Learning Trail: The Wireless Learning Trail at SBWR pioneers the use of webcams installed on Ultra Mobile Personal Computers (UMPC) as an education tool for visitors. Park visitors can receive wetland information and pictures by scanning the 2-Dimensional barcodes that are positioned strategically alongside a boardwalk through the mangrove forest. This is a public-private sector initiative among NParks, Infocomm Development Authority of Singapore, MOE and iCELL Network Pte Ltd.

CHAPTER IV: PROGRESS TOWARDS THE 2010 BIODIVERSITY TARGET

In 2002, the Parties to the Convention committed themselves to "achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth."

In 2004, the Parties adopted a framework to assess the progress towards the 2010 Biodiversity Target. This includes the seven focal areas listed below, each with goals and sub-targets, within which national and/or regional targets may be developed:

1. **Reducing the rate of loss of the components of biodiversity**, including: (i) biomes, habitats and ecosystems; (ii) species and populations; and (iii) genetic diversity;
2. **Promoting sustainable use of biodiversity**;
3. **Addressing the major threats to biodiversity**, including those arising from invasive alien species, climate change, pollution, and habitat change;
4. **Maintaining ecosystem integrity**, and the provision of goods and services provided by biodiversity in ecosystems, in support of human well-being;
5. **Protecting traditional knowledge, innovations and practices**;
6. **Ensuring the fair and equitable sharing of benefits arising out of the use of genetic resources**; and
7. **Mobilising financial and technical resources**, especially for developing countries, in particular least developed countries and small island developing States among them, and countries with economies in transition, for implementing the Convention and the Strategic Plan.

Section 4.1, Table 8 below provides an overview of Singapore's efforts in achieving the 2010 Biodiversity Target. The year 1995, in which Singapore became a Party to the CBD, is used as the baseline to chart Singapore's broad progress in addressing these goals and targets. The progress is indicated using a system of symbols () indicating whether it is significant or needs further improvement; and where progress cannot be adequately assessed due to lack of information. In addition, we have also highlighted key actions that have been taken.

4.1 Progress Towards the 2010 Biodiversity Target

Table 8: Singapore's Progress Towards the 2010 Biodiversity Target

Legend

Priority Levels		Assessment of Progress	
H	High		Significant progress
M	Medium		No significant progress
L	Low		Needs further improvement
NR	Not Relevant		Lack information to assess progress

CBD Goals and Targets	Priority Level	Key Actions	Progress
Goal 1: Promote the conservation of the biological diversity of ecosystems, habitats and biomes.			
Target 1.1 At least 10% of each of the world's ecological regions effectively conserved	H	Singapore has committed about 10% of total land area to green spaces, which include nature reserves (4.5%) and parks. A ratio of 0.08 km^2 of parkland per 10,000 persons has been adopted as a target.	
Target 1.2 Areas of particular importance to biodiversity protected	H	Singapore has legally designated 4 Nature Reserves which represent key indigenous ecosystems: BTNR, CCNR, SBWR, and LNR. SBWR and LNR were gazetted as Nature Reserves in January 2002. In addition, 22 Nature Areas have been identified in the URA Master Plan 2008 (see chapter 1.1), as areas with significant biodiversity and will be conserved for as long as possible.	
Goal 2: Promote the conservation of species diversity			
Target 2.1 Restore, maintain, or reduce the decline of populations of species of selected taxonomic groups	H	Many activities are being carried out in Singapore, designed to conserve and recover native species. Current highlights include bird, dragonfly, plant and coral reef conservation. See chapter 2.2.	
Target 2.2 Status of threatened species improved	M	Singapore species recovery programme places high priority on species that are recorded as endangered in the second edition of The Singapore Red Data Book (Davison, Ng, & Ho, 2008). The Plant Conservation Project focusses on the *ex situ* breeding of endangered plant species in nurseries, followed by planting in its natural ecosystems and other suitable sites so as to	

CBD Goals and Targets	Priority Level	Key Actions	Progress
		improve the conservation status of the flora species. Special efforts have been accorded to the conservation of orchids. The planting of dipterocarps has also been initiated as a conservation effort. The erection of artificial nest-boxes has resulted in facilitating the successful breeding of the Oriental Pied Hornbill in several parts of Singapore. Butterfly conservation has been encouraged through the enhancement of habitats in parks and roadside planting. Habitats suitable for dragonflies have been enhanced and created in several parks, hence, increasing the species diversity and the dragonfly population. A hard coral nursery has been set up to nurture hard coral fragments that had been broken off. Once the fragements had reached a reasonable size, they are introduced to degraded coral reefs to enhance the diversity and population.	
Goal 3: Promote the conservation of genetic diversity			
Target 3.1 Genetic diversity of crops, livestock, and of harvested species of trees, fish and wildlife and other valuable species conserved, and associated indigenous and local knowledge maintained	NR	Agricultural diversity is not significant in Singapore's context. Additionally, Singapore's indigenous biodiversity are not exploited for commercial uses.	-
Goal 4: Promote sustainable use and consumption			
Target 4.1 Biodiversity-based products derived from sources that are sustainably managed, and production areas managed consistent with the conservation of biodiversity	NR	Singapore's indigenous biodiversity are not exploited for commercial uses.	-
Target 4.2 Unsustainable consumption, of biological resources, or that impacts upon biodiversity, reduced	NR	Indigenous biological resources are not consumed on a commercial level.	-
Target 4.3 No species of wild flora or fauna endangered by international trade	M	Singapore is a Party to CITES and the AVA is the national authority responsible for the implementation CITES. The Endangered Species (Import and Export) Act 2006 gives legal effect to the implementation of CITES. As a signatory to CITES, Singapore abides by the provisions of the Convention. The Singapore government is interested in environmental issues and protection of endangered species. We will restrict trade in any species, which is endangered.	⟷

CBD Goals and Targets	Priority Level	Key Actions	Progress
Goal 5: Pressures from habitat loss, land use change and deforestation, and unsustainable water use, reduced.			
Target 5.1 Rate of loss and degradation of natural habitats decreased	H	As for Target 1.2. URA is the national authority on land use planning, and consultations with other government agencies are carried out when development projects are submitted. An administrative process for biodiversity impact assessments is in place whenever development projects are proposed in areas within 100m of the Nature Areas.	⟷
Goal 6: Control threats from invasive alien species			
Target 6.1 Pathways for major potential alien invasive species controlled	H	AVA monitors the ornamental fish industry and regulates the import and export of animals and plants in Singapore. NParks is consulted on potential new alien species to be imported in Singapore. Studies on ballast water and marine bio-fouling are also underway.	⟷
Target 6.2 Management plans in place for major alien species that threaten ecosystems, habitats or species	M	Currently, Singapore does not have management plans in place to address threats from major invasive alien species. However, there are activities, which discourage the introduction and removal of alien species in the nature reserves. For example, there is on-going removal of removal of potential invasives (e.g. *Smilax* and *Clidemia hirta*) from the Nature Reserves.	⟷
Goal 7: Address challenges to biodiversity from climate change and pollution			
Target 7.1 Maintain and enhance resilience of the components of biodiversity to adapt to climate change	H	Singapore became a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol in 1997 and 2006 respectively. A study is currently under way to look into the impacts of climate change on Singapore, including the impact on biodiversity in Singapore.	↑
Target 7.2 Reduce pollution and its impacts on biodiversity	H	Singapore's ambient air quality is within World Health Organisation (WHO) standards, while inland waters support aquatic life and coastal waters meet recreational water standards.	↑
Goal 8: Maintain capacity of ecosystems to deliver goods and services and support livelihoods			
Target 8.1 Capacity of ecosystems to deliver goods and services maintained	H	In-situ reforestation projects help to rehabilitate forest fragments and canopy gaps and maintain the integrity of the ecosystems for visitors to enjoy. More than 17,000 trees have been planted at BTNR, CCNR, SBWR and Pulau Ubin since the 1990s. Ecological considerations are incorporated into existing and new park connectors to facilitate the movement of fauna between Nature Areas/habitats.	↑
Target 8.2 Biological resources that support sustainable livelihoods, local food security and health care,	NR	Singapore does not exploit its biological resources for local consumption or use.	-

CBD Goals and Targets	Priority Level	Key Actions	Progress
especially of poor people maintained			
Goal 9: Maintain socio-cultural diversity of indigenous and local communities			
Target 9.1 Protect traditional knowledge, innovations and practices	NR	-	-
Target 9.2 Protect the rights of indigenous and local communities over their traditional knowledge, innovations and practices, including their rights to benefit sharing	NR	-	-
Goal 10: Ensure the fair and equitable sharing of benefits arising out of the use of genetic resources			
Target 10.1 All transfers of genetic resources are in line with the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and other applicable agreements	H	Singapore issues research permits in compliance with the Bonn Guidelines. Eighty-two research permits have been issued in 2008, compared to 57 in 2007 and 46 in 2006. Researchers provide periodic updates and reports for monitoring and administrative purposes. Singapore currently ensures benefit sharing through contractual agreements, using a licensing model.	
Target 10.2 Benefits arising from the commercial and other utilisation of genetic resources shared with the countries providing such resources			
Goal 11: Parties have improved financial, human, scientific, technical and technological capacity to implement the Convention			
Target 11.1 New and additional financial resources are transferred to developing country Parties, to allow for the effective implementation of their commitments under the Convention, in accordance with Article 20	NR	-	-

CBD Goals and Targets	Priority Level	Key Actions	Progress
Target 11.2 Technology is transferred to developing country Parties, to allow for the effective implementation of their commitments under the Convention, in accordance with its Article 20, paragraph 4.	NR	-	-

Way Forward

It is recognised that most of Singapore's forests and ecosystems were cleared during the early development years in 1900s. Today, Singapore has a new outlook – in achieving our mission to be a "City in a Garden", we have undertaken many initiatives to conserve and enhance our biodiversity. Increased research and surveys have improved our knowledge of Singapore's biodiversity, and through an integrated approach, we are engaging various stakeholders to seek pragmatic and balanced solutions to the challenges that we face.

The NBSAP functions as Singapore's master plan for biodiversity conservation, under the umbrella of the IMCSD which provides a broader framework for Singapore's strategies for sustainable development. Singapore's conservation strategies will be reviewed every 5 years, in tandem with the Master Planning process. The CBI will be used as a tool to monitor our efforts more objectively and chart our progress in the implementation of the NBSAP, which will fulfil our national objectives and international obligations.

APPENDICES

Appendix I: Members of the Report Drafting Committee

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Signature of officer responsible for submitting national report	Lena Chan
Date of submission	1 September 2010

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Appendix III: Progress towards Targets of the Global Strategy for Plant Conservation

The Plant Conservation Programme of NParks aims to reduce the rate of biodiversity loss of Singapore's flora. The programme specifically targets at improving the conservation status of selected rare and endangered native plants. The objectives include:

- To locate, map and monitor the populations of these rare and threatened native species, including understanding their respective habitats and ecosystem for future recovery and reintroduction;
- To salvage such plants where imminent danger to their habitats and sites of occurrence is known; To enhance conservation status by propagating and re-introducing the species to selected nature reserves and nature parks.

Monitoring and Salvage

Regular visits are made to sites where the threatened species are naturally growing. These visits aim to determine if the respective species population are thriving, stable, sustainable or in peril. Salvaging actions become relevant where the need arises. Currently, over 70 species of plants are being monitored at 17 different sites within Singapore. Endangered plant species at locations listed for development are identified for translocation to potentially suitable sites.

Propagation and Re-introduction

Ex-situ efforts using generative and vegetative propagation techniques are employed to enhance the conservation status of the rare plants. Seeds and various plant parts are collected in the least destructive manner possible, so as to minimize disturbance to the habitat and existing plants. Established propagated plants are then re-introduced to selected sites, which include the nature reserves and nature parks managed by the National Parks Board. The re-introduced plants are subsequently monitored for a period of time.

Examples of critically endangered species included in the programme are *Liparis ferruginea* (Orchidaceae), *Tacca leontopetaloides* (Taccaceae), *Hydnophytum formicarum* (Rubiaceae), *Barringtonia racemosa* (Lecythidaceae) and *Fagraea auriculata* (Gentianaceae).