SINGAPORE

SIXTH NATIONAL REPORT TO THE CONVENTION ON BIOLOGICAL DIVERSITY (2015-2018)

NATIONAL PARKS BOARD SINGAPORE

2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

3R	Reduce, Reuse and Recycle
ABC Waters	Active, Beautiful, Clean Waters Programme
ABM	Agent-Based Modelling
ABS	Access and Benefit Sharing
ACRES	Animal Concerns Research and Education Society
AFoCO	Asian Forest Cooperation Organisation
AVA	Agri-Food & Veterinary Authority of Singapore
AVS	Animal and Veterinary Service
BCA	Building and Construction Authority
BCN	Biophilic Cities Network
BIA	Biological impact assessment
BIOME	Biodiversity and Environment Database System
BKE	Bukit Timah Expressway
BTNR	Bukit Timah Nature Reserve
BUR	Biennial Update Report to the UNFCCC
BWM	International Convention for the Control and Management of Ships' Ballast Water and Sediments
CASU	Complexity for Artificial Substrates
CEVS	Carbon Emissions-based Vehicle Scheme
CBD	Convention on Biological Diversity
CCNR	Central Catchment Nature Reserve
CCRS	Centre for Climate Research Singapore
CIN	Community in Nature
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMBS	Comprehensive Marine Biodiversity Survey
CNA	Channel News Asia
CR	Critically Endangered
CROP	Community 3R Outreach Programme
CSR	Corporate Social Responsibility
CTWL	Closing the Waste Loop
CUGE	Centre for Urban Greenery and Ecology
EbM	Ecosystem-based Mitigation
EDB	Economic Development Board
EEAI	Electric Vehicle Early Adoption Incentive
EIA	Environmental impact assessment
EMR	Ecological Mangrove Restoration
EN	Endangered
EV	Electric vehicle
FELS	Fuel Economy Labelling Scheme
FOB	Festival of Biodiversity
FRAP	Forest Restoration Action Plan
GCF	Garden City Fund
GHG	Greenhouse Gas
GIS	Geographic Information System
GSB	Greening Schools for Biodiversity
ICE	Internal combustion engine

IAS	Invasive Alien Species
IMCCC	Inter-Ministerial Committee on Climate Change
IMO	International Maritime Organisation
IPC	Institute of Public Character
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUCM	Integrated Urban Coastal Management
IUUF	Illegal, Unreported and Unregulated Fishing
JGIS	Jane Goodall Institute (Singapore)
JTC	JTC Corporation
LKCNHM	Lee Kong Chian Natural History Museum
LULUCF	Land Use, Land-Use Change and Forestry
MCAP	Marine Conservation Action Plan
MELS	Mandatory Energy Labelling Scheme
MEWR	Ministry of the Environment and Water Resources
MND	Ministry of National Development
MOE	Ministry of Education
MSS	Meteorological Service Singapore
NBC	National Biodiversity Centre
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communication to the UNFCCC
NCCS	National Climate Change Secretariat
NCMP	Nature Conservation Masterplan
NEA	National Environment Agency
NGO	Non-Governmental Organisation
NParks	National Parks Board
NSS	Nature Society (Singapore)
NTU	Nanyang Technological University
NUS	National University of Singapore
OCBC Bank	Oversea-Chinese Banking Corporation
PCN	Park Connector Network
$PM_{2.5}$	Particulate matter smaller than 2.5 micrometres
PUB	PUB, Singapore's National Water Agency
R&D	Research and Development
REU	Reef Enhancement Unit
RIR	Round Island Route
RWG	Resilience Working Group
SBWR	Sungei Buloh Wetland Reserve
SDG	(United Nations) Sustainable Development Goals
SEAA	Singapore Environment Achievement Award
SFA	Singapore Food Agency
SGX	Singapore Exchange
SI	Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index)
SIMP	Sisters' Islands Marine Park
SLA	Singapore Land Authority
SO_2	Sulphur dioxide
SPA	Singapore Packaging Agreement
SST	Sea Surface Temperature

UNFCCC	United Nations Framework Convention on Climate Change
URA	Urban Redevelopment Authority
VES	Vehicular Emissions Scheme
VU	Vulnerable
WCR	Walk-Cycle-Ride
WELS	Water Efficiency Labelling Scheme

EXECUTIVE SUMMARY

Singapore is an island city-state with a land area of 724.2 km^2. Despite having one of the highest population densities in the world and a largely urban environment, the terrestrial, freshwater and marine habitats in the country are home to a great diversity of species. Thus, Singapore needs to carefully balance our land use for development with biodiversity conservation within the land area of a single city. Singapore's biodiversity conservation strategies also need to continually evolve to address broader environmental issues such as climate change and sustainable development. Thus, we have taken a holistic and forward-looking approach towards the implementation of the Convention on Biological Diversity's Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets. Singapore's Sixth National Report to the Convention on Biological Diversity (CBD) will highlight Singapore's conservation strategies and actions for the period 2015 to 2018.

Singapore's biodiversity conservation strategies aim to achieve a set of 18 national targets aligned to the global Aichi Biodiversity Targets. The national targets are specific objectives for biodiversity conservation or cross-cutting issues related to biodiversity (for example, climate change and pollution). Chapter 2 elaborates on our country's progress towards the national targets, focusing on the actions taken to achieve each target, progress, and contribution to Aichi Biodiversity Targets. Our evaluations reveal that Singapore is currently on track to achieve or exceed 16 out of 18 national targets by 2020.

Chapter 3 provides an updated biodiversity country profile, detailing Singapore's present context, circumstances and updated species numbers. Finally, Chapter 4 concludes the report and outlines Singapore's future plans to strengthen our biodiversity conservation efforts, by transforming Singapore into a "City in Nature" by 2030. On the whole, Singapore is continuing to make good progress on our national targets, while simultaneously balancing national development needs with biodiversity conservation.

CHAPTER 1 - INTRODUCTION

Singapore (1.3521° N, 103.8198° E) is a constantly evolving island city-state located in Southeast Asia, at the southern tip of the Malaysian peninsula, consisting of a single main island and 46 offshore islands (Tun, 2012). Despite its small size of 724.2 km^2 (Singapore Land Authority (SLA), 2018), it is home to numerous different ecosystems and a rich diversity of species due to its location within the Sundaland biodiversity hotspot. Four legally gazetted Nature Reserves and 20 other administratively protected Nature Areas[1] encompass the majority of natural ecosystems within Singapore, which include primary rainforest, secondary rainforest, freshwater swamp forest, streams, grasslands, sandy and rocky shores, mangrove forests, mudflats, seagrass meadows and coral reefs.

Due to its size, land is a scarce resource in the country. Numerous competing demands such as housing, commercial centres, infrastructure for utilities and transport, and water catchments need to be addressed when planning for land use in the country. As such, innovation and ecology-based conservation strategies are used for effective conservation of our remaining natural areas[2]. To effect this, two key national strategies were developed by the National Parks Board (NParks) to drive Singapore's progress in implementing the Convention on Biological Diversity's (CBD) Strategic Plan for Biodiversity 2011-2020, including the Aichi Biodiversity Targets (henceforth termed the Aichi Targets): the National Biodiversity Strategy and Action Plan (NBSAP; NParks, 2009) and the Nature Conservation Master Plan (NCMP; NParks, 2015a).

The NBSAP provides a framework to guide biodiversity conservation efforts in Singapore, and includes Singapore's 18 national targets for biodiversity conservation and related issues[3]. Designed as specific national objectives to guide Singapore in contributing to the global effort towards the Aichi Targets, the national targets are broad in scope, and incorporate both biodiversity conservation as well as broader concepts and initiatives linked to conservation and ecosystem services, such as sustainability and pollution. This enables us to take into account other cross-cutting issues such as the effects of climate change on natural ecosystems and cities. In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released a special report highlighting the global and unprecedented impacts of climate change at just 1.5 ºC of climate warming (IPCC, 2018). As an island-state, Singapore's natural ecosystems and biodiversity are particularly vulnerable to sea level rise, storm surges, droughts, urban heat island effect and other climate change-associated impacts. In this regard, there is an increasing urgency in Singapore to tap on nature-based solutions that can help both society and natural ecosystems to remain resilient in the face of climate change. These could include efforts addressing our country's carbon emissions or enhancing local ecosystem services through habitat enhancement and restoration. Such efforts aim to improve habitat connectivity and resilience, in order for these ecosystems to contribute towards climate resilience.

The NCMP (NParks, 2015a) operationalises the biodiversity conservation efforts outlined in Singapore's NBSAP. Due to the limited land area in Singapore, our natural areas tend to be small and isolated. In order to maintain the health and biodiversity of these areas, the NCMP emphasises 1) conserving key habitats and connecting them ecologically; 2) enhancing and restoring habitats, and

[1] Nature Areas are administratively protected areas in Singapore, specified in the Park and Waterbodies Plan under our land planning process. These areas will continue to be retained for as long as possible and are often the focus of biodiversity conservation and research efforts.
[2] Natural areas consist of Nature Areas as well as other green areas (for example, parks) in Singapore.
[3] Singapore's NBSAP was updated in 2019 to include these national targets.

implementing species recovery projects; 3) applying research to conservation biology and planning, and 4) encouraging community stewardship and outreach in nature. By providing a robust framework for biodiversity efforts in the country, the NCMP supports and complements Singapore's implementation of the CBD through the NBSAP and the national targets. More information on the NCMP and the way it guides biodiversity conservation efforts in Singapore can be found in Annex A.

The scope of the Sixth National Report will encompass Singapore's nature conservation activities from 2015 to 2018. Singapore's 18 national targets and updates on programmes and activities which help us achieve each target will be set out in Chapter 2. Chapter 3 will provide an update on the status and trends of biodiversity in Singapore up till 2018.

The Sixth National Report is also the first time Singapore will report against the national targets that were developed in 2019. The Fifth National Report provided updates of implementation against the global Aichi Targets directly, as the national targets had yet to be developed at that point in time.

The format of Singapore's Sixth National Report is modified from the original template provided by decision XIII/27 of the Conference of the Parties to the CBD, to streamline reporting and reduce repetition where the implementation of particular initiatives are applicable to both the national targets as well as the relevant Aichi Target. Information on these initiatives is found in a single chapter, Chapter 2.

CHAPTER 2 - UPDATES ON SINGAPORE'S NATIONAL TARGETS AND PROGRESS TOWARDS AICHI BIODIVERSITY GOALS

Singapore's National Biodiversity Strategy and Action Plan (NBSAP, 2009) was updated in 2019 to include a set of national targets for the country. Developed based on the Aichi Targets, Singapore's national targets were designed to provide specific objectives for Singapore's biodiversity conservation, citizen engagement, outreach efforts, sustainability and urban liveability. Due to this, every Aichi Target relevant to Singapore will have one or more corresponding national targets, and both share a common deadline of 2020. The 18 national targets have a broad scope of both biodiversity and broader conservation-related topics (for example, sustainability and pollution), but have been adapted to be more specific to Singapore's context than the Aichi Targets. As mentioned in Chapter 1, the NCMP operationalises Singapore's NBSAP in the achievement of Singapore's biodiversity conservation goals. Overall, both strategies form part of Singapore's comprehensive approach to address biodiversity conservation, sustainability and resilience.

This chapter will elaborate on the rationale, implementation strategies as well as our country's current progress towards each national target and its corresponding Aichi Target. Each national target write-up will also highlight additional projects and/or policies that form part of Singapore's efforts towards the main related Aichi Target, but are not as relevant to the national target. Table 1 summarises the relationships between the national targets and the Aichi Targets. Due to Singapore's unique context, Aichi Targets 3, 6, 7, 13, 14, 18 and 20 are not relevant to Singapore and will not be elaborated upon in this chapter.

National target	**Main related Aichi Target**	**Other related Aichi Targets**
1 - Public and private organisations' participation	1	4
2 - Citizen scientists	1	19
3 - Land use planning	2	10, 11, 19
4 - Recycling	4	19
5 - Natural Areas	5	11, 15, 19
6 - Air quality	8	-
7 - Invasive Alien Species	9	1, 12, 19
8 - Resilience to Climate Change	10	2, 12, 15, 19
9 - Natural Areas	11	2, 5
10 - Ecological Connectivity	11	5, 12, 15, 19
11 - Species recovery	12	5, 15, 19
12 - Carbon accounting	15	19
13 - Habitat enhancement	15	1, 5, 12, 19
14 - Coastal enhancement	15	5, 11, 19
15 - Forest Restoration Action Plan	15	4, 5, 11, 19
16 - Access and Benefit Sharing	16	-
17 - National Biodiversity Strategy and Action Plan	17	-
18 - National database	19	1

Table 1 Summary of Aichi Targets related to each national target.

The format for this section is modified from the Sixth National Report template from decision XIII/27, where proposed sections I to IV of the template were condensed into a standardised format to be applied to each of our national targets. As a city-state, all national targets are applied at national level only. The targets' baseline years were mostly standardised to 2010 for consistency. However, if data is unavailable for that year, data from the earliest year available was used.

2.1 National target 1 – Public and private organisations' participation

By 2020, there will be a 30% increase in the number of public and private organisations that participate in biodiversity conservation activities.

Main related Aichi Biodiversity Targets

☒ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☒ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

There are numerous stakeholders and users of biodiversity in Singapore, and NParks works with interested organisations in order to maximise the number of individuals that we can reach out to. As such, every organisation's involvement is an important step towards increased outreach and public engagement. By aiming for an increase in the number of organisations involved in biodiversity conservation, either by providing direct funding or by volunteering their time, we can improve mindsets and attitudes towards biodiversity. Together with opportunities to facilitate direct improvement to local habitats, such as participating in habitat restoration efforts, organisations gain both awareness and ownership towards local biodiversity. This in turn encourages them to put in more effort to conserve native biodiversity, whether as an organisation or as an individual, and inspires them to be more aware of the positive values of co-existence with biodiversity in our highly urbanised state.

Implementation

Singapore has numerous initiatives catered towards encouraging public and private organisations to contribute to biodiversity conservation efforts.

One main avenue is through the Garden City Fund (GCF), a registered charity and Institution of Public Character (IPC[4]). Established by NParks in 2002, the GCF is an independent organisation that allows private or public organisations to donate and support NParks' efforts to create a City In A Garden.

[4] An IPC is a registered charity in Singapore, which can issue tax deductible receipts for qualifying donations to donors. These charities are held to a higher standard in terms of regulatory compliance and governance (www.charities.gov.sg).

Beginning with the Plant-A-Tree programme in 2007, the GCF's projects have expanded into a wide range of park enhancement, outreach and conservation projects. For example, Starhub, a local telecommunications company, funded the planting of native species of trees for habitat enhancement projects on Pulau Ubin. HSBC funded the Young Naturalists Programme, an outreach initiative, at the Sungei Buloh Wetland Reserve (SBWR), which comprises both outdoor and indoor learning for children between seven and twelve years of age to learn about the mangrove ecosystem as well as local biodiversity conservation issues. Volunteer opportunities are also provided to donors to get their employees directly involved in conservation initiatives and to cultivate personal ownership towards these projects.

Guidelines, awards and incentives also continue to encourage organisations to get involved with biodiversity conservation activities. In 2011 and 2013, the Singapore Exchange (SGX) released the Guide to Sustainability Report for Listed Companies and an Investor's Guide to Reading Sustainability Reports respectively. By setting these guidelines for sustainability reporting, more companies will be encouraged to include corporate social responsibility (CSR) aspects in their business reports, allowing them to compare their sustainability efforts with that of other companies in Singapore. Awards such as the Singapore Environmental Achievement Awards (SEAA), a highly prestigious environmental award in Singapore, incentivises organisations to reach and maintain environmental excellence. These efforts will in turn encourage more companies to engage in biodiversity conservation efforts and to design innovative CSR components in their day-to-day operations. As such, because of the greater ease of contribution to conservation efforts and a strong culture of corporate responsibility for companies in Singapore, NParks is seeing a large increase in the number of companies involved in biodiversity conservation activities.

In the public sector, schools are the key organisations which participate in biodiversity conservation activities, such as conducting theatrical plays around NParks' City in a Garden theme, going on learning journeys into Singapore's parks, participating in the Nature Cares programme or getting involved with our Biodiversity Watch series (see section 2.2 for more details). Due to the large number of projects and outreach events involving students, as well as a team in NParks dedicated to conducting outreach, the number of public schools involved in biodiversity conservation activities has also grown considerably over the years.

Progress towards national target

The main indicator used for this national target is Indicator 21 of the Singapore Index on Cities' Biodiversity (SI, see Singapore's Fifth National Report to the CBD), which compiles information from various divisions across NParks, each of which implements their own collection of biodiversity conservation activities.

The baseline year is 2010, when 66 public and private organisations participated in conservation activities in Singapore. These organisations include public schools, non-governmental organisations (NGOs), academic institutions and multinational corporations. In 2018, this number increased to 476, an increase of 621%. This is indicative of our country's determined efforts to emphasise biodiversity outreach since 2010.

Category of progress towards the implementation of the selected target:

☒ On track to exceed target

☐ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Both national targets 1 and 2 (below) contribute to Aichi Target 1. The elaboration for Singapore's progress in implementing Aichi Target 1 is found below in section 2.2.

2.2 National target 2 – Citizen scientists

By 2020, Singapore will achieve a five percent increase in the total number of citizen scientists.

Main related Aichi Biodiversity Targets

☒ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Singapore takes a holistic approach to biodiversity conservation: while national target 1 was aimed towards organisations, target 2 aims to increase engagement with the local community. Hailing from all walks of life, nature volunteers and citizen scientists are a diverse group of Singaporeans who embody biodiversity awareness. A growing base of citizen scientists would therefore indicate an increasing trend of biodiversity awareness in the country, while providing an idea of the community's desire to play an active role in conserving Singapore's natural heritage. This group is also essential to imparting awareness to other members of the community and contributing towards conservation efforts, while their own active participation will also provide opportunities for them to learn more about local biodiversity and the importance of science in generating data for environmental policy in Singapore. It is, therefore, important to monitor this category of Singaporeans, who are essential to the achievement of Aichi Target 1.

In addition, youth exposed to the field through citizen science programmes might gain an interest to give back in a professional capacity in the future, creating a new generation of leaders, managers or scientists for biodiversity conservation in Singapore.

Implementation

Singapore has numerous initiatives targeted towards increasing outreach, and therefore increasing nature volunteer numbers in the country. The main biodiversity outreach initiative in Singapore is the Community in Nature (CIN) initiative, launched in 2011 (see Annex A, pg 82 for an overview of CIN) which aims to engage individuals in the community to conserve their natural heritage. Citizen science programmes form a significant part of the CIN initiative, and these are programmes in which volunteers participate in organised research endeavours to collect data intended to inform decision makers and

develop future conservation strategies. Currently, a number of citizen science programmes catered to different community and interest groups exist, including BioBlitz (for example, BioBlitz for schools (children aged seven and above)), the Coral Reef Monitoring Programme, TeamSeaGrass and Intertidal/Butterfly/Dragonfly/Heron Watch activities. Previous programmes include the Comprehensive Marine Biodiversity Survey (CMBS), a massive project to document Singapore's marine biodiversity, involving both citizen volunteers and marine taxonomy experts (see Singapore's Fifth National Report to the CBD for more details). By starting citizen science programmes in schools, NParks is purposefully engaging the youth of Singapore, as they have the greatest potential to effect change in the biodiversity field, facilitating the continuity of biodiversity awareness and appreciation in the next generation of Singaporeans.

Progress towards national target

In the baseline year of 2015, there were a total of three citizen science programmes across Singapore, involving 434 citizen scientists. In 2018, with the addition of three more programmes, the number of citizen scientists has increased to 4453, a ninefold increase in numbers, far exceeding the target of a five percent increase. This data was obtained from the Biodiversity Information and Policy branch in NParks, which is primarily responsible for spearheading the CIN initiative across Singapore and maintains records of events and activities conducted under this initiative.

Category of progress towards the implementation of the selected target:

☒ On track to exceed target

☐ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 1 aims to increase general awareness on the value of biodiversity, as well as educating people about the steps they can take to use it sustainably. The two indicators in Singapore's national targets, organisations involved (target 1) as well as number of citizen scientists (target 2), were selected to optimise measurement of the current scope of biodiversity-related outreach in the country. Organisations represent institutions or groups of people while citizen scientists represent individuals from the community. By measuring the numbers of both, we can get a good understanding on the extent of our efforts in outreach engagement at different levels of society.

The rapid increase in the number of citizen science volunteers and organisations involved in biodiversity conservation activities is partially due to the expansion of Singapore's outreach efforts, and our effective use of social media, which has greatly increased the ease of information dissemination to the public. The wide scope of activities within the CIN initiative also engages individuals and community groups from all walks of life, including students, families, gardeners, bird watchers and wildlife photographers, ensuring a broad scope of outreach.

Singapore has a global reputation as a green, innovative and sustainable city (Webb, 2012; MEWR, 2015). Together with the increased ease for companies to contribute to biodiversity conservation activities (for example, through GCF, mentioned in section 2.1 above), as well as good guidelines for sustainable activities and/or reporting, Singapore has intentionally promoted a culture of green innovation and investments amongst private organisations. On the whole, Singapore's efforts have been highly effective at achieving Aichi Target 1.

While outreach can always be improved, especially with regards to presently less-engaged community groups such as the elderly, there are other ways to engage or encourage the community to appreciate biodiversity, which will illustrate its value to Singapore citizens. NParks is currently exploring the use of therapeutic gardens, for Singaporean elderly and children with disabilities (for example, autism). Such exposure can act as an indirect form of outreach, where community members experience the rejuvenating potential of local biodiversity first-hand.

Involving the community (both organisations and individuals) will also contribute to both Sustainable Development Goals (SDGs) 14 and 15 on Life Below Water and Life on Land respectively, by promoting community stewardship of Singapore's marine, freshwater and terrestrial habitats.

2.3 National target 3 – Land use planning

Apply science and ecological principles into land use planning.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☒ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☒ 10 ☐ 15 ☐ 20

Land is an important yet scarce resource in Singapore, and forward-looking land use planning is essential to the country's future development. All land use decisions in Singapore are only made after a systematic and integrated planning process, which also includes agency and stakeholder consultations for feedback towards proposed land use plans. The incorporation of innovative, predictive and objective methods in Singapore's land use planning, through the application of science-based knowledge and concepts, enables Singapore to optimise and balance its different land use needs (see Singapore's Fifth National Report for details), while sustainably developing the country. In addition, the application of ecological concepts (for example, by taking habitat connectivity into consideration) during land use planning will help to maximise the benefits and ecosystem services which natural areas provide to our citizens. As a result, national target 3 focuses on the use of scientific concepts and studies to guide Singapore's land use planning. This directly addresses Aichi Target 2, on the integration of biodiversity values into national planning processes and reporting systems.

Implementation

The Urban Redevelopment Authority (URA) of Singapore is the primary agency responsible for land use planning, and NParks works closely with the URA as a key technical agency for biodiversity issues. As Singapore's lead agency in greenery and biodiversity conservation, NParks uses scientific research and information to inform the safeguarding of natural areas for native biodiversity. For example, agent-based modelling (ABM), a type of connectivity modelling for biological systems, is used to support decision making in land use planning. ABM was key in facilitating the designation of Sisters' Islands Marine Park (SIMP) as an important marine habitat in Singapore, for both research and marine conservation (see Annex A, pg 75 for more details). By providing relevant scientific information,

NParks provides strong justification for incorporating these natural areas as part of our land use plans, facilitating science-based and progressive decision making during land use planning.

Singapore's land use planning process falls under the Planning Act which requires all development projects to be approved by the government. As part of the approval process, development projects near to sensitive areas such as Nature Reserves, Nature Areas and areas of significant biodiversity, marine and coastal areas (see Annex A, pg 75 for more details), or have potential trans-boundary impact, will be subject to greater scrutiny. In-depth consultation with the relevant technical agencies is conducted to establish whether further environmental studies are needed to assess the impact and develop mitigating measures, and if so, whether a thorough environmental impact assessment (EIA) or a more focused study on key environmental aspects is required. As such, EIAs enable the Singapore government to make well-informed decisions on development projects.

Progress towards national target

Scientific research in ecology and the environment have been used to advise on Singapore's land use plans in relation to biodiversity conservation. Green areas[5] form an integral part of Singapore's built environment, and NParks will continue to work with the URA and other agencies to ensure that scientific information informs Singapore's land optimisation process.

Rudimentary EIAs were first formally conducted in Singapore around the 1990s (Hesp, 1995), and were an important first step towards taking environmental concerns into account in the development process. Over the years since then, the EIA process has been strengthened in tandem with increasing awareness and interest from nature groups and the public on environmental conservation issues. Now, for projects near environmentally sensitive areas, a detailed consultation process will be conducted with relevant technical agencies to discuss the scope of the works, expected impact on the environment, as well as the mitigating measures and monitoring plans to be put in place to minimise impact. Based on the feedback from the technical agencies, if the potential impact on the environment is deemed significant, URA will request for an environmental study to assess in greater detail the full impact and develop more extensive mitigating measures. To provide added robustness to the process, engagement with the public may also be conducted and has also increased over time, especially for projects with high public signature and potentially significant environmental impact. For example, a detailed EIA involving engagement with nature groups and an independent panel of experts over multiple site visits and findings sharing and analysis sessions, was conducted for high profile projects such as the Cross Island Line, an underground rail transit line with two alignment options, one of which would run under the Central Catchment Nature Reserve (CCNR). Initial sections of the EIA report have been placed online, with the remaining planned to be similarly released once completed.

In recent years, the Ministry of National Development (MND) and relevant technical agencies have been working on reviewing the EIA framework. One of the preliminary outcomes of the review was to make EIA findings from all projects publicly available, unless there were considerations that require otherwise such as security concerns (MND, 2019). This marks a significant step in the strengthening of Singapore's EIA process, which minimises the environmental impact of development projects.

[5] Green areas have the broadest definition of greenery in Singapore, as it includes both natural and man-made areas with vegetation (for example, skyrise and vertical greenery are included).

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 2 calls for the integration of biodiversity values into national processes, such as development, urban planning and national accounting. Singapore has been making efforts in this area beginning with the vision of Singapore as a "Garden City" in 1967, shortly after becoming an independent country. Over time, government policies and long-term plans relating to biodiversity continue to be updated in key policy reports, with the most recent examples being the Singapore Green Plan (1992, updated in 2012; Ministry of the Environment and Water Resources (MEWR), 2012); the Sustainable Singapore Blueprint (2009, updated in 2015; MEWR, 2015) and the operationalisation of the NBSAP (NParks, 2009) through the NCMP in 2015 (see **Error! Reference source not found.**ANNEX A). Public agencies have also been moving towards evidence-based decision making, which makes use of objectively obtained information to guide urban planning and land use optimisation for a more sustainable Singapore (see implementation section above).

All of these efforts are being complemented by a strong field of scientific research that supports policy in Singapore. For example, the Natural Capital Singapore project, which aims to value the ecosystem service provision of Singapore's habitats, was initiated in January 2018, and will be ongoing till 2021. By quantifying the benefits offered by Singapore's natural resources in economic terms, this project will allow a more accurate reflection of the value that the natural environment contributes towards the well-being of the population, which may strengthen the push to conserve natural habitats. It also aims to develop an urban planning document and decision support tool to directly assist with policy and land use planning in Singapore. Complementary to this effort are projects such as comprehensive surveys of buffer parks and Nature Reserves, which collect basal biodiversity and hydrology information to inform policy-making. These efforts ensure that Singapore incorporates these values into governance so that we can retain our biodiversity and greenery and remain sustainable amidst rapidly evolving challenges.

As these achievements and projects mainly concern land use planning and terrestrial systems, it advances Singapore's progress towards SDG 15 regarding Life on Land, by using ecosystem studies and concepts to shape urban land use and biodiversity conservation in Singapore.

2.4 National target 4 – Recycling

Achieve overall national recycling rate of 65% in 2020.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☒ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

In 2018, Singapore generated about 7.7 million tonnes of waste. At this rate of waste generation, the Semakau Landfill, which is the point of disposal of the country's incinerated and non-incinerable waste, will be completely filled by 2035. Singapore is exploring the reutilisation of incineration bottom ash in other applications, as part of efforts to extend the lifespan of the Semakau Landfill.

Given land scarcity in Singapore, a major focus in waste management in Singapore is to reduce the volume of waste disposed of at Semakau Landfill. To achieve this, Singapore has adopted the following strategies to close the waste loop and promote sustainable production, consumption and waste management:

a) Reduce and Reuse - Avoid excessive consumption and promote efficient use of resources
b) Recycle - Recover valuable materials from waste and turn waste into resources; adopt viable and efficient recycling methods for environmental sustainability
c) Waste Treatment - Adopt innovative technologies in Waste-to-Energy plants to recover energy efficiently and minimise land-take and ash residue
d) Landfill and Ash Management –Turn ash residue into a resource and maximise landfill lifespan

As part of our efforts, we aim to achieve a recycling rate of 65% by 2020 in the short term, and 70% by 2030.

Implementation

Numerous programmes have been initiated to encourage recycling of waste in Singapore. These include supporting recycling projects and research and development (R&D) of recycling technologies, as well as improving recycling infrastructure in the country.

To this end, National Environment Agency (NEA) has set up the Closing the Waste Loop (CTWL) R&D Initiative and the 3R Fund. The CTWL R&D Initiative encourages collaborations with institutes of higher learning, research institutes and private sector partners, to develop technologies and solutions for waste management. The 3R Fund co-funds waste minimisation and recycling projects.

To increase awareness on waste management and encourage recycling in commercial and industrial premises, large hotels and shopping malls are required to submit waste data and management plan since 2015 and this will be extended to large industrial buildings and convention and exhibition centres from 2021.

For residential developments, NEA has introduced the National Recycling Programme (NRP), which has been enhanced to provide greater convenience to households. Under the enhanced NRP, one recycling bin is provided to every high-rise housing block. To make it even more convenient to recycle, all new public housing developments launched from 2014 and all new non-landed private residential developments taller than four storeys from 2018 are fitted with recycling chutes.

To tackle e-waste, NEA will be implementing a regulated e-waste management system in Singapore by 2021 to ensure the proper and safe handling and extraction of resources from e-waste. This system will also fund the aggregation and recovery of valuable resources from e-waste for reuse, turning trash into treasure. The NEA is working closely with the industry to implement the e-waste management system, which will increase e-waste recycling rates.

To tackle packaging waste, which makes up a third of Singapore's domestic waste disposed of by weight, NEA will be introducing a mandatory packaging reporting framework by 2021, which is aimed at raising companies' awareness of the benefits of packaging waste reduction, and spur companies to reduce the amount of packaging used. In making producers responsible for the "end-of-life" of their products, they will also be incentivised to design products that are more easily recycled or come up with innovative circular economy business models.

Progress towards national target

In 2010, Singapore generated a total of 6,517,000 tonnes of waste, and recycled 3,758,000 tonnes, placing Singapore's overall recycling rate at 58% (Table 2). In 2018, Singapore produced 7,695,000 tonnes of waste, recycling 4,726,000 tonnes, placing the most recent recycling rate at 61% (Table 3). Hence, Singapore's overall recycling rate increased by three percentage points from 2010 to 2018. The main indicator for this national target is Singapore's national, overall recycling rate. Information for this is collected by NEA, the government agency responsible for ensuring a clean and green environment, and the sustainable development of Singapore.

Waste Type	Total Generated ('000 tonnes)	Total Recycled ('000 tonnes)	Recycling Rate	Total Disposed ('000 tonnes)
Paper/Cardboard	1,384	738	53%	646
Ferrous metal	1,195	1,128	94%	67
Construction & Demolition	922	912	99%	9
Plastics	740	78	11%	662
Food	641	102	16%	538
Used slag	383	379	99%	4
Wood*	270	190	70%	80
Horticultural*	251	99	40%	152
Textile/Leather	121	15	12%	106
Ash & sludge	114	0	0%	114
Non-ferrous metal	86	73	85%	12
Glass	80	19	24%	61
Scrap tyres	24	20	83%	4
Others (stones, ceramics, rubber etc.)	307	4	1%	304
Overall	**6,517**	**3,758**	**58%**	**2,760**

*Wood and horticultural wastes recycled include 71,600 tonnes used as fuel in biomass power plants.

Table 2 Waste generation and recycling statistics in 2010.

Waste Type	Total Generated ('000 tonnes)	Total Recycled ('000 tonnes)	Recycling Rate	Total Disposed ('000 tonnes)
Construction & Demolition	1,624	1,618	99%	7
Ferrous metal*	1,269	1,260	99%	9
Paper/Cardboard	1,054	586	56%	467
Plastics	949	41	4%	909
Food	763	126	17%	637
Horticultural**	521	428	82%	93
Wood**	320	227	71%	93
Ash & sludge	240	25	10%	215
Textile/Leather	220	14	6%	206
Used slag	181	179	99%	2
Non-ferrous metal*	171	170	99%	2
Glass	64	12	19%	52
Scrap tyres	32	29	90%	3
Others (stones, ceramics, rubber etc.)	286	11	4%	274
Overall	**7,695**	**4,726**	**61%**	**2,969**

*Metal recovered from Incineration Bottom Ash for recycling is excluded from waste disposed.
**Wood and horticultural wastes recycled include 437,900 tonnes used as fuel in biomass power plants.

Table 3 Waste generation and recycling statistics in 2018.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☐ On track to achieve target

☒ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 4 highlights the importance of engaging all stakeholders in achieving sustainable production and consumption, and to minimise the ecological impacts of natural resource use. A high-density and growing population in Singapore translates to high consumption rates, and each stakeholder and user group in the society needs to be engaged to change the country's pattern of consumption into a more sustainable one.

By declaring 2019 to be the Year Towards Zero Waste, the government has set the direction for the local movement towards sustainable use of resources by promoting the 3Rs, "Reduce, Reuse, Recycle", to build a circular economy. However, the government cannot do this alone and needs to partner businesses, individuals and organisations to come up with innovative and effective solutions.

Community outreach and education have been carried out through a variety of projects and initiatives, such as the Community 3R Outreach Programme (CROP), as well as the Singapore Environment Council-StarHub School Green Awards, Singapore's leading school recycling programme. There are also collaborations and initiatives intended to engage the private sector, including the Green and Gracious Builders Award (started by the Building and Construction Authority (BCA) for private builders), the 3R Awards (to incentivise hotels and shopping malls to minimise and recycle waste) and the Singapore Packaging Agreement (SPA; to reduce packaging waste which constitutes about one-third of Singapore's domestic waste disposed of by weight) or collaborations such as the Little Green Dot recycling programme (with Tetra Pak) and the Recycling the Nation's Electronic Waste Programme (with StarHub, DHL, and TES-AMM). Some of these initiatives also serve as platforms for the Government to engage and consult the private sector when designing new regulations, such as the regulations to manage e-waste and packaging waste that will be introduced by 2021.

Other than waste reduction and recycling, Singapore also has numerous initiatives meant to encourage sustainable use of water and electricity, namely the Mandatory Energy Labelling Scheme (MELS) and Water Efficiency Labelling Scheme (WELS) (both schemes allow consumers to make better decisions regarding the energy or water efficiency of their household products) and the Energy/Water Efficiency Funds to provide businesses with small funding opportunities to increase their energy/water efficiency. Overall, these efforts and initiatives aim to reduce Singapore's consumption of both renewable and non-renewable resources (for example, water, energy, food), where high production and consumption rates have the potential to impact natural ecosystems and biodiversity.

All of these projects also contribute to Singapore's efforts towards Aichi Target 4 and SDG 12 on creating sustainable consumption and production patterns. While there is still more progress to be made

for Singapore's movement towards a circular economy, a number of our current engagements with the private sector can be taken as good practices on the simple ways private organisations can become involved in sustainability efforts.

2.5 National target 5 – Natural Areas

By 2020, 7.5% of Singapore will remain as natural areas.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☒ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Singapore is a small and highly urbanised city-state with no hinterland. As mentioned previously, in our increasingly diversified economy (MEWR, 2015), we balance our multiple land use needs with a pragmatic approach. At the same time, we also understand the importance of our natural areas to the nation. Biodiversity is important to the welfare of Singaporeans and provides essential functions and ecosystem services such as climate change mitigation, recreation, research, education and cultural identity. As the home to a rich diversity of organisms from different ecosystems, our natural areas form the backbone of Singapore's natural heritage. As such, in this national target, Singapore has made it a national priority to continue to safeguard our remaining natural areas, consisting of our Nature Reserves and Nature Areas (identified in the Parks and Waterbodies Plan of URA's 2014 Master Plan for Singapore). This is Singapore's contribution towards Aichi Target 5, in preventing the further loss of natural habitats in the country.

Implementation

In Singapore, land use allocation is carried out by the URA. URA comprehensively reviews the Master Plan for Singapore every five years, clearly delineating land use allocation in the plan, including the provision of land for natural areas in Singapore. Today, the main natural areas in Singapore encompass the four legally gazetted Nature Reserves and 20 Nature Areas, which will be retained for as long as possible. Despite their individual sizes, the Nature Reserves and Nature Areas, together with other natural areas in Singapore, form an island-wide matrix that is continually enhanced through habitat restoration and enhancement projects (see sections 2.13, 2.15 and Annex A, pg 79).

Progress towards national target

The data for this national target is obtained via geographic information system (GIS) spatial analysis, using data from URA's 2014 Master Plan. This is the most authoritative data for Singapore as URA is the country's agency responsible for land use planning.

First, the total area (in km^2) of natural areas (Nature Reserve and Nature Areas, both terrestrial and marine) in Singapore is calculated. Following that, this area is compared with Singapore's current[6] land area to obtain the proportion of natural areas in the country. In 2018, the percentage of natural areas in Singapore was calculated to be 7.56%.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 5 calls for the reduction or full elimination of natural habitat destruction, degradation and fragmentation. High rates of deforestation and development in the colonial and early post-independence period have led to the loss of much of Singapore's original forest cover (Corlett *et al.*, 1992). With a strong focus on greening and environmental conservation, through careful and judicious land planning, Singapore endeavours to retain as much of our natural environment as possible.

While the proportion of natural areas in the country is an important indicator of biodiversity conservation, effective management of these areas is just as important. Natural areas in Singapore are closely monitored in order to facilitate effective and active management. Habitat degradation in our forests can occur as a result of disturbances or edge effects. Frequent and rigorous monitoring will facilitate the rapid detection of habitat degradation by park managers and allow them to quickly initiate restoration/rehabilitation or enhancement efforts to counter the degradation. One key example of this was the two-year closure of Bukit Timah Nature Reserve (BTNR) for rehabilitation in late 2014, after NParks observed slopes and trails showing increasing signs of erosion, as well as high soil compaction (a result of recreation) that were affecting tree survival and habitat regeneration (Tan, 2014).

On a larger scale, as part of the NCMP (see ANNEX A), NParks also promotes an island-wide holistic approach towards habitat conservation. Forward-looking research such as connectivity modelling (for example, GIS modelling of least resistance pathway or ABM) provide science-based guidelines to counter habitat fragmentation in highly-urbanised Singapore (see section 2.3 for more details). This is complemented by a set of buffer parks or areas purposefully established around the ecologically sensitive Nature Reserves (Figure 1), serving to decrease the impact of recreational activities on the reserves and to protect them against edge effects. For example, CCNR and BTNR are protected by over

[6] Singapore's land area increases due to land reclamation works in the waters around the mainland.

250 ha of buffer parks (Figure 1A), acting as alternative recreational sites and/or physical barriers against ongoing and potential development occurring near the reserves.

With good management of our protected areas and holistic biodiversity conservation measures across the island, Singapore continues to contribute to Aichi Target 5. These efforts also contribute to the SDGs 14 and 15, working towards conservation and preventing degradation of biodiversity-rich areas both in water and on land.

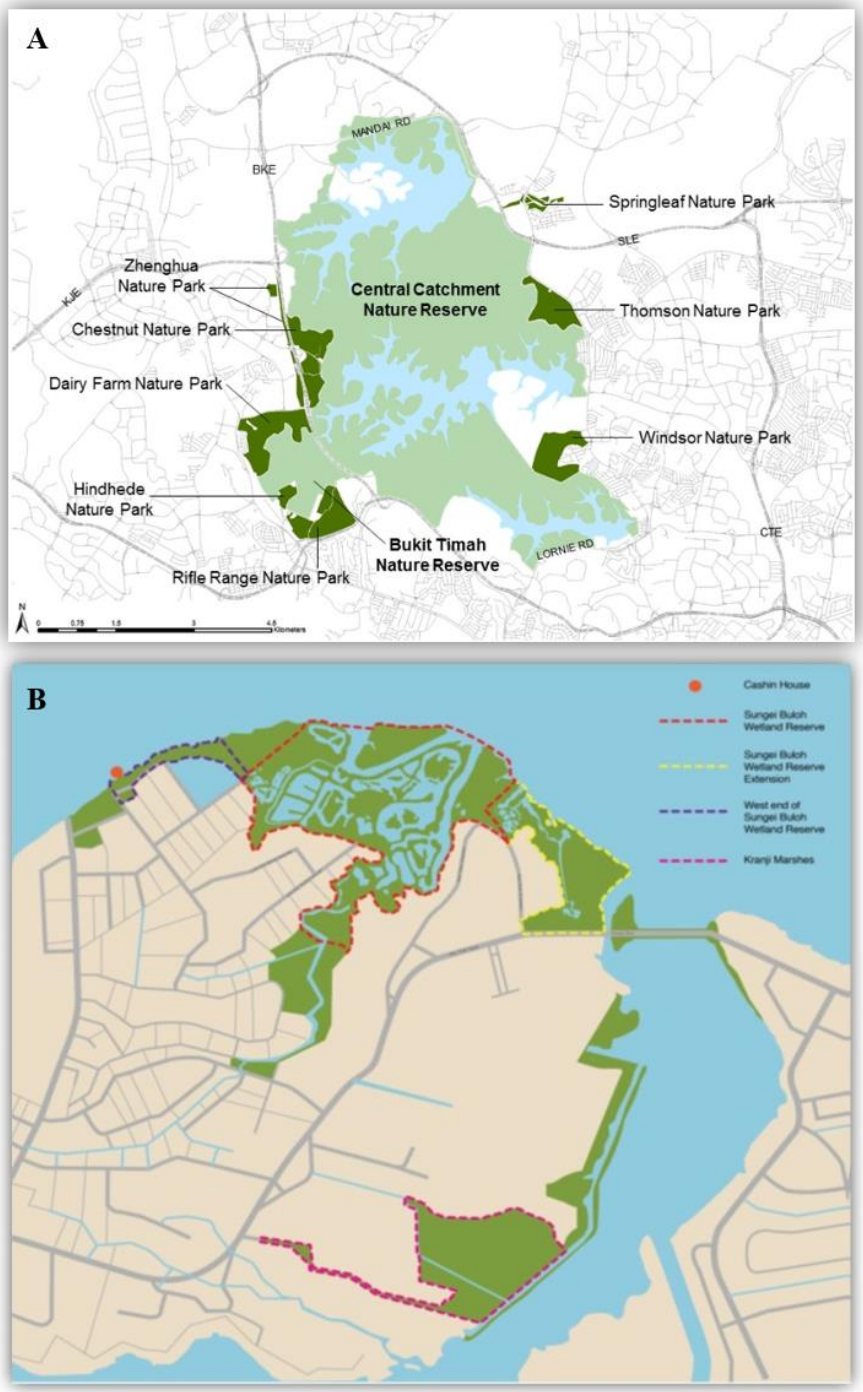

Figure 1 Buffer parks located around Nature Reserves in Singapore, at A) Bukit Timah Nature Reserve and Central Catchment Nature Reserve; and B) Sungei Buloh Wetland Reserve (source: NParks)

2.6 National target 6 – Air quality

By 2020, annual mean of $PM_{2.5}$ to reduce to 12μg/m^3; set ambient SO_2 levels at annual mean of 15μg/m^3; and set ambient SO_2 levels at 24-hour mean of 50μg/m^3.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☒ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Aichi Target 8 mainly concerns agricultural pollution, which continues to be a major cause of nutrient input into natural systems globally. Agriculture is not a significant industry in Singapore today. Moving forward, the government is also transforming the local agriculture sector into one that is high-tech, environmentally sustainable, and less pollutive.

Our national target is focused on air pollution. Not only is air pollution a threat to human health, it is also known to negatively impact sensitive species within our ecosystem (for example, certain lichens, invertebrates and other small organisms), reducing overall biodiversity (Dudley & Stolton, 1996). Singapore regularly monitors the levels of $PM_{2.5}$ and SO_2 in the air as indicators of air quality.

$PM_{2.5}$, also called fine particulate matter, are tiny pollutant particles in the air that are smaller than 2.5μm. These particles cannot be efficiently removed by our body's natural processes, resulting in them remaining in biological systems for long durations (Tan, 2016), causing cardiovascular and respiratory problems that may have greater impact on smaller animals. SO_2 or sulphur dioxide is a colourless gas that is the primary cause of acid rain, contributing to ocean acidification and directly impacting habitat quality as well as being the cause of many respiratory problems in urban areas.

Implementation

In Singapore, frequently cited sources of pollution include motor vehicles, industry (Low, 2018a) and ships (Guttikunda, 2010). The NEA has implemented a variety of measures to reduce air pollution in Singapore to achieve this national target. Progressively since 2012, the NEA has mandated that petrol for motor vehicles have progressively lower sulphur content, with the most recent requirement implemented in July 2017 for petrol sulphur content to be lower than 0.001%. Emission standards for new petrol and diesel vehicles had been tightened to Euro VI since September 2017 and January 2018 respectively. In addition, there are financial schemes such as the Early Turnover Scheme for commercial diesel vehicles which encourage owners to replace their older, less efficient vehicles with new ones that have lower emission rates. NEA is also working with the Economic Development Board (EDB) to further reduce SO_2 emissions from major industrial emitters.

To encourage the use of vehicles with lower emissions, the Carbon Emissions-based Vehicle Scheme (CEVS) and the Fuel Economy Labelling Scheme (FELS) were introduced in 2013. The FELS provides information on the fuel economy of vehicles for more informed decision on vehicle purchase, while the CEVS provides rebates for low-emission cars and imposes surcharges on high-emission cars. The CEVS was replaced by the Vehicular Emissions Scheme (VES) with a new Vehicular Emissions label

in January 2018. In addition to CO_2, the VES includes four additional pollutants (i.e. hydrocarbons, carbon monoxide, nitrogen oxides and particulate matter) in the assessment of new cars, taxis and newly imported used cars for rebate or surcharge based on the worst-performing pollutant. Based on the promising results of the VES, a similar scheme, the Commercial Vehicle Emissions Scheme, will be introduced for light goods vehicles.

Singapore is working to enhance the overall carbon efficiency of our land transport system through the large-scale adoption of green vehicles. By 2040, we aim to phase out internal combustion engine (ICE) vehicles and have all vehicles running on cleaner energy. We will introduce policies and initiatives to encourage the adoption of electric vehicles. The public sector itself will take the lead and progressively procure and use cleaner vehicles. In addition to this, we will also be launching an Electric Vehicle Early Adoption Incentive (EEAI) from 2021 to 2023. The EEAI will lower the upfront cost of an electric car through the provision of rebates, and will help to narrow the upfront cost gap between electric and ICE cars. Through these initiatives, we hope to encourage the proliferation of EVs moving forward.

Public transport remains the most energy-efficient mode of powered transport, and one of Singapore's key contributions towards reducing air pollution. Singapore's target is for the public transport modal share during the morning and evening peak hours to reach 70% by 2020 and 75% by 2030, up from 59% in 2008 and 67% in 2017. By 2040, Singapore aims to establish Walk-Cycle-Ride (WCR) transport modes, comprising active mobility (for example, walking or cycling) as well as public and shared transport modes, as the preferred way to travel. All journeys to the nearest neighbourhood centre using WCR modes of transport will take no more than 20 minutes, while nine in ten peak period WCR journeys, such as between the home and workplace, will be completed in less than 45 minutes. By expanding and improving our transport infrastructure to reduce travel times and encourage more people to take WCR transport modes, we can reduce our vehicular emissions footprint further. To encourage the use public transport, the length of the rail network will expand from 230 km in 2017 to 360 km by 2030, with eight in ten households to be within a ten minute walk from a train station.

Progress towards national target

Singapore's progress in moving towards this national target (Table 4) is monitored through NEA's network of air monitoring stations across Singapore, and the annual data is published in the Singapore Department of Statistics website.

Year	Annual mean SO_2 ($\mu g/m^3$)	24-hour mean SO_2 ($\mu g/m^3$)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)
2010	11	104	17
2018	9	65	15

Table 4 Annual mean SO_2, 24-hour mean SO_2 and annual mean $PM_{2.5}$ levels in 2010 and 2018.

Singapore's current annual mean SO_2 levels are already lower than the level set in national target 6. The other two elements of this target, the annual mean $PM_{2.5}$ and 24-hour mean SO_2, have shown some improvement but have yet to reach the national target and are still higher than the levels set by the World Health Organisation Air Quality Guidelines (WHO AQG).

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☐ On track to achieve target

☒ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

In Singapore, agriculture is not currently a significant sector and proper disposal of potential pollutants is closely monitored. In addition, the government has plans to transform the agriculture sector into one that is high-tech, environmentally sustainable and less pollutive. The main concern of Aichi Target 8 is therefore not a significant problem in the country. Our national target for Aichi Target 8 has therefore focused on reducing air pollution instead, a problem which continues to persist due to our highly urbanised environment.

Because motor vehicles are a known major source of air pollution, Singapore has implemented numerous measures specifically intended to decrease emissions from vehicles. These include increasing the efficiency of energy consumption and diverting human traffic to less polluting modes of transport such as shared electric vehicles and public transportation (see further details in the implementation section above). Frequent monitoring of various air pollution indicators across the country also assists with documentation of long-term trends, facilitating strategic planning on measures Singapore can take to combat air pollution. This national target is directly related to Singapore's achievement of SDG 3 on public health and well-being, and tangentially contributing towards biodiversity-related goals, namely SDGs 14 and 15.

2.7 National target 7 – Invasive Alien Species

By 2020, a potentially invasive alien species list for Singapore will be compiled.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☒ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☒ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☒ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Invasive species are an increasing threat to global biodiversity. Singapore, being an island-state, is more vulnerable to such invasions, due to the presence of highly specialised, local endemic species that are outcompeted by more adaptable, generalist invasive species. Defined by Yeo and Chia (2010), based on the International Union for Conservation of Nature (IUCN) definition, as “an alien species that becomes established in natural or semi-natural ecosystems or habitats, that is an agent of change, and that threatens native biological diversity”, these species can have huge negative impacts on local ecosystems. Due to Singapore’s location as an important trading port, the high volume of cargo into and out of the country facilitates the spread of potentially invasive species into our local marine and terrestrial habitats.

An identification of potential invasive species and their pathways of introduction will facilitate the implementation of preventive measures to keep alien species from establishing in Singapore, for example, by interrupting potential introduction pathways or deciding whether risk assessments should be conducted when importing selected species into the country.

Implementation

The list will be compiled using the following sources of information: 1) published scientific data on invasive species (for example, Yeo & Chia, 2010); 2) consultations with local academics and/or specialists and; 3) other internationally recognised sources (for example, The 100 of the World's Worst Invasive Alien Species, by the Invasive Species Specialist Group; global databases such as IUCN; GRIIS).

Progress towards national target

At present, NParks maintains the list of species found in Singapore, including species that are considered non-native and hence "alien". As this list is frequently updated, it can serve as the foundation from which to determine the alien species that are most likely to turn invasive. Combined with scientific studies, such as the local study on the populations of blacklisted marine invasive species in Singapore's ports (Tan, 2018), scientific documentation of present alien species in Singapore (Yeo & Chia, 2010), as well as consultations with recognised taxonomists or specialists, the information can assist with the development of new methods to manage and prevent the establishment of more invasive species in the country.

NParks is currently in the midst of data collection to compile the list of potential invasive species, in fulfilment of the national target.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 9 sets aims for the identification, control, eradication and prevention of invasive species establishment globally. Invasive species continue to be a potentially significant threat to local biodiversity, particularly in highly connected countries such as Singapore.

The invasion process begins with the physical movement of a species from one location to another followed by live release into the new environment. At this point, the species is considered an "alien" or "non-native" to the new environment. Subsequently, if the new population becomes established, reproduces and spreads rapidly and causes negative impacts to the new environment, it is termed an invasive species (Lodge *et al.*, 2006; Figure 2). The regulation and prevention of invasive species is carried out by numerous government agencies, with mandates relating to the import and export of plants and animals, and the regulation or maintenance of Singapore's natural areas and waterways (such as canals and reservoirs). This includes the Singapore Customs, Singapore Food Agency (SFA), NParks and PUB, Singapore's National Water Agency (PUB). Singapore Customs, SFA and the Animal and Veterinary Service (AVS, a division of NParks), work together to license and monitor the live animals

and plants entering or leaving the country, while the more operational divisions of NParks as well as PUB, document and contain the spread of alien species in natural and urban areas.

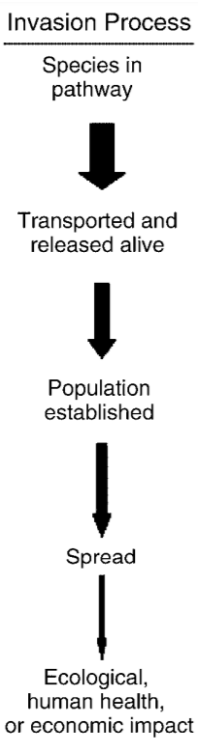

Figure 2 The stages of the "invasion process" leading up to the establishment of an invasive species at a new location (adapted from Lodge *et al.*, 2006).

On the ground, Singapore also conducts active citizen outreach to prevent the introduction of alien species. During Vesak Day, an annual holiday observed by practicing Buddhists, animals are often released due to the belief that it is an act of kindness and mercy. This, however, is a key route of entry for non-native species into our natural areas (Yeo & Chia, 2010). In response, Operation No Release was initiated to educate the public about the impacts of "mercy" release of animals into Singapore's natural areas, reservoirs and waterways. It is an annual campaign organised by NParks, PUB and the now defunct Agri-Food & Veterinary Authority (AVA) and involves numerous volunteer groups (for example, Toddycats from the Lee Kong Chian Natural History Museum (LKCNHM), Waterways Watch Society). The campaign is carried out annually in our parks, Nature Reserves and reservoirs, such as Bedok Reservoir, Labrador Nature Reserve and Windsor Nature Park (NParks, 2017), and sends out a serious message that animal releases or pet abandonments are cruel as they harm the released animals, which often have no means to fend for themselves in the wild. In addition, citizens are warned of the serious ecological impact when animals are released in our natural areas or waterways, potentially becoming invasive and competing with native species for resources or posing a risk to human users of these areas. This initiative therefore serves to decrease the odds of potential establishment of invasive species, safeguarding Singapore's native biodiversity and contributing to the implementation of Aichi Target 9.

At present, scientific records of alien freshwater fish and reptile species are the most well documented, while invertebrates are likely to be under-represented (Yeo & Chia, 2010). Studies have also been initiated to assess alien marine species present in Singapore's port areas (Tan, 2018). All these studies contribute to knowledge on these species and how to contain their spread, but still more studies and work are needed on alien species to determine management measures appropriate to the local context.

Singapore acceded in 2017 to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) under the International Maritime Organisation (IMO), which imposes obligations on Parties to put in place measures to ensure that ballast water from ships does not act as a means for introduction of invasive marine species into local waters.

These measures and efforts contribute to SDG 15, which has specific targets relating to halting the spread of invasive species across the world.

2.8 National target 8 – Resilience to Climate Change

Singapore will assess and enhance Singapore's resilience to climate change through the development of climate change adaptation strategies across multiple government agencies.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☒ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☒ 2 ☐ 7 ☒ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Changes in local weather patterns and sea level rise are some of the effects of climate change that will be increasingly felt by Singapore. As a low-lying country, 30% of the island is at an elevation of less than five metres above mean sea level, and extensive infrastructure and residential areas are located along the country's coastline.

Studies have predicted that sea levels will rise by between 0.25 m and 0.76 m in the country by the end of this century (National Climate Change Secretariat (NCCS), 2016), while the predicted negative effects of climate change include increased risks to residential areas along the coast, to local biodiversity and greenery, and to Singapore's water supply and public health (MEWR & MND, 2016). Singapore has developed a national plan, applied across all government agencies, to coordinate efforts to enhance Singapore's resilience to climate change. Due to the uncertainty of predictions and risk assessments, the national plan is updated regularly to take into consideration the latest information on climate change.

Implementation

Singapore adopts a whole-of-government approach in addressing climate change, under the guidance of the Inter-Ministerial Committee on Climate Change (IMCCC). Singapore's Climate Action Plan: "A Climate-Resilient Singapore: For a Sustainable Future", outlines our strategies to adapt to the anticipated effects of climate change. The Resilience Working Group (RWG), an inter-agency platform responsible for assessing Singapore's vulnerability to the physical effects of climate change, recommends to the IMCCC long-term adaptation plans to enhance the nation's resilience to climate change.

Under the Resilience Framework (Figure 3) specified in Singapore's Climate Action Plan, climate change risks are first identified and analysed through impact categorisation and assessment, followed by the formulation of potential adaptation pathways (to reduce risk) via adaptation planning. Under this framework, numerous agencies are involved in each process. This framework has subsequently led to measures such as elevating roads located along the coast (for example, Nicoll Drive, (Tang & Lin, 2017)) and creating different coastal protection structures along the country's east coast, such as the Geo-bag Wall or Composite Stepped Sea Wall in response to anticipated levels of sea level rise (MEWR & MND, 2016). Another example is Singapore's Project *Wolbachia*, which aims to suppress the *Aedes aegypti* (a vector of the dengue virus) population to a level that cannot sustain dengue transmission, which is becoming more challenging with changing weather patterns. *Wolbachia* bacteria-infected males are released to mate with wild females to bring about the production of non-viable eggs (MEWR & MND, 2016). The Resilience Framework also specifies that these decisions continue to be supported by a strong foundation of scientific research, ensuring that Singapore's preparation for addressing anticipated climate change impacts remains flexible and dynamic. The Centre for Climate Research Singapore (CCRS) was established under the Meteorological Service Singapore (MSS) in 2013 to better understand the science of climate change and to model its effect. The CCRS also published the Second National Climate Change Study for Singapore in 2015, which provides information on our future climate (for example, changes to mean temperature, rainfall, sea level rise).

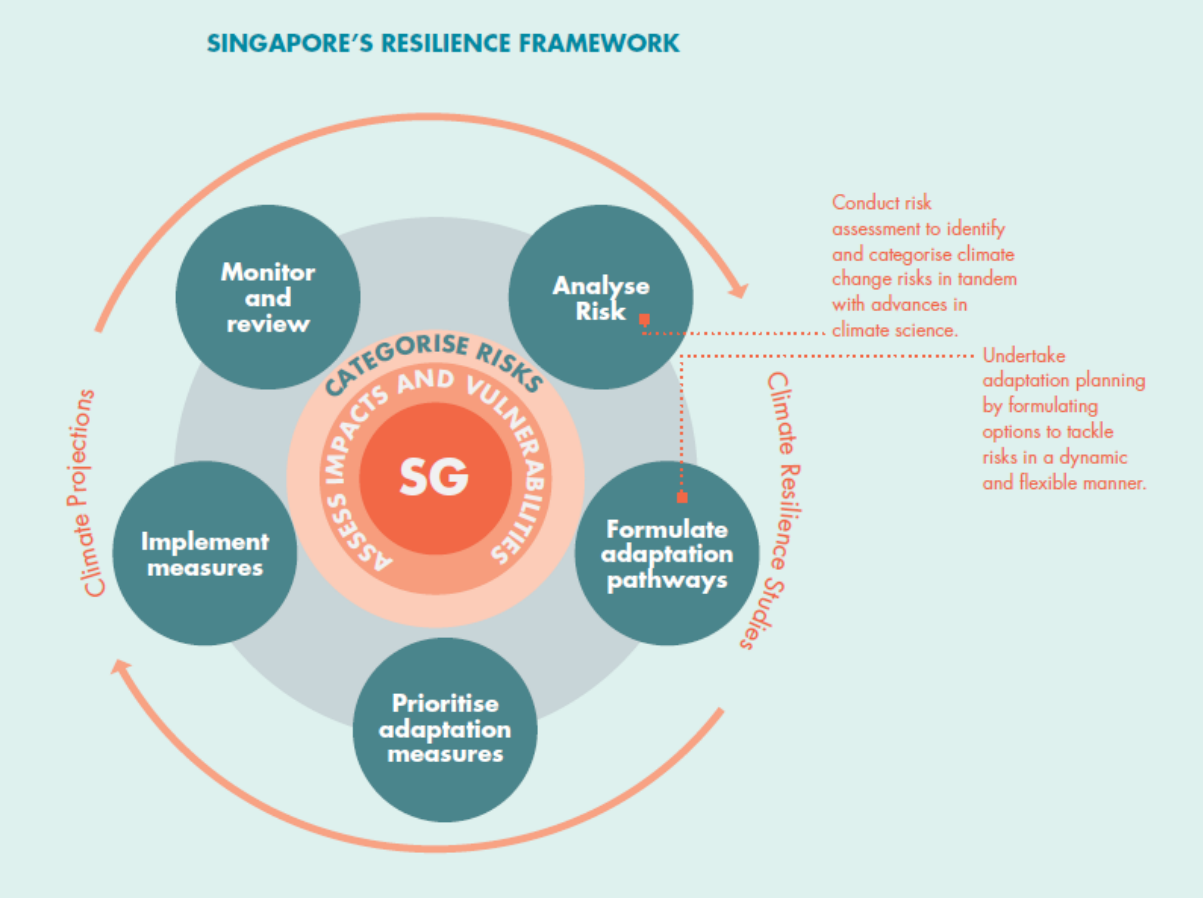

Figure 3 Singapore's Resilience Framework for climate change adaptation, prioritising risk analysis and adaptation planning, supported by thorough research, facilitating dynamic and flexible climate change adaptation for the country.

Singapore's native coastal ecosystems are natural barriers against the sea, offering coastal protection ecosystem services which are essential in light of climate change. However, these systems are also

being subjected to increasing environmental pressures, due to the changing climate. By considering native biodiversity as part of Singapore's national climate change adaptation plans, we can continue to utilise these ecosystems for nature-based coastal protection. For example, mangroves, well-known for their coastal protection ecosystem services (Yang *et al.*, 2011), can be used to complement Singapore's hard engineering coastal protection measures (such as the Geo-bag Wall, mentioned above). To enhance the climate resilience of our natural ecosystems (and to maintain their provision of ecosystem services), NParks undertakes habitat enhancement of natural coastal areas (see section 2.14 for more details). Frequent monitoring of important environmental variables, for example, monitoring of Sea Surface Temperature (SST) and its correlation with coral bleaching on SIMP, can also enable our coastal protection efforts to take into consideration the impact of climate change and sea level rise on both native biodiversity and society.

Progress towards national target

Information to inform the progress of this national target was obtained from NCCS, the government agency responsible for coordinating climate change efforts in Singapore. Singapore presently has a strong framework in place for climate change adaptation in the country (Figure 3), involving numerous government agencies and ministries. This framework will continue to evolve to facilitate the building of Singapore's long-term resilience to climate change.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 10 specifically aims for mitigation of the impacts of climate change and ocean acidification on coral reef systems. Mass coral bleaching events on Singapore's reef systems have become increasingly common, having occurred in 1998, 2010 and most recently, in 2016 (The Straits Times, 2016). While our national target on climate change does not directly address this aspect of the Aichi Target, Singapore has undertaken projects that aim to reduce climate change impacts on coral reefs.

Scientific studies and/or frequent monitoring projects are conducted to generate knowledge, document baseline biodiversity and develop monitoring protection frameworks for coral reefs in Singapore. The National Biodiversity Centre (NBC) of NParks carries out frequent monitoring of surface water temperature (i.e. Sea Surface Temperature, SST) and coral response on SIMP to gather information which can assist with determining the temperature thresholds at which local coral bleaching occurs. Long-term coral monitoring programmes that involve citizen scientists, such as the Coral Reef Monitoring Programme, also contribute important knowledge about long-term biodiversity trends of Singapore's reefs. Taken together, such information will facilitate the detection of abnormal

biodiversity trends when stressor thresholds of coral reef systems have been reached, in turn setting off appropriate stressor mitigation measures.

2.9 National target 9 – Natural Areas

By 2020, 7% of terrestrial and inland water, and 0.5% of coastal and marine areas will remain as natural areas.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☒ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☒ 5 ☐ 10 ☐ 15 ☐ 20

Singapore is a tropical island-state located within the Sundaland biodiversity hotspot as well as one of the richest marine bioregions in the world for corals (we are located near the Coral Triangle) and seagrass (Short *et al.*, 2007). We have already documented over 13,000 terrestrial and marine species (https://singapore.biodiversity.online/) and are still finding and naming new species. Such rich biodiversity relies on the presence of viable habitats and natural areas for survival. As such, Singapore has chosen to conserve selected habitats and natural areas for native biodiversity. These efforts all contribute towards Aichi Target 11 on the percentage of areas conserved for biodiversity within the country.

Implementation

NParks works with the URA to set aside Singapore's land as natural areas in the statutory medium-term Master Plan, which guides land use development over a 10 to 15-year time frame, as well as in the longer-term land use planning strategies (see section 2.3 for more details on Singapore's land planning process). This integrated approach to planning helps Singapore balance between development and nature conservation and are key policies to the retention of our terrestrial and marine natural areas.

Progress towards national target

As of 2018, Singapore's terrestrial and inland water natural areas constitute a proportion of 7.04% of Singapore's total land area, while the proportion of marine natural areas stand at 0.52%. Data for this target was collected in a similar fashion to the data for national target 5, from recent URA Master Plan maps (2014).

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Both national targets 9 and 10 (below) contribute to Aichi Target 11. The elaboration for Singapore's progress in implementing Aichi Target 11 is found below in section 2.10.

2.10 National target 10 – Ecological Connectivity

By 2020, Singapore will develop a total of 360 km of park connectors and 100 km of Nature Ways to enhance ecological connectivity.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☒ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☒ 5 ☐ 10 ☒ 15 ☐ 20

Habitat connectivity is an essential part of maintaining habitat integrity and biodiversity, as emphasised by Aichi Target 11. This is particularly pertinent in Singapore's urban context because connected habitats would allow for organisms to move between patches of natural areas, promoting gene flow between populations and facilitating habitat resilience. Within Singapore's urban matrix where natural habitats are often small and fragmented, populations within each habitat have a higher chance of being inbred and are thus more susceptible to environmental stressors and have a higher likelihood of extirpation. It is therefore essential for us to maintain and continue improving habitat connectivity across the island and expand the ecological spaces available to native biodiversity.

Implementation

Singapore has four main approaches towards maintaining habitat ecological connectivity (elaborated in the NCMP, see Annex A), and this section will elaborate upon two main approaches: the Park Connector Network (PCN) and Nature Ways. The PCN is an extensive network of green corridors that serve dual functions for the community and wildlife. Consisting of the Round Island Route (RIR), the Coast to Coast Trail and seven interlinked loops[7], the PCN serves as a recreational location for Singaporeans, while facilitating fauna connectivity across the island. In 2016, the development of the first section of the RIR was initiated, with the final aim to create a continuous 150 km-long corridor that circles the island-state by 2035. In 2018, the 20 km-long Eastern Coastal Loop was opened. Finally, the Coast to

[7] The seven park connector loops are called: 1) Northern Explorer Loop, 2) North-Eastern Riverine Loop, 3) Eastern Coastal Loop, 4) Centre-Urban Loop, 5) Southern Ridges Loop, 6) Western Adventure Loop and 7) Central Nature Loop.

Coast Trail was opened in early 2019. Stretching 36 km, this corridor begins in Jurong Lake Gardens in Western Singapore and extends to the Northeast in Coney Island Park.

The Nature Ways initiative is another measure that utilises ecological concepts to promote habitat connectivity between areas of high biodiversity in Singapore. Designed to mimic the four vertical layers of a rainforest (i.e. shrub, understory, canopy and emergent layers), the physical structure of Nature Ways appeals to fauna and facilitates their movement between green spaces. For example, the purposeful planting of flowering plants and butterfly host plants within the shrub layer aims to attract butterflies by providing resources for them to feed and reproduce along the Nature Ways. The topmost layer of Nature Ways (which comprises of exceptionally tall trees, relative to those in the canopy layer), facilitates the movement of animals adapted to living on the emergent layer in rainforests (for example, birds).

Progress towards national target

The data for the length of the PCN and Nature Ways in Singapore are obtained from NParks, the national agency which designs, develops and maintains these green corridors.

In 2010, the extent of the PCN stretched 123.8 km across the island. As of the beginning of 2019, the length of the PCN has increased to over 300 km, as a result of numerous new park connector loops being opened since 2010, including the Coast to Coast Trail which was recently opened in March 2019 (Choo, 2019). An additional 60 km of PCN, which is part of the RIR, is also slated to be completed by the end of 2020. As such, the expected length of the PCN is 390 km by 2020. In 2013, Singapore had 21 km of Nature Ways, while in 2018, this length increased to 80 km. At the rate of increase of Nature Ways as of 2018, Singapore would have a length of approximately 103 km of Nature Ways by 2020.

Category of progress towards the implementation of the selected target:

☒ On track to exceed target

☐ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 11 aims for a certain percentage of effectively managed marine and terrestrial protected areas, to ensure proper safeguarding and conservation of species and biodiversity. It is important to note that Singapore's efforts toward this Aichi Target has to take into consideration Singapore's context as a small island-state with a high population density, and land area being a scarce resource. Even with careful land planning, the needs of the nation continue to grow, and land has to be set aside for numerous other functions that may not be compatible with conservation of biodiversity. More importantly, Singapore has not lost any of its protected areas to degradation, habitat loss or poor management (see section 2.5). However, the proportion of protected areas in the country decreases gradually over time through increases in Singapore's land area from reclamation works, and not through losses of protected areas.

Singapore continues to safeguard natural areas that have been set aside for native biodiversity. This is particularly so for the four legally gazetted Nature Reserves, which were conserved due to their high biodiversity value, and continue to be safeguarded by strict enforcement under the Parks and Trees Act (2005). The four Nature Reserves encompass many of the habitats originally present in Singapore, such as terrestrial lowland primary and secondary forests, hill dipterocarp forests, coastal hill forest, freshwater streams and pools (including hill streams, the habitat of the critically endangered endemic Singapore freshwater crab, *Johora singaporensis*), freshwater swamp forests, mudflats and mangrove forests. Numerous efforts are also being made to prevent the degradation of our natural areas as a whole, such as increasing habitat connectivity (via PCN and Nature Ways programmes, elaborated above), setting guidelines for the public about proper behaviour within these areas, and conducting in-depth monitoring and research of these sites (see Annex A, pg 81 for more information). On the global scale, the sharing of best practices for these processes with other countries and cities (for example, via regional and international platforms such as the Asian Forest Cooperation Organisation's (AFoCO) project on applying the landscape approach to forest restoration, or the Biophilic Cities Network (BCN)), can potentially facilitate progress towards the Aichi Target.

2.11 National target 11 – Species recovery

By 2020, Singapore will establish populations of 11 locally endangered species in a number of new habitats.

Target Species	Targeted sites for reintroduction (by 2020)
Johora singaporensis (Singapore freshwater crab)	2
Nyctixalus pictus (Cinnamon bush frog)	3
Cliona patera (Neptune's cup sponge)	3
Gardineroseris planulata (Honeycomb coral)	3
Madracis kirbyi (Hard coral)	3
Fagraea splendens (Epiphyte)	5
Ficus stricta (Strangling fig)	5
Margaritaria indica (Tree)	5
Ormocarpum cochinchinense (Tree)	5
Scolopia macrophylla (Tree)	5
Tetrastigma rafflesiae (Climber)	5

Table 5 Target species for national target 11, and the intended number of reintroduction sites for each species.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☒ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☒ 5 ☐ 10 ☒ 15 ☐ 20

Due to Singapore's initial high rate of urbanisation in the 19th century, rapid habitat loss resulted in population declines of many species in the country. The conservation and safeguarding of these remaining populations of endangered or endemic species will ensure that natural areas in Singapore retain their species diversity and habitat resilience[8]. In addition, there is also a need to distribute resources and efforts over a wide spread of taxa as different species play different ecological roles in the ecosystem.

As such, this national target sets ambitious reintroduction targets for selected species recovery projects to promote the establishment of self-sustainable, wild populations of these threatened species. We selected 11 species from different animal and plant groups for reintroduction, originating from different habitats across Singapore (Table 5), taking various factors into consideration such as availability of suitable habitats, the feasibility of enhancing present habitat to create suitable habitats for the species of interest and the ease of breeding/translocation.

Implementation

The main initiative facilitating the implementation of this national target is the species recovery programme, which is part of the NCMP (see Annex A, pg 80). This programme focuses on direct human intervention and/or habitat preservation to assist with population recovery of selected species in Singapore, as guided by the Species Recovery Framework (Figure 8). First, NParks selects endemic or locally endangered species that have small or isolated populations. Occasionally, newly discovered or rediscovered species may also be considered for the list if they are thought to be in danger of extirpation. Next, an assessment is made if direct intervention or habitat preservation or both, will be carried out. If the habitat is to be preserved, depending on the environmental conditions (whether they are suitable for the chosen species to survive), the habitat is either enhanced or conserved. If direct intervention is required, individuals are reintroduced to new habitats, either from one suitable site to another (direct translocation) or by releasing captive bred individuals in an appropriate habitat.

Since 2016, NParks has announced a total of 94 species of flora and fauna to be prioritised for programme. These 94 species comprise 75 species of plants, 11 terrestrial animals and eight marine organisms. Each species recovery programme is at a different stage. For example, programmes for species such as the Raffles' banded langur (*Presbytis femoralis femoralis*) are still at the data collection stage, which precedes the creation of species action plans. Other species have already been translocated (for example, *Nyctixalus pictus*, the cinnamon bush frog) or were successfully bred in captivity (for example, *Tridacna gigas*, the giant clam) or produced young in captivity (for example, *Johora*

[8] Higher species richness within an ecosystem point towards a higher redundancy of species, and therefore a more resilient habitat (Peterson et al., 1998)

singaporensis, the Singapore freshwater crab) and plans are underway for their reintroduction back into the wild. This national target sets specific targets for species recovery projects that are in the latter advanced stage.

As the number of projects continues to grow, earlier efforts can inform the new projects being initiated, or lessons learned can be shared with other countries, assisting with improved success of species recovery rates over time.

Progress towards national target

Data to update the progress towards this national target was obtained from NBC, which initiated and keeps track of the various species recovery projects. Table 6 shows the number of sites that each target species has been reintroduced to, updated till early 2019. All the native plant species have been successfully reintroduced to more than one site, while the corals, sponges and fauna have been successfully reintroduced to at least one site, with the exception of *Gardineroseris planulata*.

Target Species	Targeted sites for reintroduction (by 2020)	Number of sites reintroduced
Johora singaporensis (Singapore freshwater crab)	2	1
Nyctixalus pictus (Cinnamon bush frog)	3	2
Cliona patera (Neptune's cup sponge)	3	1
Gardineroseris planulata (Honeycomb coral)	3	0
Madracis kirbyi (Hard coral)	3	1
Fagraea splendens (Epiphyte)	5	4
Ficus stricta (Strangling fig)	5	3
Margaritaria indica (Tree)	5	2
Ormocarpum cochinchinense (Tree)	5	9
Scolopia macrophylla (Tree)	5	6
Tetrastigma rafflesiae (Climber)	5	4

Table 6 Progress towards the national target on species recovery, indicating the number of sites where each target species has already been reintroduced (information as of early 2019).

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Species are an important component of the ecosystem, forming a crucial part of biodiversity and ecosystem resilience. The greater the diversity of species in a system, the greater the system's resilience to disturbances and stressors (Peterson *et al.*, 1998). Aichi Target 12 attempts to address the high rates of species extinctions across the world, by encouraging countries to work towards decreasing species extinctions and improving the conservation status of species that are known to be declining.

Due to our size, Singapore has small pockets of habitats, small species populations and small distribution ranges of endemics. As such, we have many species considered to be nationally Vulnerable (VU), Endangered (EN) or even Critically Endangered (CR) (Davison *et al.*, 2008). However, between 2012 and 2018, Singapore has documented only eight species extirpations and numerous rediscoveries and new species (a Includes species of indeterminate status

[b] 48 species of birds in the original (Fifth National Report) baseline list were removed from the list maintained by Nature Society (Singapore)
[c] The new baseline list for Odonates of 124 species was updated in January 2019, and already includes the 23 new records and rediscoveries found between 2010 and 2019
[d] The new baseline list for Orthopterans of 245 species was updated in 2015 and already includes the 20 new species, new records or rediscoveries found between 2010 and 2015
Table 8). This could be partly due to the enforcement of stringent laws such as the Parks and Trees Act (2005) for example. Another reason directly preventing species extinctions in Singapore is the species recovery programme (elaborated upon above), which helps prevent the extinction of endemic or rare native species that are in greatest danger of being extirpated. The purposeful selection of many species from different taxa and occupying a variety of ecological environments also facilitates Singapore's contribution to SDGs 14 and 15, particularly the indicators to protect and prevent the extinctions of species.

2.12 National target 12 – Carbon accounting

Singapore will report on the accounting of carbon stock and carbon flux in vegetation and land use every two years.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

The main cause of global warming is the release of carbon dioxide and other greenhouse gases (GHG) into the atmosphere from anthropogenic activities. Estimating carbon stocks and fluxes from the land use and vegetation sector over the years would enable us to deduce the impact of development and land-use changes to Singapore's GHG inventory from this sector. This provides further impetus for us to continue efforts in restoring and enhancing our green areas, especially through ecosystem-based mitigation (EbM) projects including skyrise and vertical greenery, to ensure that our green urban landscape continues to contribute towards our carbon sink.

Implementation

Singapore reports its GHG inventory from the Land Use, Land-Use Change and Forestry (LULUCF) sector based on the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and the 2013 Supplement to these guidelines on Wetlands. Land area information is derived from high resolution (0.5 m) satellite images covering the entire country and translated into IPCC-prescribed land use categories (Forest Land, Cropland, Grassland, Wetland, Settlement, and Other Land). This information is also determined for every year since 1990 using historical satellite imagery to generate a time series of Singapore's land use changes. Within each land use category, biomass, dead organic matter and soil carbon (termed "carbon pools") are estimated using a combination of modelling and field measurement methods. Field measurements, conducted every five years, help improve the accuracy of the modelling data. The land area of each category is then multiplied with a corresponding emission factor for each land use category to obtain the GHG emissions and removals for Singapore's LULUCF sector for that year.

Progress towards national target

Singapore is a Party to the United Nations Framework Convention on Climate Change (UNFCCC), and the obligations include the submission of a National Communication (NC) and Biennial Update Report (BUR) every four and two years respectively. This includes a summary of the GHG inventory from all sectors including the LULUCF sector.

Singapore submitted its fourth NC together with the third BUR to UNFCCC in December 2018. The reports concluded that for 2014, Singapore's annual GHG emissions from the LULUCF sector was 62.03 Gg CO_2-eq[9]. Plans are currently underway for NParks to conduct another National Forest Inventory in 2020 as part of the ongoing and regular ground truthing exercises to support the estimation of the GHG emissions and removals for the LULUCF sector.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

National targets 12 to 15 all contribute to Aichi Target 15 on ecosystem resilience and carbon stocks. The elaboration for Singapore's progress towards Aichi Target 15 is found below in section 2.15.

[9] For reference, Singapore also calculates GHG emissions from non-land use sectors. The country's total GHG emission from all sectors for the year 2014 was 50,908.13 Gg CO_2-eq.

2.13 National target 13 – Habitat enhancement

By 2020, natural ecosystems will be enhanced or restored within three selected parks.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☒ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☒ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☒ 5 ☐ 10 ☐ 15 ☐ 20

Natural areas in Singapore are often used for recreation and other human activities. As a result, they experience frequent disturbances from human use and urban development. Over time, these areas will degrade and lose habitat complexity, and this is detrimental to both local biodiversity as well as the quality of recreational activity for park users. Hence, there is a need for human intervention to assist with the recovery of disturbed natural areas, to prevent irreparable loss of ecosystem integrity, increase the available habitats for fauna to utilise and ensure the continued provision of ecosystem services. This particular national target sets aims for habitat enhancement projects, which focus on enhancing the ecology of more disturbed natural areas around Singapore.

Implementation

NParks maintains a total of 372 parks across Singapore, with a wide range of habitat quality and may even have degraded habitats from human use over time. To address this, the habitat enhancement programme was initiated to enhance or restore these park spaces across Singapore (NParks, 2015b). The efforts include restoration or enhancement of various habitat types such as secondary forests, forest streams, coastal and beach vegetation and mangroves.

The Ecological Restoration Framework from the NCMP provides the overall blueprint for the execution of park restoration or enhancement projects (Figure 7). First, more information must be collected on the site, including site biodiversity, ecosystem health and present environmental conditions. The information will provide a basis for decisions regarding restoration techniques that will be the most appropriate for the site. Next, efforts will focus on both improving site conditions and direct reforestation, and finally the site will be monitored to determine if the restoration efforts have been sufficient.

Reforestation can occur via three techniques, namely, assisted natural regeneration (Shono *et al.*, 2007), the framework species approach (Goosem & Tucker, 2006) or the maximal species diversity method (Sales-Come & Hölscher, 2010). The first method, assisted natural regeneration, is a process by which site managers facilitate natural regrowth of the habitat by restoring environmental or physical conditions for re-colonisation to occur. A strong example is the Ecological Mangrove Restoration (EMR) method, where site managers first assess site elevation and hydrology, before efforts are taken to alter or remove environmental conditions that prevent natural mangrove seedling establishment. Seedlings can then be allowed to re-establish at the site on their own. However, if seedling establishment was found to be slow, reforestation can be carried out to accelerate the natural regeneration process. This method was employed by a ground-up initiative called the Restore Ubin Mangroves (RUM) group in Pulau Ubin. The second method is the framework species method, which involves using transplantation methods of sun-loving, fast growing species (for example, the planting of shrubs first) to create a microclimate ideal for shade-loving species of plants. Subsequent plantings will then include the shade-loving species, such as native canopy and emergent species. This method has been initiated in Mount Faber Park and Telok Blangah Hill Park. Finally, the maximal species diversity method employs the planting of a full assemblage of climax community[10] species to recreate a healthy, rich ecosystem. This was carried out in Coney Island Park, as part of the overall reforestation effort for the island.

Monitoring of the planted flora is carried out throughout the reforestation process. Methods include establishing a baseline after the first round of planting, then short-term monitoring every quarter for the first three years, and finally, long-term annual monitoring. In addition, monitoring changes in the composition of fauna that utilise the new habitats, such as birds, dragonflies and butterflies, can indicate the success of the habitat enhancement efforts.

Progress towards national target

The information for this national target was obtained from the NBC, which initiated the habitat enhancement programme. To date, the habitat enhancement programme has been completed in thirteen parks in Singapore, while projects are ongoing in a number of other parks.

Several of these sites have also seen increased fauna species diversity as a result of the restoration or enhancement efforts. For example, in Bishan-Ang Mo Kio Park, surveys in August 2018 (just two months after the completion of their habitat enhancement works) found an increase of six species of dragonflies, relative to dragonfly species records during the initial monitoring back in 2016.

[10] A stable community of species that eventually arises from the ecological succession process.

Category of progress towards the implementation of the selected target:

☒ On track to exceed target

☐ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

National targets 12 to 15 all contribute to Aichi Target 15 on ecosystem resilience and carbon stocks. The elaboration for Singapore's progress towards Aichi Target 15 is found below in section 2.15.

2.14 National target 14 – Coastal enhancement

By 2020, the habitats of three coastal areas would be restored and enhanced, by incorporating design elements that are suitable for coastal substrates.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☒ 5 ☐ 10 ☐ 15 ☐ 20

Singapore's coastal environment has been highly impacted by development works, particularly land reclamation (Yaakub *et al.*, 2014). Low water quality decreases the amount of light reaching the benthic community (organisms inhabiting the sea floor), affecting the growth of primary producers and the health of local marine ecosystems. While Singapore's reefs and other marine habitats have appeared resilient to such impacts (as evidenced by the high species diversity still present), such stressors have the potential to decrease habitat resilience over time, possibly leading to ecosystem degradation. To prevent this, there is a need to enhance local marine habitats and improve their resilience. One method to do so is the addition of design elements or artificial reef structures that provide shelter and additional surfaces for corals and other organisms to settle (Ng *et al.*, 2016). This way, habitat complexity is increased, facilitating habitat growth and increasing ecosystem integrity. Overall, these efforts can assist with increasing coastal ecosystem resilience and improving low diversity urban structures (such as sea walls), contributing to climate change mitigation and adaptation as per Aichi Target 15.

Implementation

In the 1990s, reef enhancement units (REUs) were added to a number of Singapore's reefs to enhance local habitats. Designed with steep sloping surfaces to minimise sediment accumulation, these structures were relatively successful after being installed for a decade (Ng *et al.*, 2016). In 2007, a two-year coral nursery project was launched, making use of "corals of opportunity" (i.e. coral fragments found naturally on reefs due to prior physical impact) to grow new colonies (NParks, 2007), which were then used to enhance existing reefs across Singapore. Today, new technologies and further research

have facilitated the design of fresh and innovative projects for coastal enhancement of our marine environment.

One of the most recent marine enhancement projects is a coral reef enhancement project, carried out in 2018 (Figure 4). The "Grow-a-Reef Garden" project, a collaboration between NParks and JTC Corporation (JTC), is the largest artificial reef installation project to date, where eight reef structures were installed on bare seabeds to facilitate the growth of new coral reefs on SIMP. Each structure, termed a "terrace house" for corals (Low, 2018b), was specially designed to maximise coral settlement and the growth of encrusting species, and to provide shelter to fishes and other mobile organisms.

Figure 4 Reef enhancement structures that were placed in SIMP in 2018 (Source: Low, 2018b)

In addition to the reef enhancement efforts, some mangrove restoration projects have also been undertaken, as many important mangrove sites have been undergoing severe erosion and there is an urgency to improve their climate resilience. One such site is Pulau Tekong, which is home to one of Singapore's largest remaining patches of mangrove habitat, stretching about three km along the offshore island's coast, with a size of approximately 92 ha. After experimenting with different mangrove restoration methods in 2009, a unique combination design was chosen to optimise mangrove restoration for the site conditions. This design comprised defensive rock revetments planted with mangrove species adapted to harder substrate, and a layer of tougher pioneer mangrove species planted further out to sea (Figure 5). With this unique design, mangrove seedling recruitment is also promoted, accelerating habitat recovery and growth (Yang *et al.*, 2011). Similar methodologies have subsequently been implemented in other mangrove sites such as SBWR, and plans are underway for a mangrove enhancement project in Chek Jawa Wetlands on Pulau Ubin.

Figure 5 Restored section of the shore on Pulau Tekong Island (Source: NParks)

The third project is the installation of design elements to enhance Singapore's sea walls. Sea walls currently make up over 70% of Singapore's coastline (Lai *et al.*, 2015). However, they are "hard" engineering structures that do not promote the settlement of marine biodiversity. This is due to the lack of structural complexity such as can be found in a natural rocky shore that allows for organisms to take shelter from the harsh intertidal environment. Design elements, called BioBoss tiles, installed on the seawall can assist with increasing the structural complexity of these coastal protection structures. Designed in collaboration with the National University of Singapore (NUS), using their software Complexity for Artificial Substrates (CASU; Loke *et al.*, 2014), the tiles maximise the provision of microhabitats for marine organisms to grow, feed and seek shelter, increasing intertidal biodiversity on the seawalls.

Progress towards national target

Information for this national target was collected from NBC, which is also responsible for marine conservation activities in Singapore.

The progress of the three coastal restoration/enhancement projects are as follows:

1) The "Grow-a-Reef Garden" reef structures are presently being monitored through research initiatives coordinated by NParks;
2) Mangrove enhancement at Pulau Tekong was completed in 2014, and the mangrove saplings at the site continue to be monitored every two to three years; and
3) An initial research project testing the design and implementation of the BioBoss tiles has been completed. Plans have been made to deploy the tiles onto sea walls on SIMP as part of the Marine Conservation Action Plan (MCAP; outlined in Annex A, pg 75).

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

National targets 12 to 15 all contribute to Aichi Target 15 on ecosystem resilience and carbon stocks. The elaboration for Singapore's progress towards Aichi Target 15 is found below in section 2.15).

2.15 National target 15 – Forest Restoration Action Plan

By 2020, 25,000 trees and shrubs will be planted across the nature parks[11] and Nature Reserves as part of the Forest Restoration Action Plan 2019-2029.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☒ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☐ 1 ☐ 6 ☒ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☒ 4 ☐ 9 ☐ 14 ☒ 19

☒ 5 ☐ 10 ☐ 15 ☐ 20

Singapore's Nature Reserves are legally protected areas that are maintained and conserved for their ecological and cultural values, and are particularly valuable for biodiversity in the densely populated city-state. To further conserve these areas, Singapore designated a number of buffer areas in the form of nature parks around the Nature Reserves (see Annex A, pg 75), in an attempt to divert potential impacts from recreational activities away from the Nature Reserves, to maintain their ecological integrity.

However, ecosystem processes such as nitrogen fixing and nutrient recycling in the soil are likely to become disrupted over time, usually as a result of disturbances or stressors. As such, the Forest Restoration Action Plan (FRAP) was announced in early 2019, to increase the resilience of Singapore's Nature Reserves and nature parks. A mode of ecosystem restoration, FRAP is one of Singapore's measures that will contribute to the achievement of Aichi Target 15, concerning ecosystem resilience and restoration.

Implementation

Working to complement the habitat enhancement programme (section 2.13, which focuses on restoring more disturbed natural areas such as neighbourhood parks), the FRAP focuses on planting native trees within the CCNR and BTNR, as well as selected nature parks around the two reserves. Adopting a

[11] The eight nature parks to be restored under the Forest Restoration Action Plan are Springleaf, Thomson, Windsor, Rifle Range, Hindhede, Dairy Farm, Zhenghua and Chestnut Nature Parks, all of which are part of the Central Nature Park Network.

science-based, ecological approach, the project uses different methods to target various aspects of the ecosystem (for example, habitat heterogeneity, soil quality, species competition), in an attempt to increase overall resilience of these areas.

First, sustained plantings of native rainforest species will be carried out over a decade, including planting of primary rainforest species such as dipterocarps. Secondly, native species that are capable of fixing nitrogen to facilitate nutrient cycling in the soils will also be planted to establish a self-sustaining nutrient cycle in the tropical rainforest habitats and in doing so will promote habitat regeneration. Thirdly, removal of non-native weed species, which compete with native plants for resources to grow and survive, will also be carried out. Finally, as streams are found abundantly within BTNR and CCNR, and are closely interlinked with the terrestrial rainforest ecosystem, the action plan includes a focus on regenerating riparian (i.e. river bank) vegetation along natural streams within these reserves.

Progress towards national target

1,700 trees have been planted in various areas across the BTNR, CCNR and nature parks, just two months after the announcement of the FRAP in late January 2019.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Overall, Singapore has numerous initiatives in place to increase ecosystem resilience and to monitor carbon stocks, as evidenced from national targets 12 to 15. All these measures serve to contribute to climate change mitigation and adaptation, as specified in Aichi Target 15.

Ecosystem resilience of Singapore's biodiversity and greenery is being enhanced via the habitat enhancement programme and FRAP, and coastal and marine habitats in Singapore are also being improved. In turn, these ecosystems will provide a variety of services that help mitigate the impacts of climate change on Singapore, including improving coastal protection against rising sea levels, combatting increasing temperatures by mitigating the urban heat island effect and ensuring sufficient refugia and healthy habitats for the survival of native species. Through the use of these nature-based solutions, Singapore's society and biodiversity will be better able to adapt to climate change.

In addition, many of these projects involve different groups of civil society. For example, the FRAP is led by the Singapore government (NParks), working closely with the local nature community, including Friends of the Parks groups. The FRAP is also being funded by private organisations, such as the Oversea-Chinese Banking Corporation (OCBC Bank), through the GCF. These efforts will encourage community stewardship in protecting native biodiversity and addressing climate change impacts.

The overall efforts that Singapore makes in these diverse areas can be measured in terms of the carbon stocks in the country. Singapore measures our carbon stocks through a long-term, rigorous monitoring programme for the LULUCF sector. Due to the long-term nature of this monitoring effort, the data will be valuable to policy makers, particularly for forward-looking, long-term planning processes.

2.16 National target 16 – Access and Benefit Sharing

By 2020, preliminary policy and guideline on Access and Benefit Sharing.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☒ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Singapore is home to a rich diversity of organisms, which have the potential to be used for scientific research and bioprospecting. There is presently an administrative framework governing non-commercial research in the country, i.e. the research permit system, which regulates access to all our green areas for scientific research. This system is administered by NParks, which oversees the bulk of the natural areas in Singapore. NParks also coordinates with other landowning agencies to grant research permits for land that is not within NParks' jurisdiction. However, access and benefit sharing (ABS) is not limited to scientific research, but also concerned with commercial utilisation of genetic resources. As the research permits do not regulate commercial bioprospecting, this national target was designed to supplement Singapore's ABS framework.

Implementation

Background information to draw from lessons from other countries is currently being collected, while appropriate discussions and consultations are underway with the relevant agencies and ministries in Singapore to develop a preliminary ABS framework.

Progress towards national target

There are ongoing discussions between NParks and other government agencies on the commercial bioprospecting framework for the country.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 16 calls for the Nagoya Protocol to be operational for Parties to the CBD by 2015. Singapore is still considering accession to the Nagoya Protocol, but is currently focused on developing a preliminary ABS framework that will cover both academic research as well as commercial utilisation.

2.17 National target 17 – National Biodiversity Strategy and Action Plan

By 2019, Singapore has updated the National Biodiversity Strategy and Action Plan (NBSAP, 2009) to include national targets to guide its efforts in biodiversity conservation in the country.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☒ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

The NBSAP acts as Singapore's master plan for biodiversity conservation. In 2009, we released our first NBSAP, aiming for a pragmatic approach towards safeguarding our natural heritage within Singapore's highly urbanised environment. While the NBSAP continues to remain relevant today, it has recently been updated in 2019 to include our national targets.

Progress towards national target

As of the writing of this report, Singapore's 2009 version of the NBSAP has been updated to include Singapore's 18 national targets to contribute to the achievement of the relevant Aichi Targets.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 17 aims for the adoption, implementation and update of a Party's NBSAP. Singapore has updated its 2009 NBSAP with the 18 national targets mentioned in this report. All biodiversity projects conducted under the umbrella of the NBSAP (2009) and the NCMP (2015) continue to be tracked and reported in our National Reports to the CBD. These projects include the species recovery and habitat enhancement programmes (Annex A, pg 79), FRAP (section 2.15), outreach (sections 2.1, 2.2 and Annex A, pg 82) and many more.

2.18 National target 18 – National database

By 2020, Singapore will put in place an updated national database system with biodiversity-related information to be used to aid decision making within government and sharing of biodiversity information with the public.

Main related Aichi Biodiversity Targets

☐ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☒ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

Other related Aichi Biodiversity Targets (Please select one or more Aichi Biodiversity Target to which the national target is indirectly related.)

☒ 1 ☐ 6 ☐ 11 ☐ 16

☐ 2 ☐ 7 ☐ 12 ☐ 17

☐ 3 ☐ 8 ☐ 13 ☐ 18

☐ 4 ☐ 9 ☐ 14 ☐ 19

☐ 5 ☐ 10 ☐ 15 ☐ 20

A national database for biodiversity-related information will facilitate easy access to all past, present and future natural heritage and biodiversity information. This would facilitate decision making as Singapore seeks to balance between urban development/growth and the conservation of our natural areas. In addition, when made available to the public, such information can also serve as educational material, increasing citizens' knowledge and appreciation of local biodiversity. These efforts contribute towards Singapore's achievement of Aichi Target 19, which calls for the use of technology to conduct effective outreach and information sharing on biodiversity.

Implementation

BIOME, the Biodiversity and Environment Database System, is the national database for Singapore's biodiversity and environment related data. Containing significant amounts of information obtained from government agencies, educational institutions, NGOs and the public, this repository is frequently updated with new research findings and biodiversity-related information. It is intended as a user-friendly, one-stop location for biodiversity-related knowledge in Singapore and includes a search engine and other analytical functions. For example, one of its analytical operations is a spatial function, which can show species distributions across the country. By providing information on the distributions and biology of local species, policy-makers can adapt policies to take these into consideration. For example, urban planners can plan for developments to avoid natural areas that have been identified as important to the survival of rare or endemic species.

As an online database, BIOME is accessible to all members of the public, allowing them to obtain information about any local species of interest. To further increase engagement with the community, a citizen science function was added to the database to allow users to upload their sightings of local plants and animals, while an additional geotag function allows the user to record the location of the sighting. This citizen science reporting process is facilitated by a smartphone application, SGBioAtlas, allowing convenient access and information entry to BIOME. Due to the sheer volume of information from citizen sightings, such data can potentially contribute to documentation of species distributions and diversity in each park or Nature Area, contributing to urban planning. Government agencies also use BIOME as a repository for data from scientific reports, studies and surveys that have been conducted. Having all the useful information available in a single portal facilitates easy access to the wealth of information that is needed to inform biodiversity conservation policy-making in Singapore. The information can also be used during outreach events, such as the Festival of Biodiversity (FOB), Singapore's largest annual biodiversity outreach event, to further encourage use of BIOME and the sharing of biodiversity data, including for education about biodiversity conservation challenges and opportunities.

Other biodiversity-related database websites set up by NParks include trees.sg and Flora&Fauna Web, while sites such as Biodiversity of Singapore, the Butterfly Circle Checklist, Wild Singapore and the Bird Ecology Study Group are also useful biodiversity databases that were set up by NGOs, scientists/taxonomists and passionate naturalists of Singapore.

Progress towards national target

By 2018, Singapore has already established a platform for the compilation, use and sharing of local biodiversity information. At the initiative of NGOs and the Singapore nature community, other websites which compile and share biodiversity data have also emerged. Future efforts can focus on further outreach to promote and encourage the platform's use and to increase the scope of this platform by reaching out to more organisations to contribute and share more information on BIOME.

Category of progress towards the implementation of the selected target:

☐ On track to exceed target

☒ On track to achieve target

☐ Progress towards target but at an insufficient rate

☐ No significant change

☐ Moving away from target

☐ Unknown

Progress towards global Aichi Targets

Aichi Target 19 sets aims to facilitate the use of technology for outreach as well as the sharing and application of biodiversity knowledge. As Singapore moves towards becoming a smart nation, a country which utilises technology for societal benefits (for example, improving public transport, liveability and healthcare), the collection and sharing of biodiversity information by NParks can similarly be conducted using interactive websites, geotagging and inputs from citizen scientists. All these initiatives contribute towards Singapore's implementation of Aichi Target 19.

CHAPTER 3 - UPDATED BIODIVERSITY COUNTRY PROFILE

3.1 Introduction to Singapore

Singapore is a constantly evolving island city-state located in Southeast Asia, at the southern tip of the Malaysian peninsula, consisting of a single main island and 46 offshore islands. Despite its small size of 724.2 km^2, it is home to numerous different ecosystems and a rich diversity of species, due to its location within the Sundaland biodiversity hotspot. The climate is tropical, with abundant rainfall, uniform temperatures and high humidity all year round. It is the ideal climate for year-round plant growth, giving rise to the large variety of habitats and ecological niches found on the island. These are home to the high diversity of species in Singapore. Despite the rapid urbanisation and development that characterised Singapore's initial growth as a city-state, our rich diversity of species has continued to thrive.

3.2 Singapore's Context

As a city-state, Singapore has a relatively small land area when compared to other countries. Apart from conservation, land is also required for other functions such as defence, housing and transport amongst other uses (Table 7). To address this, Singapore has implemented a highly integrated, long-term approach to land use planning in consultation with stakeholders, spearheaded by the Urban Redevelopment Authority (URA). The forward-looking process considers the economic, social and environmental aspects of Singapore's development for the coming years, facilitating the creation of a quality living environment, sufficient growth opportunities and a biophilic urban environment for all its citizens. Long-term planning strategies are then implemented in the medium-term through a statutory land use Master Plan, which guides development in Singapore over a 10 to 15-year timeframe, and is comprehensively reviewed every five years.

Land Use	**2010**		**2030**	
	Ha	**%**	**Ha**	**%**
Defence	13,300	19.0	14,800	19.3
Housing	10,000	14.3	13,000	17.0
Industry and Commerce	9,700	13.8	12,800	16.7
Land Transport Infrastructure	8,300	11.8	9,700	12.7
Parks and Nature Reserves	5,700	8.1	7,250	9.5
Community, Institution and Recreational Facilities	5,400	7.7	5,500	7.2
Ports and Airports	2,200	3.1	4,400	5.7
Reservoirs	3,700	5.3	3,700	4.8
Others	10,000	14.3	2,800	3.7
Utilities (for example, Power, water treatment plants)	1,850	2.6	2,600	3.4
Total	**71,000**	**100**	**76,600**	**100**

Table 7 Land allocation plan in 2010 and 2030 (Ministry of National Development (MND), 2017).

NParks, a statutory board under the Ministry of National Development (MND), is the key agency responsible for biodiversity conservation in Singapore. NParks is the designated focal point for implementation of the Convention of Biological Diversity (CBD). Two other statutory boards in Singapore which manage areas that are in close proximity to, or deal with issues related to biodiversity, are PUB, Singapore's National Water Agency (PUB) and the now defunct Agri-Food & Veterinary

Authority of Singapore (AVA). PUB has jurisdiction over Singapore's waterways and water catchment areas, which are closely linked to the freshwater habitats on the island. AVA was responsible for food imports and food safety in Singapore and was a first responder for all animal-related feedback. In 2019, AVA was disbanded, with its food-related functions transferred to the newly formed Singapore Food Agency (SFA), and its non-food plant and animal-related functions transferred to NParks as the Animal and Veterinary Service (AVS) cluster and a Wildlife Management division. The AVS cluster in NParks is currently responsible for all animal-related feedback while the Wildlife Management division is responsible for regulating wildlife trade, human-wildlife management, research and outreach.

Singapore has gradually been increasing citizen involvement and engagement for biodiversity-related activities and events. Today, numerous NGOs (for example, Nature Society (Singapore) (NSS), Toddycats from the Lee Kong Chian Natural History Museum (LKCNHM), Wild Singapore, LepakSG, Seastainable Co., Zero Waste SG) have emerged to initiate ground-up activities for biodiversity mainstreaming and outreach. Singaporeans have also become increasingly active in providing their views towards conservation plans for Singapore's natural areas and habitats to the government both online and through forum letters.

3.3 Biodiversity Facts

3.3.1 Current Status of Biodiversity in Singapore

The majority of Singapore's protected areas are primary and secondary forests. Four legally gazetted Nature Reserves (covering about 4.6% of Singapore's land area) and 20 other administratively protected Nature Areas encompass the majority of natural habitats within Singapore. These areas, together with over 350 parks, 80 km of nature ways, over 300 km of linear park connectors and 100 ha of rooftop and vertical greenery, form a complex matrix of interconnected habitats that create the green, biophilic landscape that is Singapore[12]. Most of Singapore's green areas serve recreational and educational functions, and none of our forests are commercially exploited for timber or relied on for subsistence by indigenous people. Marine areas in Singapore consist of numerous coastal ecosystems, including coral reefs, seagrass meadows and mangroves. The conservation of marine areas in Singapore received a boost recently, with the designation of the Sisters' Islands as a marine park in 2014. Now at the forefront of marine conservation science and implementation, there are plans to explore the expansion of measures initially tested at Sisters' Islands Marine Park (SIMP) to other coastal and marine conservation areas in the country. This is important in light of the numerous anthropogenic effects Singapore's marine areas are subjected to, due to their importance for a variety of functions such as shipping and port facilities.

As of December 2018, Singapore has recorded a total of about 23,579 species (Table 8**Error! Not a valid bookmark self-reference.**). A number of taxonomic groups have seen increases of over 20 species in the last five years, including orthopterans and butterflies, which have benefited from the work of new local experts entering the field. Despite extirpations being reported, the biodiversity trends for Singapore continue to be positive, due to the large number of species still being rediscovered or named.

	Taxonomic group	No. of species	Increase in number	New Species	New Records	Rediscoveries	Extirpations
Plants and	Vascular Plants	3729	179	4	60	119	4
	Algae	1085	31	0	31	0	0

[12] Statistics as of 2018

	Fungi	950	0	0	0	0	0
	Lichens	402	26	7	19	0	0
	Bryophytes	233	1	0	1	0	0
Vertebrates	Mammals	96[a]	5	0	4	1	0
	Birds	404[b]	89	3	81	5	0
	Reptiles	157[a]	9	1	8	0	0
	Amphibians	30	1	0	1	0	0
	Freshwater fishes	106[a]	2	0	2	0	0
	Marine fishes	621	49	0	40	9	0
Insects and Arachnids	Butterflies	335	40	0	33	9	2
	Beetles	>10000	14	8	5	1	0
	Dipterans	950	40	40	0	0	0
	Hymenopterans	555	15	2	14	0	1
	Myriapods	55	0	0	0	0	0
	Odonates	124[c]	23	0	19	4	0
	Orthopterans	245[d]	20	18	1	1	0
	Spiders	431	32	6	26	0	0
Marine invertebrates	Crustaceans	>1000	24	3	20	1	0
	Molluscs	1335	51	4	42	6	1
	Octocorallia	63	32	2	30	0	0
	Hard corals	255	0	0	0	0	0
	Ascidians	45	27	0	27	0	0
	Sponges	229	4	2	1	1	0
	Echinoderms	134	14	0	14	0	0

[a] Includes species of indeterminate status

[b] 48 species of birds in the original (Fifth National Report) baseline list were removed from the list maintained by Nature Society (Singapore)

[c] The new baseline list for Odonates of 124 species was updated in January 2019, and already includes the 23 new records and rediscoveries found between 2010 and 2019

[d] The new baseline list for Orthopterans of 245 species was updated in 2015 and already includes the 20 new species, new records or rediscoveries found between 2010 and 2015

Table 8 Summary of species numbers for different taxonomic groups. Detailed lists for each taxonomic group are included in Annex B.

3.3.2 Main pressures and drivers of change

Singapore's context has created a variety of unique challenges to biodiversity conservation for both terrestrial (including freshwater) and marine habitats in the country. However, we are also taking an innovative and science-based approach to solving these challenges, by pioneering new techniques to improve conservation in Singapore.

Terrestrial pressures in Singapore include limited land and factors such as a high volume of recreational use and other urbanisation-related disturbances like light, sound and air pollution. Many of Singapore's natural areas exist in small pockets, giving rise to edge effects that negatively impact biodiversity. High recreational use over a prolonged period results in soil compaction and degradation of the edges of walking trails (for example, in the Bukit Timah Nature Reserve, BTNR), negatively affecting the forest ecosystem. To address this, Singapore has created numerous other types of accessible green areas, such as rooftop gardens, buffer parks and park connectors, to create a landscape of greenery across the island that provides alternatives for recreation and spreads out the potential impact to any one natural or green area.

Coastal and marine habitats in Singapore experience strong urban and development influences as a result of land reclamation and maritime traffic. Major oil spills (as a result of maritime accidents) have occurred in Singapore's waters, and depending on various factors (for example, location of spill, local currents), might potentially pose threats to our marine biodiversity. Algal blooms have occurred in Singapore's waters, causing mass fish deaths that affect aquaculture and beach cleanliness (Neo, 2015). Coral bleaching has been recorded with increasing frequency over the last decade (The Straits Times, 2016), due to exceptionally high water temperatures that exceeded the corals' bleaching threshold. The National Biodiversity Centre (NBC) has been leading marine biodiversity conservation efforts in Singapore, with initiatives such as the development of an Integrated Urban Coastal Management (IUCM) plan for multi-stakeholder engagement and partnership building, as well as the establishment of the SIMP.

Another potential issue affecting native habitats is vulnerability to invasive alien species (IAS). According to Yeo and Chia (2010), many alien species have become ubiquitous in Singapore's urban areas or forest edges, for example, the red-eared slider (*Trechemys scripta elegans*), Javan myna (*Acridotheres javanicus*), Koster's curse (*Clidemia hirta*) and Zanzibar yam (*Dioscorea sansibarensis*). A marine alien species, the American brackish-water mussel (*Mytella strigata*) has also been documented in Singapore (Tan, 2018). Due to our vulnerability to the establishment of invasive species, the government, academics and NGOs continue to educate, monitor and actively manage non-native species in Singapore.

3.4 Measures to Enhance Implementation of the Convention

3.4.1 Implementation of the NBSAP

Singapore's National Biodiversity Strategy and Action Plan (NBSAP; NParks, 2009) comprises five strategies and associated actions: 1) safeguard our biodiversity; 2) consider biodiversity issues in policy and decision making; 3) improve knowledge of our biodiversity and the natural environment; 4) enhance education and public awareness; and 5) strengthen partnership with all stakeholders and promote international collaboration. Since 2015, the NBSAP (2009) has been operationalised by the Nature Conservation Master Plan (NCMP), which provides more specific directions for conservation and management of Singapore's biodiversity. The NBSAP was also updated in 2019 to include Singapore's national targets.

3.4.2 Actions taken to achieve the 2020 Aichi Biodiversity Targets

Aichi Biodiversity Target	Key Actions
Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	Singapore has a global reputation as a green city, having gradually evolved from a Garden City into a biophilic City in a Garden and with upcoming plans to transform Singapore into a City in Nature. As part of the efforts to mainstream biodiversity, we have established a strong outreach movement to both the public sector (for example, schools), the private sector (sustainability reporting and donations to the Garden City Fund (GCF)) and the general public (volunteering and citizen science programmes such as the Community in Nature (CIN) initiative). Our two national targets on organisational involvement and citizen scientists are the two main target groups for our country's public awareness efforts.
Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	Singapore's most recent efforts to incorporate biodiversity values into its long-term plans include the Sustainable Singapore Blueprint (2015) and the Nature Conservation Master Plan (NCMP, 2015). This is supported by strong research efforts to facilitate science-based decision making. Examples include the Natural Capital Singapore project which is conducting a major natural capital assessment study, as well as the use of environmental impact assessments (EIAs) or biological impact assessments (BIAs) in our land use planning to mitigate the impacts of development projects in the country. Due to the importance of land allocation in Singapore, we are prioritising the mainstreaming of ecological principles into land use planning as one of our national targets.
Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.	Not Applicable. Singapore does not have any large-scale natural resource extraction or agricultural activities.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	With the release of our national target on recycling, and the declaration of 2019 as the Year of Zero Waste, we are prioritising sustainable living and the creation of a circular economy. Singapore conducts numerous public recycling and school outreach programmes (for example, National Recycling Programme), and promotes sustainable production and consumption using a variety of initiatives across a range of different societal groups. These measures will facilitate Singapore's move towards more viable consumption rates, indirectly reducing the pressure on global natural resources.
Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	Our four Nature Reserves are legally protected areas, as specified under the Parks and Trees Act (Chapter 216) and another 20 Nature Areas have administrative arrangements for their protection. We continue to prevent habitat loss, degradation and fragmentation through careful land use planning around these sensitive areas (where development projects are shaped by technical input from NParks and the results of environmental impact assessments), effective management of Nature Reserves and Nature Areas, and various green infrastructure measures that promote island-wide green habitat connectivity.
Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	Not Applicable. Singapore continues to work with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to regulate the international trade on marine fish and invertebrates, and to prevent the import and transhipment of illegal products in relation to Illegal, Unreported and Unregulated Fishing (IUUF). The SFA also licenses and monitors commercial fishing activities.
Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	Not Applicable. Singapore does not have significant agriculture and aquaculture sectors, while forestry is not practiced in the country.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	Singapore has strict regulations on waste and sewage treatment, safeguarding our water bodies from major pollutants including nutrients. As an alternative, our national target relating to pollution is focused on reducing air pollution. Singapore's measures towards this include promoting the use of more energy efficient vehicles (including electric vehicle sharing schemes) and the expansion of our public transport network.
Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	With the national target to compile a list of potentially invasive species, Singapore can direct resources to manage these species, perhaps before their impacts become significant. Present non-native species continue to be managed via direct population control (for example, weeding) or prevention and outreach campaigns (for example, Operation No Release).
Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	As an island-state, Singapore continues to monitor local coral reefs with the help of academics and citizen scientists. These measures facilitate the implementation of appropriate stressor mitigation measures to prevent the collapse of local reef systems. As climate change associated impacts are a significant concern for Singapore, policy bodies have been established such as the Inter-Ministerial Committee on Climate Change (IMCCC), which guides the actions of the Resilience Working Group (RWG), to assess and respond to predicted climate change impacts. Examples of projects being implemented to address these impacts include the construction of sea walls along the coast and the release of *Wolbachia* infected mosquitos to control *Aedes aegypti* mosquito populations.
Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas, and ten per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	It is difficult for Singapore to retain large areas of land as protected areas due to its small size. However, many programmes (for example, the Park Connector Network (PCN) and Nature Ways) have been implemented to create a matrix of natural and green areas in the country. These initiatives complement the efforts taken in natural areas by ensuring ecological connectivity between such areas.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	NParks has identified 94 species of flora and fauna to be prioritised for species recovery programme, selected due to their biology (for example, endemic to Singapore) and/ or conservation status. By reintroducing these prioritised species to new sites, we facilitate the recovery of these species' populations, and prevent their extinction in Singapore.
Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	Not Applicable. The agricultural sector is not a significant sector in the country.
Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	Not Applicable. Singapore does not have any indigenous communities that rely on nature areas for daily subsistence.
Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	Singapore has set four national targets aimed at expediting our progress towards this Aichi Target, covering various terrestrial green areas and coastal habitats in Singapore. The measures include island-wide, long-term carbon accounting and habitat enhancement and restoration projects.
Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	Singapore is currently working on developing a preliminary Access and Benefit Sharing framework.
Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	Singapore released its NBSAP in 2009 and has subsequently updated it to include national targets in 2019. The Nature Conservation Masterplan was developed in 2015 to operationalise Singapore's NBSAP effectively.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	Not Applicable. Singapore does not have any indigenous and local communities.
Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	BIOME, the Biodiversity and Environment Database System, is Singapore's national online biodiversity database and contains information that can be widely shared with the public. BIOME's analytical and geotag functions also facilitate the collection and storage of island-wide data that can be used to inform biodiversity and conservation policy in the country.
Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	Not Applicable. Singapore obtains its financial resources for biodiversity projects internally.

Table 9 Key actions taken in contribution towards the global Aichi Biodiversity Targets.

3.4.3 Support mechanisms for national implementation

NParks is Singapore's lead agency on nature conservation, and therefore assumes the role of national focal point for the CBD. The organisation is primarily responsible for providing and enhancing Singapore's biodiversity and greenery, through management of Singapore's four Nature Reserves and the greenery throughout Singapore, which includes parks, roadside greenery and other green infrastructure. Within NParks, the NBC division, established on 22 May 2006, is the lead department dealing with biodiversity conservation for all of Singapore, with the Conservation and Parks divisions responsible for the operations of managing the Nature Reserves and parks respectively. NParks has the capability, capacity and mandate to a) carry out research on biodiversity conservation and horticulture, b) formulate pragmatic policies and guidelines based on sound science, and translate and implement the policies to ensure that native biodiversity can thrive harmoniously with humans in an urban city.

In alignment with Singapore's vision of becoming a "City in Nature", strong inter-agency coordination is a key element in ensuring that the country retains its greenery and biodiversity amidst strong development and land use pressures (see Chapter 4 for details). To enhance these coordination efforts, the Garden City Action Committee (GCAC) was set up in 1970 to oversee policies for greening the whole island and coordinates the activities of the various government agencies in this respect. Some of

these agencies include the URA, our national land use planning authority, the Ministry of the Environment and Water Resources (MEWR) and its relevant statutory boards, namely the National Environment Agency (NEA) and the PUB, responsible for maintaining and ensuring sustainability of Singapore's environment and water resources respectively.

The Singapore government has also put in place legislation to safeguard the country's greenery and biodiversity. Relevant legislation for biodiversity-related issues includes the Wild Animals and Birds Act (Chapter 351), the Control of Plants Act (Chapter 57A), the Endangered Species (Import and Export) Act (Chapter 92A), the Fisheries Act (Chapter 111), the National Parks Board Act (Chapter 198A), and the Parks and Trees Act (Chapter 216).

3.4.4 Mechanisms for monitoring and reviewing implementation

NParks initiates numerous monitoring efforts and surveys in our natural areas, often involving local universities and academics (for example, from the National University of Singapore (NUS) or the Nanyang Technological University (NTU)) or NGOs (for example, NSS). During the 1990s, a comprehensive five-year survey of BTNR was carried out to collect baseline biodiversity information. In 2010, the five-year Comprehensive Marine Biodiversity Survey (CMBS) of Singapore's intertidal habitats was conducted, while a re-survey of BTNR was recently carried out from 2015 to 2017.

As a city-state, one of the means by which Singapore monitors its biodiversity conservation efforts is through the use of the City Biodiversity Index (CBI, also known as the Singapore Index on Cities' Biodiversity or SI). The SI is a comprehensive self-assessment tool used to evaluate a city's progress in urban biodiversity conservation. In 2014, Singapore conducted its first application of the SI using data collected in 2010 (see Fifth National Report to the CBD for details of Singapore's application). NParks is currently collecting data for Singapore's second application of the SI. Such information will facilitate science-based decision making for the better management and continued safeguarding of the Singapore's natural areas and rich biodiversity in our urban landscape.

CHAPTER 4 – CONCLUSION

Singapore is on track to achieve or exceed 16 out of 18 national targets. This is very positive, and provides important feedback on the areas that we are doing well, and areas that we will continue to work on (see **Error! Reference source not found.** for a summary of Singapore's progress towards each national target). Singapore's circumstances have required us to weave greenery and natural habitats into our urban fabric, and to safeguard and restore nature in the heart of our city. Our national targets reflect these unique circumstances, while demonstrating Singapore's determination to contribute towards the global Aichi Targets.

Singapore made the most significant progress in the areas of outreach (national targets 1 and 2; Aichi Target 1), ecological connectivity (national target 10; Aichi Target 11) and habitat enhancement (national target 15; Aichi Target 15). This is consistent with Singapore's circumstances. As the majority of our land area is urban in nature, our biodiversity conservation efforts are designed to enhance our remaining habitats as well as to ensure that they are ecologically connected with one another, while engaging citizens to build an appreciation for nature, and for the benefits that nature provides. Aside from the four targets where we are likely to exceed our national targets, we are also on track to achieve another 12 national targets, which is a demonstration of Singapore's commitment towards biodiversity conservation. The remaining two national targets where we have made some progress, but are unlikely to be able to achieve them before the set deadline are in relation to recycling (national target 4) and air quality (national target 6). Singapore is committed to continue raising our overall recycling rates to 70% by 2030 as part of our broader national efforts to move towards becoming a Zero Waste Nation. We are also committed to further reducing air pollutants and will continue to review existing measures and introduce new measures to reduce air pollutants.

The Way Forward: A City in Nature, Transforming Singapore Together

Today, Singapore is a biophilic City in a Garden, with greenery integrated throughout our city. Going forward, NParks and the community will be working together to transform Singapore into a City in Nature by 2030, as the next bound of our greening and biodiversity conservation journey. We will further integrate nature into our city to strengthen Singapore's distinctiveness as a highly liveable city, while mitigating the impacts of urbanisation and climate change. To achieve this, we will safeguard and extend Singapore's natural capital island-wide through four key strategies—extending our Nature Park Network, intensifying nature in gardens and parks, restoring nature into the urban landscape, and strengthening connectivity between Singapore's green spaces.

The Nature Park Network will be extended to more nature reserves and core biodiversity areas, to provide additional buffers that protect our nature reserves against the impact of urbanisation and human activities (see Annex A, pg 75), as well as providing more spaces for Singaporeans to enjoy nature-based recreation such as hiking, mountain biking and bird watching. We will also naturalise our gardens, parks, and streetscapes, as well as waterways and waterbodies within our parks. We will restore more forest, coastal and marine habitats, and conserve more native plant and animal species. Furthermore, we recognise that it is not enough to intensify nature in isolated pockets. For Singapore to be a healthy natural ecosystem, we must continue to strengthen the ecological connectivity between our green spaces. Thus, we will be developing more Nature Ways and park connectors. These initiatives will bring Singaporeans closer to nature, thereby bringing forth benefits to health and well-being, as well as safeguarding our natural heritage and rich native biodiversity.

Underpinning the future success of our City in Nature is the active support and participation of our people. We will work with communities, schools and individuals, who can all become stewards of

greenery and biodiversity. For example, we aim to plant one million additional trees all across Singapore, through the One Million Trees movement, which will be conducted in partnership with the community. The Community in Nature initiative will also involve more schools and partners in reforestation efforts and citizen science projects, such as biodiversity surveys. Through partnership and outreach with the community, we will build appreciation for nature and engender a new way of living with and alongside nature. In so doing, we can foster a more gracious and caring society.

Singapore remains committed towards the implementation of the CBD. To this end, we will leverage our position as a city-state to highlight the efforts made by the cities and subnational constituency of the CBD towards the implementation of the global biodiversity agenda, and continue to engage with this constituency to encourage greater participation by more cities and subnational governments in these efforts.

Related Aichi Biodiversity Target	National target	Progress towards national target
	1 - Public and private organisations' participation	
	2 - Citizen scientists	
	3 - Land use planning	
	4 - Recycling	
	5 - Natural Areas	
	6 - Air quality	
	7 - Invasive Alien Species	
	8 - Resilience to Climate Change	
	9 - Natural Areas	
	10 - Ecological Connectivity	
	11 - Species recovery	
	12 - Carbon accounting	
	13 - Habitat enhancement	
	14 - Coastal enhancement	
	15 - Forest Restoration Action Plan	
	16 - Access and Benefit Sharing	
	17 - National Biodiversity Strategy and Action Plan	
	18 - National database	

Legend:

 - On track to exceed target

 - On track to achieve target

 - Progress towards target but at an insufficient rate

Table 10 Summary of progress towards each national target and related Aichi Biodiversity Target

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ANNEX A

The Nature Conservation Masterplan

Formulated in late 2015, the Nature Conservation Master Plan (NCMP) operationalises Singapore's NBSAP, by ensuring timely and coordinated conservation efforts to further protect and safeguard Singapore's biodiversity. The effects of climate change will result in increasing stressors and pressures on Singapore's remaining natural areas. The NCMP acts as an integrated plan to safeguard the health of Singapore's natural habitats. Comprising four key thrusts, it outlines the means of conserving core areas for biodiversity, followed by programmes meant to facilitate habitat resilience and species survival, supported by underlying research and outreach. The NCMP facilitates Singapore's implementation of the CBD Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets[13], specifically through Singapore's national targets.

The four key thrusts of the NCMP and the ten Aichi Targets they address are shown in **Error! Not a valid bookmark self-reference.**. As the NCMP operationalises the NBSAP only in biodiversity conservation but not related areas, it does not directly address all Aichi Targets. The other Aichi Targets applicable to Singapore, such as those relating to topics such as pollution and sustainability, are addressed by other national policies.[14]

NCMP Key Thrust	Relevant Aichi Targets
Conservation of Key Habitats	2, 5, 10 and 11
Habitat Enhancement, Restoration and Species Recovery	2, 5, 12 and 15
Applied Research in Conservation Biology and Planning	15 and 19
Community Stewardship and Outreach in Nature	1, 4 and 9

Table 11 Linkages between each thrust of the NCMP with its directly relevant Aichi Targets.

Conservation of Key Habitats

Singapore's natural areas harbour a rich diversity of flora and fauna (see section 3.3.1). The survival of these species and ecosystems in our highly urbanised environment requires coordinated efforts, and larger natural habitats and interconnected landscapes would improve the odds of survival for native species. This thrust thus focuses on the conservation of Singapore's natural areas, aiming to maintain ecosystem integrity and health over time. This would in turn facilitate extant native species' continued survival.

The NCMP identified four core biodiversity-rich areas that harbour the majority of Singapore's flora and fauna. The core areas are dispersed over the entire geographical span of Singapore (Figure 6), and include terrestrial, marine and freshwater systems. The spatial delineation of these core areas will allow

[13] Aichi Targets 3, 6, 7, 13, 14, 18 and 20 are not applicable to Singapore due to our unique circumstances as a small island-state and will not be elaborated upon in this report.

[14] The remaining three Aichi Targets, namely 8, 9 and 16, are addressed as part of the national targets (part of Singapore's revised NBSAP) in Chapter 2.

for Singapore to focus its biodiversity conservation measures in these key areas, which can in turn support biodiversity and natural ecosystems across the entire island-state.

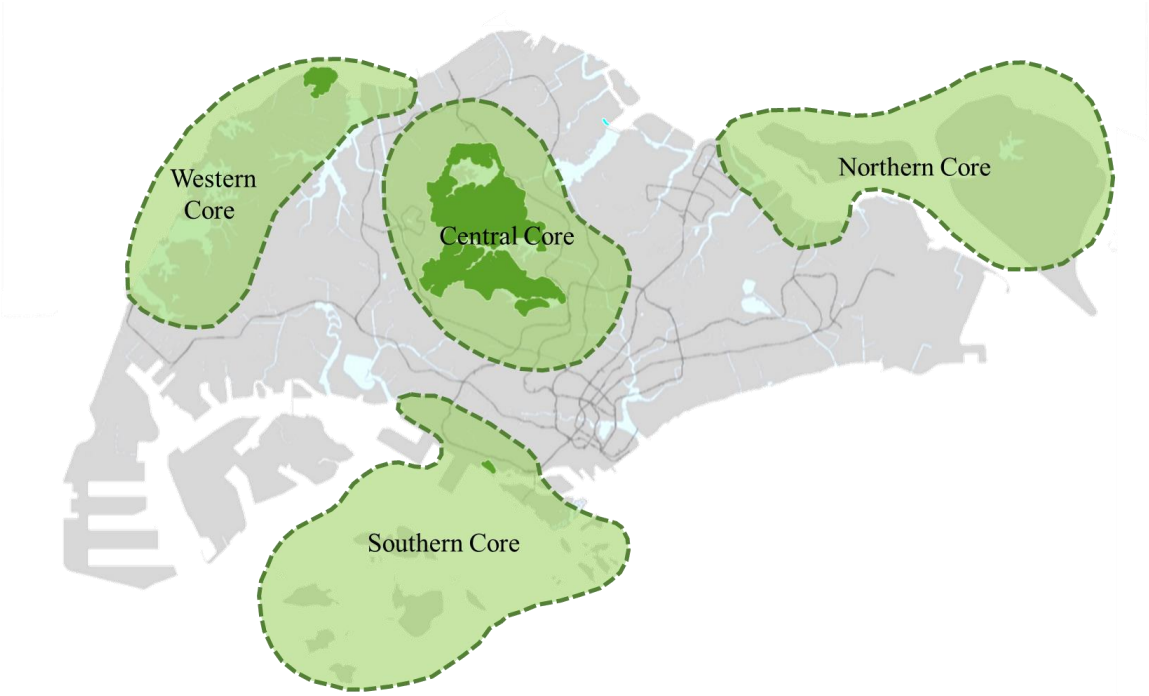

Figure 6 Four core biodiversity-rich areas as delineated by the NCMP (Source: NParks)

The Central Core includes both the Bukit Timah Nature Reserve (BTNR) and the Central Catchment Nature Reserve (CCNR), as well as their immediate buffer areas and environs (Figure 6). Numerous ecosystems that exist within this core cannot be found elsewhere in Singapore, including hill dipterocarp forests and freshwater swamp forest. Large swaths of primary rainforest, mature and young secondary forests, and freshwater forest streams are also found within this area. Part of this core area had recently been re-surveyed (from 2015 to 2017, see pg 81 for details) to document biodiversity and to determine if any species require intervention in the form of species recovery efforts (see pg 80 for details).

The Western Core comprises Sungei Buloh Wetland Reserve (SBWR), Mandai mudflats, Kranji Marshes and a military training area. In addition to the forests and reservoirs in this core, this area also consists of coastal and marine habitats such as mangroves, sandy shores, mud flats, rocky shores and seagrass meadows. Populations of relict plant species are also located in this area, such as the last wild populations of *Dipteris conjugata*, the sealing wax palm and several other rare plant species including *Thottea praetermissa* and *Lithocarpus bennetti*. Kranji Marshes, which was opened in 2016, is home to 22 nationally threatened species (Davison *et al.*, 2008).

The Northern Core encompasses a few offshore islands and the North-eastern shore of Singapore's mainland. This core includes Pulau Ubin, Pulau Tekong, Coney Island and Pasir Ris Mangroves – and is home to majority of the remaining mangroves in Singapore (Lai *et al.*, 2015). Pulau Ubin alone houses the largest continuous mangrove forest in Singapore (149 ha), as well as mudflats and secondary forests (Yang *et al.*, 2011). In 2017, Coney Island Park (located on Pulau Serangoon, a recreational island connected to the mainland) was enhanced through seedling planting (see pg 79 for details). The project included the planting of nationally threatened species such as the small-leaved Nutmeg (*Knema globularia*) and Silver Bush (*Sophora tormentosa*).

The Southern Core includes the Southern Ridges (a collection of three parks, namely Kent Ridge Park, Telok Blangah Hill Park and Mount Faber Park), Labrador Nature Reserve and its associated buffer areas and Singapore's Southern Islands. There are a variety of habitats found in this Core. The Southern Ridges is a ten km-long stretch of forest and open spaces leading towards the coast, where secondary rainforest in Kent Ridge Park steadily transforms into coastal secondary forest in Labrador Nature Reserve. One of the last remaining natural rock shores on mainland Singapore is also located within Labrador Nature Reserve which is protected from coastal development. The Southern Islands are home to numerous marine habitats including coral reefs (both fringing and patch reefs), large seagrass meadows and sandy and rocky shores. Singapore's largest seagrass meadow, Cyrene Reef (14 ha), and our first designated marine park, Sisters' Islands Marine Park (SIMP), are also located within this core area.

In order to further improve Singapore's marine biodiversity conservation efforts, the Marine Conservation Action Plan (MCAP; NParks, 2015) was developed to outline our intended marine conservation measures. Centred around conservation on SIMP, the MCAP details new programmes to be implemented, including species reintroductions, habitat and coastal enhancement, setting up a coral nursery and conducting applied research to increase the integrity of the coastal and marine habitats on the island. Knowledge gained from such work can then be applied to other marine habitats around Singapore. Coastal systems in the country are coming under increasingly intense stressors due to climate change and sea level rise. For instance, Singapore's corals have been experiencing more frequent instances of coral bleaching events since 1998 (The Straits Times, 2016). The implementation of MCAP programmes will assist with increasing coastal habitat complexity and biodiversity, improving and maintaining the resilience of coral reefs and other marine habitats to climate change (Aichi Target 10).

Land continues to be a scarce resource in Singapore, and its proper management and allocation (including for functions related to habitat conservation) continue to be important to our small island-state. As such, NParks works closely with the Urban Redevelopment Authority (URA) on Singapore's medium-term and long-term land use planning (see Singapore's Fourth National Report to the CBD for more details). NParks also provides input to development control processes under the URA. Under the Planning Act (1998), all development projects (for example, new buildings or facilities) cannot proceed unless approved by the government. This approval will be provided only after inter-agency discussions and careful consideration of trade-offs (Ministry of National Development (MND), 2019). Biodiversity considerations, with NParks as the technical advisory agency, continue to be a key part of this evaluation process, where environmental impact assessments (EIAs) are often conducted to evaluate the potential impacts of the development on local habitats. If serious environmental impact is anticipated for any project, EIAs will propose development alternatives and/or impact mitigation measures. These efforts ensure that biodiversity considerations are integrated into Singapore's national land use planning processes (contributing to Aichi Target 2; more details can be found in section 2.3).

The Parks and Trees Act (2005) is an important law that supports habitat conservation in Singapore. This act places strong legislative restrictions on removing, releasing or harming any organisms within parks and Nature Reserves under NParks' jurisdiction, in turn minimising human impact and reducing the degradation of key natural areas in Singapore. The presence of buffer areas or nature parks (for example, Dairy Farm Nature Park, Rifle Range Nature Park and Springleaf Nature Park) are also used to redirect human activity. Strategically chosen in areas surrounding Nature Reserves, buffer areas serve to decrease direct human disturbance to the protected areas, while simultaneously reducing edge effects and acting as a physical barrier against impacts from nearby developments (Er, 2018). All these measures contribute to conserving our natural habitats, while simultaneously preventing their degradation, addressing Aichi Target 5.

This thrust of the NCMP also focuses on connecting fragmented habitats in Singapore. This is because patches of habitat that are ecologically connected create a larger overall area for flora and fauna to use as habitats and increase the chances of offspring survival after dispersal. Through modelling of the least resistance pathways for fauna using geographic information system (GIS) technology, Singapore identified a number of green corridors to facilitate north-south and east-west ecological connectivity across the entire island (Er, 2018). Today, the Park Connector Network (PCN), Nature Ways, intensified streetscape planting and skyrise and vertical greenery are found along these modelled pathways, creating connections between the four core areas. In addition, the incorporation of ecological concepts into the design of these connections (for example, Nature Ways are built with multiple layers mimicking the vertical layers of a tropical rainforest; see national target 10 in section 2.10) will maximise their utilisation by fauna. Over time, as the green connections expand across Singapore, nature also becomes integrated into Singapore's wider urban landscape. Another example of an important ecological corridor in Singapore is the Eco-Link@Bukit Timah Expressway (Eco-Link@BKE, see Singapore's Fifth National Report to the CBD). Completed in 1983, the BKE was built to connect the northwest and central regions of the island. However, the southern end of the BKE is located between BTNR and CCNR, and numerous road kills (including Sunda pangolins, which are critically endangered globally) along this expressway (Chew & Pazos, 2015) imply that the BKE is a connectivity barrier between the two Nature Reserves. Recognising this, NParks initiated the construction of the 59 m-wide Eco-Link@BKE and planted native forest trees and shrubs on the bridge to facilitate its use by wildlife. Today, pangolins, birds, bats and small mammals have been documented using the Eco-Link@BKE to cross between the Nature Reserves. Such measures ensure that Singapore's biodiversity-rich areas remain well connected across our urban landscape, to facilitate ecosystem health and integrity, while contributing to Aichi Target 11.

Marine habitats, on the other hand, have to be managed differently from terrestrial habitats. Due to the presence of water, currents and tides, conditions in marine ecosystems are generally more difficult to predict. To counter this, NParks has utilised ecological modelling to facilitate science-based decision making for marine conservation. By considering both the physical and biological aspects of Singapore's southern shores, agent-based modelling (ABM) of coral larvae along the southern coast found that the reefs on the Sisters' Islands act as source reefs: larvae released from these reefs tend to disperse to and settle on the reefs of nearby islands such as St John's Island, Kusu Island and Pulau Semakau. Hence, the model provided strong evidence that direct conservation of source reefs at Sisters' Islands will facilitate natural dispersal, increased diversity, growth and survival of corals across Singapore's southern islands, contributing to the designation of the SIMP as Singapore's first marine park. On a larger scale, ABM can also be used to evaluate national or regional connectivity of key habitats in Singapore's waters. Such information will allow us to effectively assess a system's response to stressors (for example, mortality and recovery; Grech *et al.*, 2018), in turn shaping future measures or projects meant to conserve key coastal habitats or increase their ecosystem resilience.

Habitat Enhancement, Restoration and Species Recovery

Singapore's fragmented habitats are subject to regular disturbances and significant edge effects. The onset of climate change also has the potential to bring unprecedented changes to Singapore's ecosystems. In order to maintain the functionality of natural habitats within our urban landscape and to increase their resilience against climate change, both habitat enhancement and restoration, as well as species conservation projects are being implemented as part of the second thrust of the NCMP (related to Aichi Targets 2, 5, 12 and 15).

Habitat enhancement and restoration

Resilient ecosystems generally have a complex and heterogeneous environment (Unsworth *et al.*, 2015) which is able to provide sufficient resources for the survival of a large number of species with overlapping niches (Oliver *et al.*, 2015). Habitat enhancement or restoration efforts will improve the physical makeup and structure of a habitat. Higher habitat complexity, in turn, creates environmental conditions that will encourage more flora and fauna to enter, live and reproduce in the area, facilitating the creation of resilient habitats. While NParks' initial efforts for habitat enhancement have been on an *ad hoc* basis, the NCMP provides a systematic approach for these efforts (i.e. providing guidelines for different enhancement approaches for different habitat types, and classifying different restoration methods) to halt further habitat degradation in the country.

First, the NCMP classified habitat enhancement and restoration into three ecological categories: terrestrial, freshwater and marine. Terrestrial habitat enhancement can occur directly, for example, by reforestation or planting nursery-grown seedlings, or indirectly, by weeding out non-native plants, which compete for resources with native plants. Freshwater habitats, on the other hand, are less well studied and there is a need to establish long-term monitoring protocols before any enhancement efforts are undertaken. More uniquely, marine habitat restoration methods tend to differ depending on habitat types (for example, coral reefs, mangrove forests or seawalls). For example, coral translocation has been carried out for reef diversification on SIMP, while the addition of high complexity structures such as BioBoss tiles facilitates the establishment of marine organisms on man-made coastal structures, such as seawalls.

In-house training and capacity building workshops are also carried out to educate site managers (who execute these programmes) about the Ecological Restoration Framework (Figure 7). By providing guidelines and knowledge, NParks empowers site managers to conduct ecologically sound and well-planned enhancement or restoration projects, further increasing the success rate. Examples of habitat enhancement or restoration guidelines include the pond restoration ecological guidelines by NParks' Centre for Urban Greenery and Ecology (CUGE), as well as the Active, Beautiful, Clean Waters (ABC Waters) Programme design guidelines. Since enhancement or restoration efforts are not limited to Nature Areas, but can be carried out for any of the 372 parks under NParks' jurisdiction, these efforts will assist with the survival of vulnerable species in Singapore that have distributional ranges outside of the four core areas (see Figure 6).

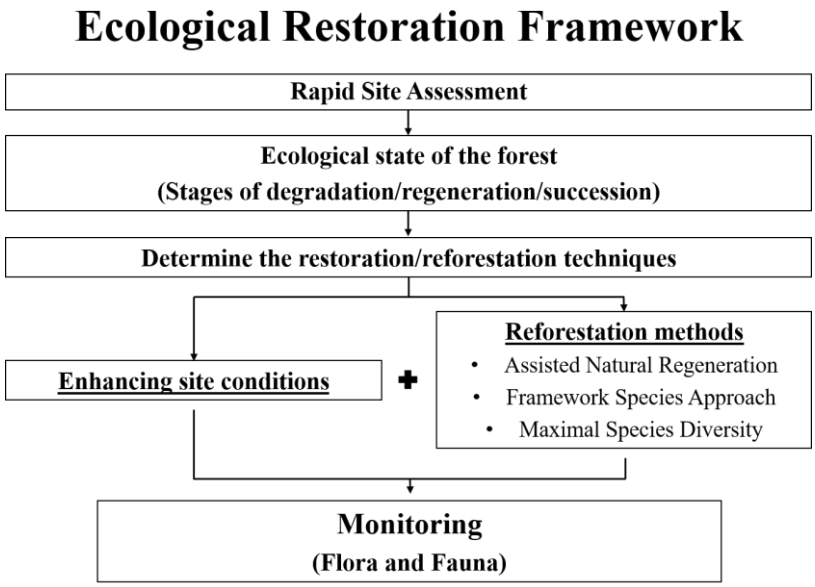

Figure 7 The Ecological Restoration Framework, designed to guide site managers' decision making when planning and implementing a terrestrial habitat enhancement and/or restoration project.

Species recovery programme

Another aspect of a resilient ecosystem is the presence of a high diversity of species occupying different ecological niches. The greater the species diversity in a habitat, the higher the odds of multiple species performing the same ecological function in an ecosystem, resulting in functional redundancy, which confers habitat resilience or improved ecosystem recovery rates after disturbances (Kang *et al.*, 2015). As habitats in Singapore come under increasing urban- and climate change-related pressures, there is an urgency to conserve the numerous rare and endemic species that are present on the island-state.

As such, NParks initiated the species recovery programme under the NCMP, which focuses on assisting the population recovery of selected species in Singapore. Guided by the Species Recovery Framework (Figure 8), the main methods for species recovery are reintroduction (via direct translocation or after captive breeding of individuals) or habitat preservation. These efforts in turn prevent species declines and potential extinctions (Aichi Target 12). Species prioritised for this programme are generally endemic or critically endangered species with small ranges of distribution. They could also be species that were recently rediscovered after being presumed to be nationally extinct. As part of the programme, the habitat and ecosystem conditions required for the survival of a species have to be established first (usually via habitat enhancement), after which the reintroduction process can begin. An alternative method is to directly conserve hotspots for the species (i.e. habitats in which the species is known to thrive in) and allow the species to recover over time. A successful species recovery project would then re-establish or facilitate the growth of a self-sustaining population for the prioritised species.

Numerous projects have already been initiated under the species recovery programme, resulting in successful increases in population numbers of numerous orchid species (for example, *Grammatophyllum speciosum*, the tiger orchid), as well as the oriental pied hornbill (*Anthracoceros albirostris*). Over the period from 2016 to 2018, NParks has announced a total of 94 species of flora and fauna species recovery projects. Examples include critically endangered species such as the Sunda pangolin (*Manis javanica*). A key outcome of the species recovery programme within these two years has been the successful translocation and successful production of captive born crablets of the endemic Singapore freshwater crab (*Johora singaporensis*).

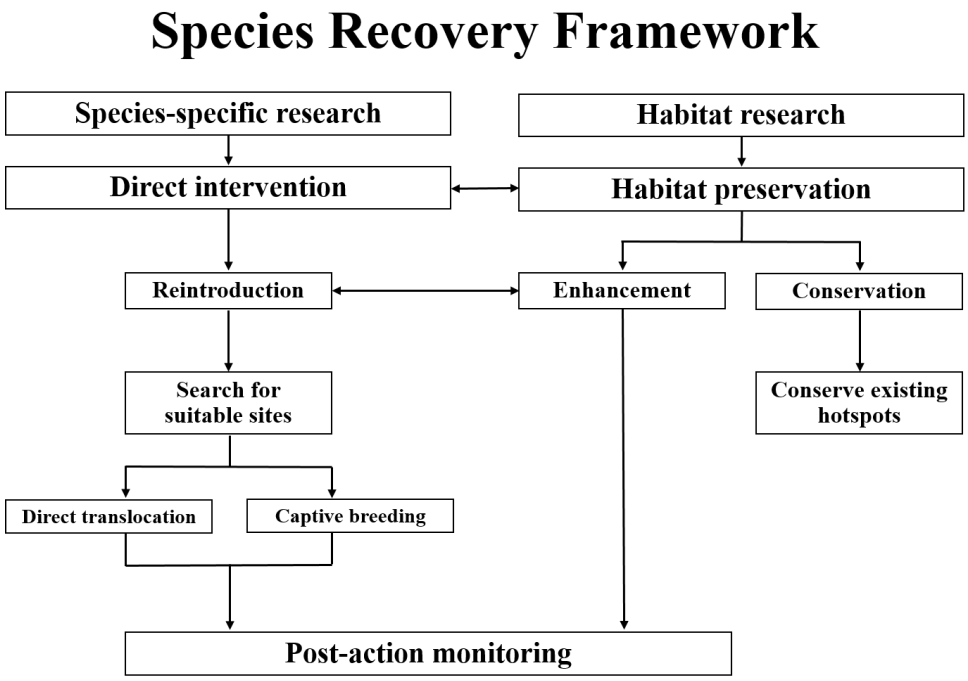

Figure 8 The Species Recovery Framework, designed for the planning and implementation of a species recovery programme.

Applied Research in Conservation Biology and Planning

Research is essential to conservation planning, due to its ability to generate reliable data that can shape future management policies. As such, it underpins the NCMP's conservation work in Singapore. An innovative and holistic approach to research will enable us to assimilate information from numerous disciplines to further improve our understanding of Singapore's natural ecosystems. In turn, this would guide future conservation projects and operations. Through online platforms such as the Biodiversity and Environment Database System (BIOME), trees.sg, publications and other outreach methods, information gained from research is also shared with other stakeholders, such as agencies, researchers and the public (Aichi Target 19).

One of the major types of research conducted by NParks are biological surveys, which allow us to closely monitor the ecological health of our natural areas. An example of a recent biological survey is the second comprehensive survey of BTNR, commenced in April 2015, led by NParks in collaboration with academics and other specialists. Relative to the first BTNR survey conducted in 1997, the methodology for data collection, the nature of data to be collected and the number of focal taxonomic groups have been expanded. Since the second comprehensive survey's completion in 2017, preliminary results have revealed several new species records (such as *Scindapsus lucens*, a climber) and rediscoveries (for example, *Dapania racemosa*, a liana, and *Ichthyophis paucisulcus*, the Sumatran striped caecilian). A separate interdisciplinary research project has also been initiated for a unique habitat within the CCNR, the Nee Soon freshwater swamp. The Nee Soon Biodiversity and Hydrology Project involves scientific fields ranging from biodiversity, hydrology and geology to cryogenics and modelling (Cai *et al.*, 2018), and gathering data about Singapore's sole freshwater swamp forest.

The advent of new technologies has facilitated research projects that were not possible in the past, enabling improved planning and management of Singapore's natural areas. Genetic sequencing and geospatial technologies, advanced modelling techniques and enhanced database capabilities have been applied to our research as part of the NCMP. Genomic studies, for example, have greatly improved the

reliability of taxonomic data, and enabled population viability analyses to detect inbreeding in small populations (Sadanandan & Rheindt, 2015). Under such circumstances, measures to increase habitat connectivity can be taken up to promote outbreeding. GIS software, on the other hand, can be used for the mapping of population distributions, biodiversity hotspots and habitat connectivity/fragmentation (Er, 2018). Together with ecological modelling and quantitative research, research data will greatly facilitate science-based decision making. For example, quantitative data and GIS information can be combined to provide carbon stock estimates for different green areas in Singapore. Such information can subsequently contribute to climate change mitigation efforts (Aichi Target 15).

As urban and green networks in Singapore become increasingly integrated, human-wildlife interaction rates will increase. Local fauna that are often encountered by Singaporeans in the urban environment includes species such as the long-tailed macaque (*Macaca fascicularis*) and wild boar (*Sus scrofa*), with occasional cases of conflict. With the assistance of both social research and species population studies, causes of the human-wildlife conflict can be ascertained (for example, Riley *et al.*, 2016), which can in turn provide directions for management decisions. Education and information sharing are key to preventing human-wildlife conflict (Aichi Target 19). For example, in 2018, a six-month long Biodiversity Challenge was initiated for interested members of the public to learn more about harmonious coexistence with wildlife through training sessions, seminars and the shadowing of researchers and park managers. Numerous non-governmental organisations (NGOs) are also involved in human-animal interaction outreach, such as the Animal Concerns Research and Education Society (ACRES), Jane Goodall Institute (Singapore) (JGIS) and Nature Society (Singapore) (NSS).

Community Stewardship and Outreach in Nature

Outreach is an essential part of engaging the entire community in Singapore's efforts to conserve nature. Through education, Singaporeans can understand nature, learn how to do their part to conserve it and how to co-exist with nature in our highly urbanised environment (Aichi Targets 1 and 4). Within the NCMP, the Community in Nature (CIN) initiative is NParks' flagship initiative for nature outreach and to encourage community stewardship. Launched in 2011, this national movement aims to connect with and engage a variety of groups within the community to help conserve Singapore's natural heritage, including a) educational and research institutions; b) families; c) corporations and companies; d) NGOs; e) other agencies and f) passionate individuals. Through the design of targeted activities for each community group, effective engagement and outreach can be conducted.

For outreach to students, NParks provides technical inputs on the preparation of school textbooks and collaborates with the Ministry of Education (MOE) to design programmes for students, such as the Every Child a Seed and Greening Schools for Biodiversity (GSB) programmes. For example, the Every Child a Seed programme provides each child with a plant starter kit – children learn to care for their own seeds and watch their seedlings grow, while learning about the plant life cycle in class. With the launch of the Families for Nature initiative, families can also get involved in conservation activities while building familial bonds and learning together. For the community, there are both annual events, such as Biodiversity Week, the Festival of Biodiversity (FOB) and BioBlitz, and year-long citizen science activities (see section 2.2 for details), allowing people from all walks of life to learn more about Singapore's rich flora and fauna. Through the Garden City Fund (GCF) and corporate volunteer opportunities, companies too can choose to give back to nature or learn more about it through volunteering (see section 2.1 for details).

Many of the CIN efforts involve citizen science, where community members have the opportunity to engage in organised research activities. In this way, people from all walks of life can contribute to accurate and systematic data collection meant to shape conservation strategies. Due to the large number

of people who can be involved, data can be collected on large geographic scales or consistently over a long duration, allowing more information and better insights to be gained. Such initiatives, including TeamSeaGrass, the Comprehensive Marine Biodiversity Survey (CMBS) and the CIN Biodiversity Watch series (see section 2.2 for details), are led by experienced researchers who assist with data collection, analysis and interpretation.

ANNEX A REFERENCES

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ANNEX B

Species list of new records, new species, rediscoveries and extinctions in Singapore.

Species highlighted in blue were featured in Singapore's Fifth National Report to the CBD.

Plants and Others

Vascular Plants

S/N	Species Name	Status	Source
1	*Aglaia crassinervia*	New record	Khoo *et al.* (2018)
2	*Aglaia erythrosperma*	New record	Pannell (2013)
3	*Aglaia yzermannii*	New record	Chong *et al.* (2018)
4	*Albertisia crassa*	New record	Lim *et al.* (2018)
5	*Alphonsea johorensis*	New record	Khoo *et al.* (2018)
6	*Arcangelisia flava*	New record	Lim *et al.* (2018)
7	*Artabotrys scortechinii*	New record	Chen *et al.* (2018)
8	*Blechum pyramidatum*	New record	Neo *et al.* (2014)
9	*Cayratia japonica*	New record	Yeo & Ang *et al.* (2012)
10	*Cryptocarya nitens*	New record	Neo *et al.* (2014)
11	*Dacryodes incurvata*	New record	Chong *et al.* (2018)
12	*Dacryodes nervosa*	New record	Khoo *et al.* (2018)
13	*Dehaasia cuneata*	New record	Khoo *et al.* (2018)
14	*Dendrokingstonia nervosa*	New record	Lim *et al.* (2018)
15	*Dioscorea alata*	New record	Neo *et al.* (2013)
16	*Diplazium bantamense*	New record	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
17	*Dischidia acutifolia*	New record	NParks SBWR Branch (2013), pers. comm. 3 Dec
18	*Dracaena trachystachys*	New record	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
19	*Drypetes crassipes*	New record	Khoo *et al.* (2018)
20	*Dysoxylum grande*	New record	Khoo *et al.* (2018)
21	*Eleutherococcus trifoliatus*	New record	Neo *et al.* (2014)
22	*Endiandra maingayi*	New record	Khoo *et al.* (2018)
23	*Gluta malayana*	New record	Khoo *et al.* (2018)
24	*Halophila decipiens*	New record	Yaakub *et al.* (2013)
25	*Hanguana podzolicola*	New record	Niissalo & Leong-Skornickova (2017)
26	*Hewittia malabarica*	New record	Lim *et al.* (2018)
27	*Hopea ferruginea*	New record	Khoo *et al.* (2018)
28	*Hoya caudata*	New record	Rodda & Ang (2012)
29	*Hoya imperialis*	New record	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
30	*Lepisanthes fruticosa*	New record	Khoo *et al.* (2018)
31	*Litsea resinosa*	New record	Chong *et al.* (2016)
32	*Litsea spathacea*	New record	de Kok (2017)

33	*Litsea tomentosa*	New record	de Kok (2017)
34	*Mangifera gracilipes*	New record	Khoo *et al.* (2018)
35	*Margaritaria indica*	New record	NParks (2017)
36	*Melanochyla angustifolia*	New record	Chong *et al.* (2018)
37	*Melochia umbellata*	New record	Ganesan *et al.* (2018)
38	*Merremia vitifolia*	New record	Neo *et al.* (2013)
39	*Micrechites lancifolia*	New record	Middleton *et al.* (2018)
40	*Neoscortechinia philippinensis*	New record	Khoo *et al.* (2018)
41	*Neoscortechinia sumatrensis*	New record	Ang *et al.* (2010c)
42	*Palaquium impressionervium*	New record	Khoo *et al.* (2018)
43	*Paraderris elliptica*	New record	Neo *et al.* (2014)
44	*Phyllanthus reticulatus*	New record	Lim *et al.* (2018)
45	*Plectocomiopsis geminiflora*	New record	Tan, L. L. *et al.* (2011)
46	*Pleocnemia conjugata*	New record	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
47	*Rhizophora x larmarckii*	New record	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
48	*Scindapsus lucens*	New record	Ho *et al.* (2018)
49	*Securidaca philippinensis*	New record	Tan & Chong *et al.* (2016)
50	*Shorea johorensis*	New record	Ganesan *et al.* (2018)
51	*Sphaeropteris trichodesma*	New record	Lim *et al.* (2018)
52	*Tectaria incisa*	New record	Neo *et al.* (2014)
53	*Terminalia citrina*	New record	Khoo *et al.* (2018)
54	*Thottea praetermissa*	New record	NParks Plant Information Unit (2013), pers. comm. 13 Dec
55	*Uvaria micrantha*	New record	Lim *et al.* (2018)
56	*Vatica odorata*	New record	Khoo *et al.* (2018)
57	*Vitex rotundifolia*	New record	de Kok *et al.* (2016)
58	*Evolvulus nummularius*	New record/ Introduced	Chua (2016)
59	*Hanguana neglecta*	New species	Niissalo *et al.* (2014)
60	*Hanguana nitens*	New species	Leong-Škorničková & Boyce (2015)
61	*Hanguana rubinea*	New species	Leong-Škorničková & Boyce (2015)
62	*Hanguana triangulata*	New species	Leong-Škorničková & Boyce (2015)
63	*Acacia kekapur*	Rediscovery	Chong *et al.* (2012)
64	*Acriopsis ridleyi*	Rediscovery	Leong *et al.* (2018)
65	*Actinodaphne macrophylla*	Rediscovery	Chong *et al.* (2012)
66	*Adinandra integerrima*	Rediscovery	Chong *et al.* (2012)
67	*Aeschynanthus parvifolius*	Rediscovery	Chong *et al.* (2012)
68	*Aglaia elliptica*	Rediscovery	Chong *et al.* (2012)
69	*Aglaia macrocarpa*	Rediscovery	Chong *et al.* (2012)
70	*Aglaia oligophylla*	Rediscovery	Chong *et al.* (2012)

71	*Aglaia palembanica*	Rediscovery	Ho *et al.* (2018)
72	*Albizia retusa*	Rediscovery	Chong *et al.* (2012)
73	*Amomum hastilabium*	Rediscovery	Leong-Skornickova, J. (2013), pers. comm. 10 Oct
74	*Ampelocissus thyrsiflora*	Rediscovery	Yeo *et al.* (2013)
75	*Anisoptera costata*	Rediscovery	Chong *et al.* (2012)
76	*Aquilaria hirta*	Rediscovery	Chong *et al.* (2012)
77	*Aralidium pinnatifidum*	Rediscovery	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
78	*Artocarpus maingayi*	Rediscovery	Chong *et al.* (2012)
79	*Athyrium accedens*	Rediscovery	Lai (2010)
80	*Bolbitis sinuata*	Rediscovery	Ho *et al.* (2018)
81	*Bromheadia alticola*	Rediscovery	Yam *et al.* (2012)
82	*Bulbophyllum pulchellum*	Rediscovery	NParks Plant Information Unit (2013), pers. comm. 13 Dec
83	*Bulbophyllum singaporeanum*	Rediscovery	Yam *et al.* (2010)
84	*Calamus javensis*	Rediscovery	NParks Plant Information Unit (2013), pers. comm. 13 Dec
85	*Calamus ornatus*	Rediscovery	Ho *et al.* (2018)
86	*Callerya dasyphylla*	Rediscovery	Lim *et al.* (2018)
87	*Callistopteris superba (= Cephalomanes superbum)*	Rediscovery	Chong *et al.* (2018)
88	*Callostylis pulchella (= Eria pulchella)*	Rediscovery	Lok *et al.* (2012)
89	*Casearia clarkei*	Rediscovery	Chong *et al.* (2012)
90	*Cheilosa montana* Blume	Rediscovery	Chong *et al.* (2012)
91	*Claoxylon longifolium*	Rediscovery	Ho *et al.* (2018)
92	*Cocculus orbiculatus*	Rediscovery	Lim *et al.* (2018)
93	*Coelogyne rochussenii*	Rediscovery	Lok *et al.* (2011b)
94	*Coptosapelta flavescens*	Rediscovery	Chong *et al.* (2012)
95	*Coptosapelta griffithii*	Rediscovery	Chong *et al.* (2012)
96	*Coptosapelta tomentosa*	Rediscovery	Ang (2010)
97	*Cyrstachys renda*	Rediscovery	NParks Plant Information Unit (2013), pers. comm. 13 Dec
98	*Dalbergia parviflora*	Rediscovery	Chong *et al.* (2012)
99	*Dapania racemosa*	Rediscovery	Ho *et al.* (2018)
100	*Dendrobium aloifolium*	Rediscovery	Ang *et al.* (2010b)
101	*Dichapetalum sordidum*	Rediscovery	Chong *et al.* (2012)
102	*Dienia ophrydis*	Rediscovery	Ibrahim *et al.* (2011)
103	*Dioscorea kingii*	Rediscovery	Ho *et al.* (2018)
104	*Dioscorea orbiculata*	Rediscovery	Chong *et al.* (2012)
105	*Dioscorea stenomeriflora*	Rediscovery	Chong *et al.* (2018)
106	*Dischidia hirsuta*	Rediscovery	Rodda *et al.* (2012)
107	*Dissochaeta annulata*	Rediscovery	Chong *et al.* (2012)
108	*Dracaena singapurensis*	Rediscovery	Chong *et al.* (2012)

109	*Dysoxylum acutangulum*	Rediscovery	Chong *et al.* (2012)
110	*Endocomia canarioides*	Rediscovery	Chong *et al.* (2012)
111	*Erycibe festiva Prain*	Rediscovery	Chong *et al.* (2012)
112	*Fagraea acuminatissima*	Rediscovery	Chong *et al.* (2012)
113	*Fagraea ridleyi*	Rediscovery	NParks Pulau Ubin Branch (2013), pers. comm. 11 Dec
114	*Ficus delosyce* Corner	Rediscovery	Ang *et al.* (2014)
115	*Ficus rosulata*	Rediscovery	Ho *et al.* (2018)
116	*Ficus ruginervia* L.	Rediscovery	Chong *et al.* (2012)
117	*Freycinetia javanica*	Rediscovery	Ang *et al.* (2012a)
118	*Friesodielsia glauca*	Rediscovery	Chong *et al.* (2012)
119	*Grenacheria amentacea*	Rediscovery	Chong *et al.* (2012)
120	*Helicia excelsa*	Rediscovery	Chong *et al.* (2012)
121	*Hetaeria obliqua*	Rediscovery	Leong & Yam (2013)
122	*Hoya coronaria*	Rediscovery	NParks Plant Information Unit (2013), pers. comm. 13 Dec
123	*Hoya wallichii*	Rediscovery	Rodda *et al.* (2016)
124	*Hypserpa nitida*	Rediscovery	Chong *et al.* (2012)
125	*Ixora umbellata*	Rediscovery	Chong *et al.* (2012)
126	*Lasianthus reticulatus*	Rediscovery	Ho *et al.* (2018)
127	*Lecananthus erubescens*	Rediscovery	Lim *et al.* (2018)
128	*Lindsaea divergens*	Rediscovery	Tan & Yeo (2012)
129	*Lindsaea repens*	Rediscovery	Chong *et al.* (2018)
130	*Liparis barbata*	Rediscovery	Lok *et al.* (2010)
131	*Loeseneriella macrantha*	Rediscovery	Lim *et al.* (2018)
132	*Mapania squamata*	Rediscovery	Lim *et al.* (2018)
133	*Marsdenia maingayi*	Rediscovery	Yeoh *et al.* (2013)
134	*Meliosma pinnata*	Rediscovery	Chong *et al.* (2012)
135	*Memecylon pauciflorum*	Rediscovery	Chong *et al.* (2012)
136	*Memecylon pubescens*	Rediscovery	Chong *et al.* (2012)
137	*Neesia malayana*	Rediscovery	Chong *et al.* (2012)
138	*Nephelium laurinum*	Rediscovery	Chong *et al.* (2012)
139	*Nephelium ramboutan-ake*	Rediscovery	Chong *et al.* (2012)
140	*Ormocarpum cochinchinense*	Rediscovery	Chong *et al.* (2012)
141	*Oxyceros penangianus*	Rediscovery	Chong *et al.* (2012)
142	*Palaquium oxleyanum*	Rediscovery	Chong *et al.* (2012)
143	*Pholidocarpus kingianus*	Rediscovery	NParks Plant Information Unit (2013), pers. comm. 13 Dec
144	*Pinanga simplicifrons*	Rediscovery	Ang *et al.* (2010a)
145	*Plagiostachys lateralis*	Rediscovery	Lim *et al.* (2018)
146	*Poikilospermum cordifolium*	Rediscovery	Chong *et al.* (2012)
147	*Polystachya concreta*	Rediscovery	Lok *et al.* (2011a)
148	*Pterisanthes cissoides*	Rediscovery	Yeo *et al.* (2012a)
149	*Pterospermum diversifolium*	Rediscovery	Chong *et al.* (2012)

150	*Renanthera elongate*	Rediscovery	Ang *et al.* (2011a)
151	*Rinorea lanceolata*	Rediscovery	Chong *et al.* (2012)
152	*Rourea acutipetala*	Rediscovery	Chong *et al.* (2012)
153	*Rubus moluccanus*	Rediscovery	Ang *et al.* (2010d)
154	*Ryparosa hullettii*	Rediscovery	Ho *et al.* (2018)
155	*Salacca affinis*	Rediscovery	Loo (2011)
156	*Salacia maingayi* Laws.	Rediscovery	Chong *et al.* (2012)
157	*Schizostachyum gracile*	Rediscovery	Chong *et al.* (2012)
158	*Scolopia macrophylla*	Rediscovery	Lim *et al.* (2018)
159	*Senegalia kekapur*	Rediscovery	Ho *et al.* (2018)
160	*Spatholobus maingayi*	Rediscovery	Lim *et al.* (2018)
161	*Strychnos axillaris*	Rediscovery	Chong *et al.* (2012)
162	*Syzygium attenuatum*	Rediscovery	Chong *et al.* (2012)
163	*Syzygium conglomeratum*	Rediscovery	Chong *et al.* (2012)
164	*Syzygium glabratum*	Rediscovery	Chong *et al.* (2018)
165	*Syzygium griffithii*	Rediscovery	Chong *et al.* (2012)
166	*Syzygium kunstleri*	Rediscovery	Chong *et al.* (2012)
167	*Syzygium leptostemon*	Rediscovery	Chong *et al.* (2018)
168	*Syzygium pseudocrenulatum*	Rediscovery	Chong *et al.* (2018)
169	*Syzygium scortechinii*	Rediscovery	Chong *et al.* (2012)
170	*Tetrastigma rafflesiae (Dennst.) Alston ex Mabb.*	Rediscovery	NParks Plant Information Unit (2018), pers. comm.
171	*Toxocarpus griffithii*	Rediscovery	Chong *et al.* (2012)
172	*Trichotosia velutina*	Rediscovery	Ang *et al.* (2012b)
173	*Trigoniastrum hypoleucum*	Rediscovery	Chong *et al.* (2018)
174	*Uncaria acida*	Rediscovery	Chong *et al.* (2012)
175	*Uncaria attenuata*	Rediscovery	Chong *et al.* (2012)
176	*Uncaria callophylla*	Rediscovery	Turner (2018)
177	*Uncaria canescens*	Rediscovery	Turner (2018)
178	*Uncaria roxburghiana*	Rediscovery	Turner (2018)
179	*Uvaria curtisii*	Rediscovery	Ang (2010)
180	*Uvaria lobbiana*	Rediscovery	Chong *et al.* (2018)
181	*Vrydagzynea lancifolia*	Rediscovery	Lim *et al.* (2014)
	Deplanchea bancana (Scheff.) Steen.	Rediscovered in the wild*	Chong *et al.* (2018)
	Dipterocarpus chartaceus	Rediscovered in the wild*	Lim *et al.* (2018)
	Eulophia graminea	Rediscovered in the wild*	Ang *et al.* (2011b)
	Fagraea splendens Blume	Rediscovered in the wild*	Chong *et al.* (2012)
	Ficus stricta	Rediscovered in the wild*	Yeo & Ng *et al.* (2012)
	Kleinhovia hospita L.	Rediscovered in the wild*	Chong *et al.* (2012)
	Knema glaucescens Jack	Rediscovered in the wild*	Chong *et al.* (2012)

	Myrmecodia tuberosa	Rediscovered in the wild*	NParks Plant Information Unit (2013), pers. comm. 13 Dec
	Shorea sumatrana	Rediscovered in the wild*	Ganesan & Ibrahim (2018)
	Sindora echinocalyx	Rediscovered in the wild*	Khoo *et al.* (2018)
	Tetrastigma dichotomum	Rediscovered in the wild*	Yeo, Ang & Lok (2012)
	Chaetocarpus castanocarpus	Extinct	Lim *et al.* (2018)
	Cystorchis variegata var. purpurea	Extinct	Lok *et al.* (2011b)
	Haplopteris sessilifrons	New record/Extinct	Lim *et al.* (2018)
	Spermacoce parviceps	New record/Extinct	Lim *et al.* (2018)
Baseline	3550 species		Chong *et al.* (2009)

*These species are already included in the baseline as cultured species and were not counted as additions to the final species count.

Algae

S/N	Species Name	Status	Source
1	*Alexandrium affine*	New record	Tan & Leaw *et al.* (2016)
2	*Alexandrium tamiyavanichii*	New record	Tan & Leaw *et al.* (2016)
3	*Alexandrium tamutum*	New record	Tan & Leaw *et al.* (2016)
4	*Amphidinium carterae*	New record	Tan & Leaw *et al.* (2016)
5	*Ceratium furca*	New record	Tan & Leaw *et al.* (2016)
6	*Ceratium fusus*	New record	Tan & Leaw *et al.* (2016)
7	*Ceratium tripos*	New record	Tan & Leaw *et al.* (2016)
8	*Chaetoceros affinis*	New record	Tan & Leaw *et al.* (2016)
9	*Chaetoceros decipiens*	New record	Tan & Leaw *et al.* (2016)
10	*Cochlodinium polykrikoides*	New record	Tan & Leaw *et al.* (2016)
11	*Coolia malayensis*	New record	Tan & Leaw *et al.* (2016)
12	*Gonyaulax spinifera*	New record	Tan & Leaw *et al.* (2016)
13	*Gyrodinium spirale*	New record	Tan & Leaw *et al.* (2016)
14	*Helicotheca tamesis*	New record	Tan & Leaw *et al.* (2016)
15	*Karenia mikimotoi*	New record	Leong *et al.* (2015)
16	*Karlodinium cf. australe*	New record	Leong *et al.* (2015)
17	*Karlodinium cf. veneficum*	New record	Leong *et al.* (2015)
18	*Lauderia annulata*	New record	Tan & Leaw *et al.* (2016)
19	*Ostreopsis ovata*	New record	Tan & Leaw *et al.* (2016)
20	*Planktoniella blanda*	New record	Tan & Leaw *et al.* (2016)
21	*Prorocentrum concavum*	New record	Tan & Leaw *et al.* (2016)
22	*Prorocentrum emarginatum*	New record	Tan & Leaw *et al.* (2016)
23	*Prorocentrum gracile*	New record	Tan & Leaw *et al.* (2016)
24	*Prorocentrum micans*	New record	Tan & Leaw *et al.* (2016)
25	*Pseudo-nitzschia brasiliana*	New record	Tan & Leaw *et al.* (2016)
26	*Pseudo-nitzschia cuspidata*	New record	Tan & Leaw *et al.* (2016)
27	*Pseudo-nitzschia micropora*	New record	Tan & Leaw *et al.* (2016)

28	*Pseudo-nitzschia multistriata*	New record	Tan & Leaw *et al.* (2016)
29	*Pyrodinium bahamense var. compressum*	New record	Tan & Leaw *et al.* (2016)
30	*Pyrophacus stenii*	New record	Tan & Leaw *et al.* (2016)
31	*Scrippsiella trochoidea*	New record	Tan & Leaw *et al.* (2016)
Baseline	1054 species		Pham *et al.* (2010)

Fungi

S/N	**Species name**	**Status**	**Source**
Baseline	950 species		Wee & Ng (1994)

Lichen

S/N	**Species Name**	**Status**	**Source**
1	*Cruentotrema kurandense*	New record	Weerakoon *et al.* (2015)
2	*Dyplolabia afzelii*	New record	Weerakoon *et al.* (2015)
3	*Graphis chloroalba*	New record	Weerakoon *et al.* (2015)
4	*Graphis cremicolor*	New record	Weerakoon *et al.* (2015)
5	*Graphis diplocheila*	New record	Weerakoon *et al.* (2015)
6	*Graphis leprographa*	New record	Weerakoon *et al.* (2015)
7	*Graphis novopalmicola*	New record	Weerakoon *et al.* (2015)
8	*Graphis sayeri*	New record	Weerakoon *et al.* (2015)
9	*Graphis srilankensi*	New record	Weerakoon *et al.* (2015)
10	*Graphis subhiascens*	New record	Weerakoon *et al.* (2015)
11	*Melanotrema platystomum*	New record	Weerakoon *et al.* (2015)
12	*Myriotrema clandestinum*	New record	Weerakoon *et al.* (2015)
13	*Ocellularia ascidioidea*	New record	Weerakoon *et al.* (2015)
14	*Ocellularia depressa*	New record	Weerakoon *et al.* (2015)
15	*Ocellularia exigua*	New record	Weerakoon *et al.* (2015)
16	*Ocellularia granulifera*	New record	Weerakoon *et al.* (2015)
17	*Ocellularia viridipallens*	New record	Weerakoon *et al.* (2015)
18	*Ocellularia zamboangensis*	New record	Weerakoon *et al.* (2015)
19	*Sarcographa oculata*	New record	Weerakoon *et al.* (2015)
20	*Astrochapsa sipmanii*	New species	Weerakoon *et al.* (2015)
21	*Fissurina duplomarginata*	New species	Weerakoon *et al.* (2015)
22	*Graphis bukittimaensis*	New species	Weerakoon *et al.* (2015)
23	*Graphis singaporensis*	New species	Weerakoon *et al.* (2015)
24	*Ocellularia subudupiensis*	New species	Weerakoon *et al.* (2015)
25	*Ocellularia gueidaniana*	New species	Weerakoon *et al.* (2015)
26	*Ocellularia rivasplatana*	New species	Weerakoon *et al.* (2015)
Baseline	Estimated 376 species		Ng *et al.* (2011)

Bryophytes

S/N	Species name	Status	Source
1	*Marchantia emarginata*	New record	Ho (2013)
Baseline	232 species		Ho, B. C. (2014), pers. comm. 30 April

Vertebrates

Mammals

S/N	Species name	Status	Source
1	*Hipposideros cineraceus*	New record	NParks (2017)
2	*Hypsugo macrotis*	New record	Lee & Teo (2018)
3	*Taphozous longimanus*	New record	Teo (2018)
4	*Myotis horsfieldi*	New record	Lim & Leong (2014)
5	*Cervus unicolour*	Rediscovery	Cai (2010)
Baseline	91 species (includes species of indeterminate status)		Baker & Lim (2008), Miller (1991), Nature Society (Singapore) (2014)

Birds

S/N	Species name	Status	Source
1	*Accipiter nisus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
2	*Acridotheres melanopterus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
3	*Aerodramus maximus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
4	*Aethopyga siparaja*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
5	*Agropsar philippensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
6	*Agropsar sturninus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
7	*Amandava amandava*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
8	*Anastomus oscitans*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
9	*Anhinga melanogaster*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
10	*Anthracoceros malayanus*	New record	Nature Society (Singapore) Bird Group Records Committee (2017)

11	*Anthus hodgsoni*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
12	*Anthus richardi*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
13	*Ardea alba*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
14	*Ardeola grayii*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
15	*Calidris minuta*	New record	NParks (2018)
16	*Cecropis daurica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
17	*Chalcoparia singalensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
18	*Chloropsis cyanopogon*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
19	*Chroicocephalus brunnicephalus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
20	*Chroicocephalus ridibundus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
21	*Chrysococcyx maculatus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
22	*Chrysophlegma miniaceum*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
23	*Cinnyris jugularis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
24	*Clamator jacobinus*	New record	Nature Society (Singapore) Bird Group Records Committee (2017)
25	*Clanga clanga*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
26	*Collocalia affinis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
27	*Cyornis brunneatus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
28	*Ducula badia*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)

29	*Dupetor flavicollis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
30	*Egretta intermedia*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
31	*Esacus magnirostris*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
32	*Eumyias thalassinus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
33	*Excalfactoria chinensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
34	*Falco amurensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
35	*Ficedula narcissina*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
36	*Gelochelidon nilotica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
37	*Geokichla citrina*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
38	*Geokichla sibirica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
39	*Haliaeetus ichthyaetus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
40	*Hemipus hirundinaceus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
41	*Hemixos cinereus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
42	*Hirundapus caudacutus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
43	*Hydroprogne caspia*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
44	*Iduna caligata*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
45	*Larus fuscus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
46	*Larus heuglini*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)

47	*Larvivora cyane*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
48	*Leptocoma brasiliana*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
49	*Leptocoma calcostetha*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
50	*Leptoptilos javanicus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
51	*Lonchura atricapilla*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
52	*Lonchura ferruginosa*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
53	*Lophotriorchis kienerii*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
54	*Motacilla tschutschensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
55	*Mulleripicus pulverulentus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
56	*Muscicapa latirostris*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
57	*Ninox japonica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
58	*Nisaetus alboniger*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
59	*Nisaetus cirrhatus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
60	*Onychoprion aleuticus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
61	*Onychoprion anaethetus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
62	*Padda oryzivora*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
63	*Phylloscopus borealoides*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
64	*Phylloscopus tenellipes*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)

65	*Porzana paykullii*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
66	*Prionochilus thoracicus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
67	*Puffinus tenuirostris*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
68	*Spilopelia chinensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
69	*Spodiopsar sericeus*	New record	Nature Society (Singapore) Bird Group Records Committee (2017)
70	*Stercorarius longicaudus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
71	*Stercorarius pomarinus*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
72	*Streptopelia tranquebarica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
73	*Strix leptogrammica*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
74	*Sturnia sinensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
75	*Sula sula*	New record	Nature Society (Singapore) Bird Group Records Committee (2013)
76	*Thalasseus bengalensis*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
77	*Thalasseus bergii*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
78	*Tyto javanica*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
79	*Xenus cinereus*	New record	Nature Society (Singapore) Bird Group Records Committee (2018)
80	*Actitis hypoleucos*	New record/ Introduced	Nature Society (Singapore) Bird Group Records Committee (2018)
81	*Bubulcus coromandus*	New record/ Introduced	Nature Society (Singapore) Bird Group Records Committee (2018)
82	*Bubo sumatranus*	Rediscovery	Nature Society (Singapore) Bird Group Records Committee (2013)

83	*Meiglyptes tristis*	Rediscovery	Nature Society (Singapore) Bird Group Records Committee (2013)
84	*Pastor roseus*	Rediscovery	Nature Society (Singapore) Bird Group Records Committee (2018)
85	*Mulleripicus pulverulentus*	Rediscovery**	Nature Society (Singapore) Bird Group Records Committee (2018)
86	*Pycnonotus melanoleucos*	Rediscovery	Nature Society (Singapore) Bird Group Records Committee (2013)
87	*Cyanoptila cumatilis*	Species Split*	Nature Society (Singapore) Bird Group Records Committee (2017)
88	*Terpsiphone affinis*	Species Split*	Nature Society (Singapore) Bird Group Records Committee (2017)
89	*Terpsiphone incei*	Species Split*	Nature Society (Singapore) Bird Group Records Committee (2017)
Baseline	363 species		Wang & Hails (2007)

*Considered as a new species

**Was previously reported as extinct in the Fifth National Report (Wang & Hails, 2007)

Reptiles

S/N	Species name	Status	Source
1	*Asthenodipsas laevis*	New Record	Lim (2009)
2	*Cyrtodactylus quadrivirgatus*	New Record	Law *et al.* (2016)
3	*Cyrtodactylus semenanjungensis*	New Record	Baker (2014)
4	*Dendrelaphis haasi*	New Record	Lim & Cheong (2011)
5	*Norops sageri*	New Record	Tan & Lim (2012)
6	*Phytolopsis punctata*	New Record	Thomas *et al.* (2014)
7	*Chrysopelea ornata*	New record/ Introduced	Maury & Low (2015)
8	*Podocnemis unifilis*	New record/ Introduced	Chua (2018)
9	*Tytthoscincus temasekensis*	New species	Grismer *et al.* (2017)
	*Calamaria gimletti**	Rediscovery	Serin *et al.* (2017)
	*Lygosoma quadrupe**	Rediscovery	Lim (2016)
Baseline	148 species (includes species of indeterminate status)		Baker & Lim (2008), Nature Society (Singapore) (2014)

*initially considered of indeterminate status by Baker & Lim (2008), already included in baseline.

Amphibians

S/N	Species name	Status	Source
1	*Eleutherodactylus planirostris*	New record/ Introduced	Groenewoud & Law (2016)
Baseline	29 species		Baker & Lim (2008)

Freshwater Fishes

S/N	Species name	Status	Source
1	*Danio rerio*	New record	Tan *et al.* (2013)
2	*Macropodus opercularis*	New record	Tan *et al.* (2013)
Baseline	104 species (includes species of indeterminate status)		Baker & Lim (2008) Nature Society (Singapore) (2014)

Marine Fishes

S/N	Species name	Status	Source
1	*Abudefduf notatus*	New record	Taira (2018a)
2	*Amphilophus citrinellus*	New record	Tan, H. H. (2015)
3	*Arius cf. gagora*	New record	Ng (2012)
4	*Arothron caeruleopunctatus*	New record	Yap & Sankar (2015)
5	*Bryaninops loki*	New record	Larson *et al.* (2016)
6	*Chaetodon adiergastos*	New record	Low (2013)
7	*Conger cinereus*	New record	Koh & Lim (2017)
8	*Dascyllus reticulatus*	New record	Low (2016)
9	*Dascyllus trimaculatus*	New record	Low (2013)
10	*Diademichthys lineatus*	New record	Low (2013)
11	*Dunckerocampus dactyliophorus*	New record	Lim (2015)
12	*Engyprosopon grandisquama*	New record	Lim (2018)
13	*Entomacrodus striatus*	New record	Ng & Lim (2015)
14	*Gobiodon quinquestrigatus*	New record	Larson *et al.* (2016)
15	*Laeops guentheri*	New record	Lim (2017)
16	*Lubricogobius ornatus*	New record	Tan & Jaafar (2015)
17	*Myripristis amaena*	New record	Low (2013)
18	*Netuma bilineata*	New record	Ng (2012)
19	*Oplopomus caninoides*	New record	Larson *et al.* (2016)
20	*Ostorhinchus fleurieu*	New record	Koh & Lim (2015b)
21	*Ostorhinchus wassinki*	New record	Low & Lim (2016)
22	*Oxycheilinus digramma*	New record	Taira (2018b)
23	*Oxymetopon compressus*	New record	Goh & Tan (2015)
24	*Pandaka rouxi*	New record	Larson *et al.* (2016)
25	*Parachaeturichthys polynema*	New record	Larson *et al.* (2016)
26	*Parapercis lineopunctata*	New record	Toh & Lim (2015)
27	*Pegasus laternarius*	New record	Lim & Ong (2015)
28	*Pomacentrus moluccensis*	New record	Low (2013)

29	*Pseudolarimichthys terengganui*	New record	Lim & Tan (2018)
30	*Ptereleotris hanae*	New record	Jaafar & Ng (2012)
31	*Scarus ghobban*	New record	Low (2013)
32	*Scarus quoyi*	New record	Ng & Taira (2018)
33	*Scarus rivulatus*	New record	Low (2013)
34	*Scarus schlegeli*	New record	Taira (2018c)
35	*Sphaeramia nematoptera*	New record	Low (2013)
36	*Stethojulis interrupta*	New record	Taira (2018d)
37	*Thysanophrys celebicus*	New record	Koh & Lim (2015a)
38	*Trypauchen pelaeos*	New record	Larson *et al.* (2016)
39	*Trypauchenichthys sumatrensis*	New record	Larson *et al.* (2016)
40	*Trypauchenichthys typus*	New record	Larson *et al.* (2016)
41	*Yongeichthys virgatulus*	New record	Jaafar *et al.* (2012)
42	*Pterois volitans*	New record/ Introduced	Heng & Lim (2015)
43	*Chromis atripectoralis*	Rediscovery	Low (2018)
44	*Epibulus insidiator*	Rediscovery	Low (2015b)
45	*Epinephelus quoyanus*	Rediscovery	Tan (2017)
46	*Hemiarius sona*	Rediscovery	Ng (2012)
47	*Labroides dimidiatus*	Rediscovery	Toh, Low & Ng (2015)
48	*Macrotrema caligans*	Rediscovery	Tan *et al.* (2018)
49	*Ostracion rhinorhynchos*	Rediscovery	Sam (2018)
Baseline	572 species		Froese & Pauly (2014)

Insects and Arachnids

Lepidoptera (Butterflies)

S/N	Species Name	Status	Source
1	*Amathusia friderici holmanhunti*	New record	Jain *et al.* (2018)
2	*Appias indra plana*	New record	Khew (2014)
3	*Appias paulina distanti*	New record	Khew (2014)
4	*Arhopala alitaeus pardenas*	New record	Khew (2015)
5	*Arhopala muta maranda*	New record	Khew (2015)
6	*Arhopala sublustris ridleyi*	New record	Jain *et al.* (2018)
7	*Ariadne ariadne ariadne*	New record	Khew (2014)
8	*Caltoris malaya*	New record	Khew (2015)
9	*Cirrochroa emalea emalea*	New record	Khew (2014)
10	*Cirrochroa tyche rotundata*	New record	Khew (2015)
11	*Graphium bathycles bathycloides*	New record	Khew (2014)
12	*Graphium euryplus mecisteus*	New record	Khew (2014)
13	*Hyarotis microsticta*	New record	Jain *et al.* (2018)
14	*Ideopsis juventa sitah*	New record	Khew (2014)
15	*Mooreana trichoneura trichoneura*	New record	Khew (2014)
16	*Nacaduba kurava nemana*	New record	Khew (2015)
17	*Oriens paragola*	New record	Khew (2014)

18	*Papiliio helenus helenus*	New record	Khew (2014)
19	*Parthenos sylvia lilacinus*	New record	Jain *et al.* (2018)
20	*Polyura moori moori*	New record	Khew (2014)
21	*Potanthus ganda ganda*	New record	Jain *et al.* (2018)
22	*Prioneris philonome themana*	New record	Khew (2014)
23	*Prosotas aluta nanda*	New record	Khew (2014)
24	*Prosotas lutea sivoka*	New record	Khew (2014)
25	*Saletara panda distanti*	New record	Khew (2014)
26	*Salanoemia tavoyana*	New record	Khew (2014)
27	*Semanga superba deliciosa*	New record	Khew (2015)
28	*Symbrenthia hippoclus selangorana*	New record	Khew (2014)
29	*Telicota linna*	New record	Khew (2015)
30	*Tirumala limniace*	New record	Jain *et al.* (2018)
31	*Tirumala septentrionis septentrionis*	New record	Jain *et al.* (2018)
32	*Celaenorrhinus asmara asmara*	Rediscovery	Khew (2014)
33	*Cepora iudith malaya*	Rediscovery	Jain *et al.* (2018)
34	*Deudorix staudingeri*	Rediscovery	Jain *et al.* (2018)
35	*Pareronia valeria lutescens*	Rediscovery	Khew (2014)
36	*Pelopidas agna agna*	Rediscovery	Khew (2015)
37	*Potanthus trachala tytleri*	Rediscovery	Khew (2014)
38	*Troides amphrysus ruficollis*	Rediscovery	Khew (2014)
39	*Vagrans sinha sinha*	Rediscovery	Khew (2014)
40	*Zographetus ogygia ogygia*	Rediscovery	Jain *et al.* (2018)
	Gerosis phisara phisara	New record/Extinct*	Jain *et al.* (2018)
	Thaumantis noureddin noureddin	New record/Extinct*	Jain *et al.* (2018)
Baseline	295 species		Khew (2014)

*These species were not counted as additions to the final species count

Coleoptera (Beetles)

S/N	Species Name	Status	Source
1	*Aristobia approximator*	New Record	Foo (2017)
2	*Aulacochthebius asiaticus*	New Record	Jäch *et al.* (2013)
3	*Hydraena (Hydraenopsis) formula*	New Record	Jäch *et al.* (2013)
4	*Hydraena (Hydraenopsis) jacobsoni*	New Record	Jäch *et al.* (2013)
5	*Pachyteria dimidiata*	New Record	Yap (2017)
6	*Brachycoraebus aeneus*	New Species	Cheong (2016)
7	*Hydraena hendrichi*	New Species	Jäch *et al.* (2013)
8	*Hydraena michaelbalkei*	New Species	Jäch *et al.* (2013)
9	*Hydraena paulmoritz*	New Species	Jäch *et al.* (2013)
10	*Hydraena singaporensis*	New Species	Jäch *et al.* (2013)
11	*Hydraena yangae*	New Species	Jäch *et al.* (2013)
12	*Metasambus circularis*	New Species	Cheong (2016)
13	*Pseudaspidimerus palatus*	New Species	Huo *et al.* (2017)
14	*Catharsius molossus*	Rediscovery	Ong *et al.* (2013)
Baseline	Estimated 10, 000 species		Ng *et al.* (2011)

Diptera (Flies)

S/N	Species Name	Status	Source
1	*Chersodromia bulohensis*	New species	Grootaert & Shamshev (2012)
2	*Chersodromia glandula*	New species	Grootaert & Shamshev (2012)
3	*Chersodromia malaysiana*	New species	Grootaert & Shamshev (2012)
4	*Chersodromia sylvicola*	New species	Grootaert & Shamshev (2012)
5	*Crossopalpus temasek*	New species	Grootaert & Shamshev (2012)
6	*Drapetis bakau*	New species	Grootaert & Shamshev (2012)
7	*Drapetis hutan*	New species	Grootaert & Shamshev (2012)
8	*Drapetis laut*	New species	Grootaert & Shamshev (2012)
9	*Drapetis mandai*	New species	Grootaert & Shamshev (2012)
10	*Drapetis pantai*	New species	Grootaert & Shamshev (2012)
11	*Elaphropeza albicornis*	New species	Grootaert & Shamshev (2015)
12	*Elaphropeza bakau*	New species	Grootaert & Shamshev (2015)
13	*Elaphropeza chanae*	New species	Grootaert & Shamshev (2012)
14	*Elaphropeza chanoides*	New species	Grootaert & Shamshev (2015)
15	*Elaphropeza collini*	New species	Grootaert & Shamshev (2012)
16	*Elaphropeza gohae*	New species	Grootaert & Shamshev (2012)
17	*Elaphropeza kranjiensis*	New species	Grootaert & Shamshev (2012)
18	*Elaphropeza lowi*	New species	Grootaert & Shamshev (2012)
19	*Elaphropeza lowioides*	New species	Grootaert & Shamshev (2015)
20	*Elaphropeza melanuroides*	New species	Grootaert & Shamshev (2015)
21	*Elaphropeza obscura*	New species	Grootaert & Shamshev (2015)
22	*Elaphropeza pallida*	New species	Grootaert & Shamshev (2015)
23	*Elaphropeza semakau*	New species	Grootaert & Shamshev (2012)
24	*Elaphropeza shufenae*	New species	Grootaert & Shamshev (2012)
25	*Nanodromia hutan*	New species	Grootaert & Shamshev (2012)
26	*Nanodromia spinulosa*	New species	Grootaert & Shamshev (2012)
27	*Nepalomyia negrobovi*	New species	Grootaert (2013)
28	*Nepalomyia priapus*	New species	Grootaert (2013)
29	*Nepalomyia singaporenis*	New species	Grootaert (2013)
30	*Nepalomyia spinata*	New species	Grootaert (2013)
31	*Nepalomyia temasek*	New species	Grootaert (2013)
32	*Nepalomyia yangi*	New species	Grootaert (2013)
33	*Platypalpus singaporensis*	New species	Grootaert & Shamshev (2012)
34	*Pontodromia pantai*	New species	Grootaert & Shamshev (2012)
35	*Stilpon arcuatum*	New species	Grootaert & Shamshev (2012)
36	*Stilpon neesoonensis*	New species	Grootaert & Shamshev (2012)
37	*Stilpon nigripennis*	New species	Grootaert & Shamshev (2012)
38	*Stilpon singaporensis*	New species	Grootaert & Shamshev (2012)
39	*Stilpon ubinensis*	New species	Grootaert & Shamshev (2015)
40	*Stilpon weilingae*	New species	Grootaert & Shamshev (2012)
Baseline	Estimated 910 species		Ng *et al.* (2011)

Hymenoptera (Ants, bees, wasps etc.)

S/N	Species Name	Status	Source
1	*Megachile (Aethomegachile) nr. borneana*	New record	Ascher *et al.* (2016)
2	*Megachile (Aethomegachile)* sp. (*fusciventris* group)	New record	Ascher *et al.* (2016)
3	*Megachile (Alocanthedon) indonesica*	New record	Ascher *et al.* (2016)
4	*Megachile (Callomegachile) fulvipennis*	New record	Ascher *et al.* (2016)
5	*Megachile (Callomegachile) ornata*	New record	Ascher *et al.* (2016)
6	*Megachile (Callomegachile)* sp. (*biroi* group)	New record	Ascher *et al.* (2016)
7	*Megachile (Callomegachile)* sp. 1 (*nr. stulta*)	New record	Ascher *et al.* (2016)
8	*Megachile (Callomegachile) stulta*	New record	Ascher *et al.* (2016)
9	*Megachile (Callomegachile) tuberculata*	New record	Ascher *et al.* (2016)
10	*Megachile (Chelostomoda) moera*	New record	Ascher *et al.* (2016)
11	*Megachile (Eutricharaea)* sp. 1	New record	Ascher *et al.* (2016)
12	*Megachile (Paracella) tricincta*	New record	Ascher *et al.* (2016)
13	*Polistes tenebricosus*	New record	Lee, J. X. Q. (2013), pers. comm. 28 Oct
14	*Strumigenys eggersi*	New record/ Introduced	Wang & Yamane (2017)
15	*Eupetersia (Nesoeupetersia) singaporensis*	New species	Pauly (2012)
16	*Polistes (Polistella) tenebris*	New species	Nguyen *et al.* (2017)
	Polybioides raphigastra	Extinct	Lee, J. X. Q. (2013), pers. comm. 28 Oct
Baseline	Estimated 540 species		Ng *et al.* (2011)

Myriapoda (Milipedes, Centipedes etc.)

S/N	Species name	Status	Source
Baseline	55 species		Decker (2013)

Odonata (Dragonflies and Damselflies)

S/N	Species Name	Status	Source
1	*Acrogomphus malayanus*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
2	*Agriocnemis minima*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
3	*Amphicnemis bebar*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
4	*Anax panybeus*	New Record	Soh *et al.* (2018)
5	*Archibasis rebeccae*	New Record	Tang *et al.* (2010)
6	*Burmagomphus arthuri*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
7	*Coeliccia didyma*	New Record	Tang *et al.* (2010)
8	*Echo modesta*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb

9	*Indothemis carnatica*	New Record	Soh *et al.* (2019)
10	*Libellago lineata*	New Record	Tang *et al.* (2010)
11	*Macromia cincta*	New Record	Tang *et al.* (2010)
12	*Macromia cydippe*	New Record	Tang *et al.* (2010)
13	*Mortonagrion arthuri*	New Record	Tang *et al.* (2010)
14	*Oligoaeschna foliacea*	New Record	Tang *et al.* (2010)
15	*Prodasineura humeralis*	New Record	Ngiam *et al.* (2016)
16	*Rhyothemis fulgens*	New Record	Ngiam *et al.* (2016)
17	*Teinobasis cryptica*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
18	*Vestalis gracilis*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
19	*Zyxomma obtusum*	New Record	Ngiam, W. J. (2014), pers. comm. 6 Feb
20	*Dysphaea dimidiata*	Rediscovery	Ngiam *et al.* (2016)
21	*Libellago stigmatizans*	Rediscovery	Ngiam *et al.* (2016)
22	*Neurobasis chinensis*	Rediscovery	Ngiam *et al.* (2016)
23	*Orolestes wallacei*	Rediscovery	Ngiam *et al.* (2016)
Baseline revised to 124 species, as listed in Soh *et al.* (2019), already includes the 23 new records and rediscoveries found between 2010 and 2019			Soh *et al.* (2019)

Orthoptera (Grasshoppers, crickets, katydids etc.)

S/N	**Species Name**	**Status**	**Source**
1	*Gonista cf. bicolor*	New record	Tan & Wang (2012)
2	*Asiophlugis temasek*	New species	Gorochov & Tan (2011)
3	*Glenophisis singapura*	New species	Tan M. K. (2012a)
4	*Gryllotalpa nymphicus*	New species	Tan M. K. (2012b)
5	*Gryllotalpa wallace*	New species	Tan M. K. (2012b)
6	*Jambiliara selita*	New species	Ingrisch & Tan (2012)
7	*Lebinthus luae*	New species	Robillard & Tan (2013)
8	*Micrornebius kopisua*	New species	Tan & Ingrisch (2013)
9	*Nahlaksia bidadari*	New species	Ingrisch & Tan (2012)
10	*Ornebius insculpta*	New species	Tan & Ingrisch (2013)
11	*Ornebius tampines*	New species	Tan & Robillard (2012)
12	*Oxylakis singaporensis*	New species	Ingrisch & Tan (2012)
13	*Phaloria jerelynae*	New species	Gorochov & Tan (2012)
14	*Singapuriola separata*	New species	Gorochov & Tan (2012)
15	*Svistella chekjawa*	New species	Tan & Robillard (2012)
16	*Trellius neesoon*	New species	Gorochov & Tan (2012)
17	*Tremellia timah*	New species	Gorochov & Tan (2012)
18	*Cardiodactylus singapura*	New species	Robillard (2011)
19	*Varitrella (Cantotrealla) orion*	New species	Gorochov & Tan (2014)
20	*Asiophlugis thaumasia*	Rediscovery	Tan (2011)
Baseline revised to 245 species, as listed in Tan, M.K. (2015), and includes newly recorded species or species rediscovered before 2015.			Tan, M. K. (2015)

Arachnida (Spiders)

S/N	Species Name	Status	Source
1	*Argiope catenulata*	New record	Koh & Leong (2013)
2	*Calapnita phyllicolla*	New record	Huber (2011)
3	*Cosmophasis lami*	New record	Zabka & Waldock (2012)
4	*Eriovixia pseudocentrodes*	New record	Koh & Leong (2013)
5	*Fecenia ochracea*	New record	Tan *et al*., (2018)
6	*Fecenia protensa*	New record	Bayer (2011)
7	*Gamasomorpha insomnia*	New record	Eichenberger *et al.* (2012)
8	*Gamasomorpha squalens*	New record	Eichenberger *et al.* (2012)
9	*Hamataliwa incompta*	New record	Koh & Leong (2013)
10	*Heliconilla globularis*	New record	Dankittipakul *et al.* (2012)
11	*Hersilia deelemanae*	New record	Koh & Leong (2013)
12	*Hersilia sumatrana*	New record	Koh & Leong (2013)
13	*Heteropoda boiei*	New record	Koh & Leong (2013)
14	*Ischnothyreus peltifer*	New record	Platnick *et al.* (2012)
15	*Janula triangularis*	New record	Yoshida & Koh (2011)
16	*Lipocrea fusiformis*	New record	Koh & Leong (2013)
17	*Mallinella allorostrata*	New record	Dankittipakul *et al.* (2012)
18	*Miagrammopes oblongus*	New record	Koh & Leong (2013)
19	*Micropholcus fauroti*	New record	Huber (2011)
20	*Orsima ichneumon*	New record	Koh & Leong (2013)
21	*Pholcus kohi*	New record	Huber (2011)
22	*Prethopalpus pahang*	New record	Baehr *et al.* (2012)
23	*Prethopalpus schwendingeri*	New record	Baehr *et al.* (2012)
24	*Theridion zebrinum*	New record	Koh & Leong (2013)
25	*Uthina luzonica*	New record	Huber (2011)
26	*Workmania botuliformis*	New record	Dankittipakul *et al.* (2012)
27	*Ischnothyreus an*	New species	Tong *et al.* (2016)
28	*Ischnothyreus brunneus*	New species	Tong *et al.* (2016)
29	*Ischnothyreus dactylinus*	New species	Tong *et al.* (2016)
30	*Ischnothyreus poculu*	New species	Tong *et al.* (2016)
31	*Ischnothyreus tectorius*	New species	Tong *et al.* (2016)
32	*Telema fabata*	New species	Wang & Li (2010)
Baseline	399 species		Court, D. J. (2009), pers. comm. 6 Oct

Other Invertebrates

Crustacea

S/N	Species Name	Status	Source
1	*Alpheus ehlersii*	New record	Anker & de Grave (2016)
2	*Automate anacanthopus*	New record	Anker & de Grave (2016)
3	*Cardisoma carnifex*	New record	Tan, A. Y. H. & Tan (2016)
4	*Cirolana willeyi*	New record	Cai & Teo (2012)
5	*Heteropilumnus sasekumari*	New record	Lee & Ng (2012)
6	*Latreutes anoplonyx*	New record	Anker & de Grave (2016)
7	*Leptochela crosnieri*	New record	Anker & de Grave (2016)
8	*Lysmata lipkei*	New record	Anker & de Grave (2016)
9	*Notopus dorsipes*	New record	Low & Tan (2012)
10	*Ogyrides orientalis*	New record	Anker & de Grave (2016)
11	*Periclimenaeus arabicus*	New record	Anker & de Grave (2016)
12	*Periclimenaeus orontes*	New record	Anker & de Grave (2016)
13	*Philocheras pilosus*	New record	Anker & de Grave (2016)
14	*Podocerus cyrenensis*	New record	Niel *et al.* (2016)
15	*Pontonides loloata*	New record	Anker & de Grave (2016)
16	*Prionalpheus sulu*	New record	Anker & de Grave (2016)
17	*Salmoneus seticheles*	New record	Anker & de Grave (2016)
18	*Sphaeroma walkeri*	New record	Cai & Teo (2012)
19	*Thor marguitae*	New record	Anker & de Grave (2016)
20	*Thuylamea camelus*	New record	Anker & de Grave (2016)
21	*Leelumnus radium*	New species	Mendoza & Ng (2011)
22	*Synidotea poorei*	New species	Cai & Teo (2012)
23	*Tritodynamia yeoi*	New species	Naruse & Ng (2010)
24	*Harrovia longipes*	Rediscovery	Tan, H. H. (2012)
Baseline	over 1,000 species		Ng *et al.* (2011)

Mollusca

S/N	Species Name	Status	Source
1	*Aegires villosus*	New record	Ng & Toh (2016)
2	*Ascobulla fischeri*	New record	Jensen (2015)
3	*Babylonia spirata*	New record	Tan & Low (2013a)
4	*Berthellina delicata*	New record	Ong *et al.* (2017)
5	*Bulbaeolidia alba*	New record	Toh (2017a)
6	*Canarium erythrinum*	New record	Tan & Low (2017a)
7	*Coralliophila fearnleyi*	New record	Tan, Tan & Tan (2017)
8	*Dendrodoris guttata*	New record	Mendez & Ng (2018)
9	*Dermatobranchus fortunatus*	New record	Tan, C. H. (2015)
10	*Doridomorpha gardineri*	New record	Toh & Ong (2015)
11	*Doto greenamyeri*	New record	Kek & Toh (2017)
12	*Doto ussi*	New record	Toh (2017c)

13	*Elysia tomentosa*	New record	Jensen (2015)
14	*Emarginella incisura*	New record	Tan *et al.* (2016)
15	*Eubranchus ocellatus*	New record	Ang & Toh (2017)
16	*Falcidens sp.*	New record	Ang & Tan (2013)
17	*Favorinus tsuruganus*	New record	Tay (2018)
18	*Glossocardia obesa*	New record	Tan & Low (2013b)
19	*Hypselodoris tryoni*	New record	Toh (2016b)
20	*Indomodulus tectum*	New record	Tan *et al.* (2016)
21	*Kaloplocamus acutus*	New record	Lee *et al.* (2018)
22	*Leucotina casta*	New record	Tan & Low (2017b)
23	*Limulatys okamotoi*	New record	Toh & Tan (2015a)
24	*Lobiger viridis*	New record	Jensen & Ong (2015)
25	*Mitrella essingtonensis*	New record	Tan, Tan, & Iesa (2017)
26	*Monotygma amoena*	New record	Tan & Low (2017b)
27	*Nassarius acuticostus*	New record	Ng & Chan (2017)
28	*Odontoglaja mosaica*	New record	Toh (2016a)
29	*Placida cremoniana*	New record	Toh (2016c)
30	*Pleurobranchus weberi*	New record	Toh (2018)
31	*Polycera risbeci*	New record	Lu (2018)
32	*Pomacea maculata*	New record	Ng *et al.* (2014)
33	*Sagaminopteron nigropunctatum*	New record	Lee & Ang (2018)
34	*Sakuraeolis kirembosa*	New record	Toh (2016e)
35	*Smaragdia souverbiana*	New record	Tan, Toh & Tan (2017)
36	*Solenogastres sp.*	New record	Ang & Tan (2013)
37	*Tenguella ceylonica*	New record	Ng & Chan (2017)
38	*Tenguella granulata*	New record	Ng & Chan (2017)
39	*Trapania caerulea*	New record	Toh (2016d)
40	*Trapania gibbera*	New record	Toh (2017b)
41	*Triplostephanus triseriatus*	New record	Toh, Tan & Low (2015)
42	*Volvatella ventricosa*	New record	Jensen (2015)
43	*Amphidromus atricallosus temasek*	New species	Tan, S. K. *et al.* (2011)
44	*Berthelinia singaporensis*	New species	Jensen (2015)
45	*Kerryclarkella inconspicua*	New species	Jensen (2015)
46	*Volvatella maculata*	New Speces	Jensen (2015)
47	*Atys naucum*	Rediscovery	Toh & Tan (2015b)
48	*Conus caracteristicus*	Rediscovery	Koh (2018)
49	*Murex ternispina*	Rediscovery	Tan *et al.* (2016)
50	*Oxymeris maculata*	Rediscovery	Tan, Toh, Tan & Low (2017)
51	*Pisania ignea*	Rediscovery	Tan & Tan (2016)
52	*Verpa penis*	Rediscovery	Tan, Tan & Low (2011)
	Hippopus hippopus	Extinct	Neo & Todd (2012)
Baseline	1284 species		Tan & Woo (2010), Wong (2011)

Octocorallia (Soft Corals + Gorgonians)

S/N	Species name	Status	Source
1	*Briareum excavatum*	New record	Benayahu & Chou (2010)
2	*Cladiella hartogi*	New species	Benayahu & Chou (2010)
3	*Cladiella pachyclados*	New record	Benayahu & Chou (2010)
4	*Heliopora coerulea*	New record	Benayahu & Chou (2010)
5	*Lobophytum crassum*	New record	Benayahu & Chou (2010)
6	*Lobophytum pauciflorum*	New record	Benayahu & Chou (2010)
7	*Lobophytum sarcophytoides*	New record	Benayahu & Chou (2010)
8	*Sansibia flava*	New record	Benayahu & Chou (2010)
9	*Sarcophyton crassocaule*	New record	Benayahu & Chou (2010)
10	*Sarcophyton ehrenbergi*	New record	Benayahu & Chou (2010)
11	*Sarcophyton glaucum*	New record	Benayahu & Chou (2010)
12	*Sarcophyton tenuispiculatum*	New record	Benayahu & Chou (2010)
13	*Sarcophyton trocheliophorum*	New record	Benayahu & Chou (2010)
14	*Sinularia abrupta*	New record	Benayahu & Chou (2010)
15	*Sinularia acuta*	New record	Benayahu & van Ofwegen (2011)
16	*Sinularia brassica*	New record	Benayahu & Chou (2010)
17	*Sinularia capillosa*	New record	Benayahu & Chou (2010)
18	*Sinularia choui*	New species	Benayahu & van Ofwegen (2011)
19	*Sinularia compressa*	New record	Benayahu & Chou (2010)
20	*Sinularia depressa*	New record	Benayahu & Chou (2010)
21	*Sinularia erecta*	New record	Benayahu & Chou (2010)
22	*Sinularia exilis*	New record	Benayahu & Chou (2010)
23	*Sinularia gibberosa*	New record	Benayahu & Chou (2010)
24	*Sinularia hirta*	New record	Benayahu & Chou (2010)
25	*Sinularia lochmodes*	New record	Benayahu & Chou (2010)
26	*Sinularia maxima*	New record	Benayahu & van Ofwegen (2011)
27	*Sinularia microclavata*	New record	Benayahu & Chou (2010)
28	*Sinularia molesta*	New record	Benayahu & van Ofwegen (2011)
29	*Sinularia polydactyla*	New record	Benayahu & van Ofwegen (2011)
30	*Sinularia triangula*	New record	Benayahu & Chou (2010)
31	*Sinularia verseveldti*	New record	Benayahu & van Ofwegen (2011)
32	*Studeriotes spinosa*	New record	Benayahu & Chou (2010)
Baseline	31 species		Goh & Chou (1996)

Hard Corals

S/N	Species name	Status	Source
Baseline	255 species		Huang *et al.* (2009)

Ascidiacea (Sea squirts)

S/N	Species Name	Status	Source
1	*Ascidia gemmata*	New record	Lee *et al.* (2013)
2	*Didemnum psammatodes*	New record	Lee & Chan *et al.* (2016
3	*Distaplia mikropnoa*	New record	Lee & Chan *et al.* (2016
4	*Ecteinascidia nexa*	New record	Lee & Chan *et al.* (2016
5	*Ecteinascidia thurstoni*	New record	Lee & Chan *et al.* (2016
6	*Eudistoma amplum*	New record	Lee & Chan *et al.* (2016
7	*Eudistoma laysani*	New record	Lee & Chan *et al.* (2016
8	*Eudistoma reginum*	New record	Lee & Chan *et al.* (2016
9	*Eusynstyela hartmeyeri*	New record	Lee & Chan *et al.* (2016
10	*Herdmania pallida*	New record	Lee *et al.* (2013)
11	*Lissoclinum timorense*	New record	Su *et al.* (2013)
12	*Perophora modificata*	New record	Lee & Chan *et al.* (2016
13	*Perophora namei*	New record	Lee & Chan *et al.* (2016
14	*Phallusia arabica*	New record	Lee *et al.* (2013)
15	*Phallusia nigra*	New record	Lee *et al.* (2013)
16	*Polycarpa argentata*	New record	Lee *et al.* (2013)
17	*Polycarpa aurita*	New record	Lee *et al.* (2013)
18	*Polycarpa captiosa*	New record	Lee *et al.* (2013)
19	*Polycarpa olitoria*	New record	Lee *et al.* (2013)
20	*Pseudodistoma fragile*	New record	Lee & Chan *et al.* (2016
21	*Pyura curvigona*	New record	Lee *et al.* (2013)
22	*Rhodosoma turcicum*	New record	Lee *et al.* (2013)
23	*Rhopalaea crassa*	New record	Lee *et al.* (2013)
24	*Rhopalaea macrothorax*	New record	Lee & Chan *et al.* (2016
25	*Styela canopus*	New record	Lee *et al.* (2013)
26	*Symplegma brakenhielmi*	New record	Lee & Chan *et al.* (2016
27	*Tridemnum cyclops*	New record	Su *et al.* (2013)
Baseline	18 species		Ng *et al.* (2011)

Porifera (Sponges)

S/N	Species Name	Status	Source
1	*Eunapius conifer*	New record	Lim & Tan (2013)
2	*Forcepia (Forcepia)vansoesti*	New species	Lim *et al.* (2012a)
3	*Theonella laena*	New species	Lim & Tan (2016)
4	*Cliona patera*	Rediscovery	Lim, Tun & Goh (2012)
Baseline	225 species		Lim, de Voogd & Tan (2008, 2009, 2012), de Voogd & Cleary (2009)

Echinodermata

S/N	Species Name	Status	Source
1	*Cenometra bella*	New record	Tay (2015)
2	*Hemithyone semperi*	New record	Ong *et al.* (2016)
3	*Holothuria (Lessonothuria) pardalis*	New record	Ong *et al.* (2016)
4	*Holothuria (Metriatyla) martensi*	New record	Ong *et al.* (2016)
5	*Holothuria (Platyperona) crosnieri*	New record	Ong *et al.* (2016)
6	*Holothuria (Stauropora) fuscocinerea*	New record	Teo *et al.* (2010)
7	*Mespilia globulus*	New record/ Introduced	Low (2015a)
8	*Ophioconis permixta*	New record	Fujita (2016)
9	*Ophiodyscrita instrata*	New record	Fujita (2016)
10	*Paracaudina chilensis*	New record	Ong *et al.* (2016)
11	*Phyllophorella kohkutiensis*	New record	Ong *et al.* (2016)
12	*Protankyra bidentata*	New record	Ong *et al.* (2016)
13	*Synaptula minima*	New record	Ong *et al.* (2016)
14	*Toxopnesustes pileolus*	New record	Thean & Toh (2016)
Baseline	Estimated 120 species		Ng *et al.* (2011)

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