The Nature Conservation Masterplan

NATIONAL PARKS
LET'S MAKE SINGAPORE OUR CITY IN NATURE

The Nature Conservation Masterplan
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1 AN INTRODUCTION TO THE NATURE CONSERVATION MASTERPLAN

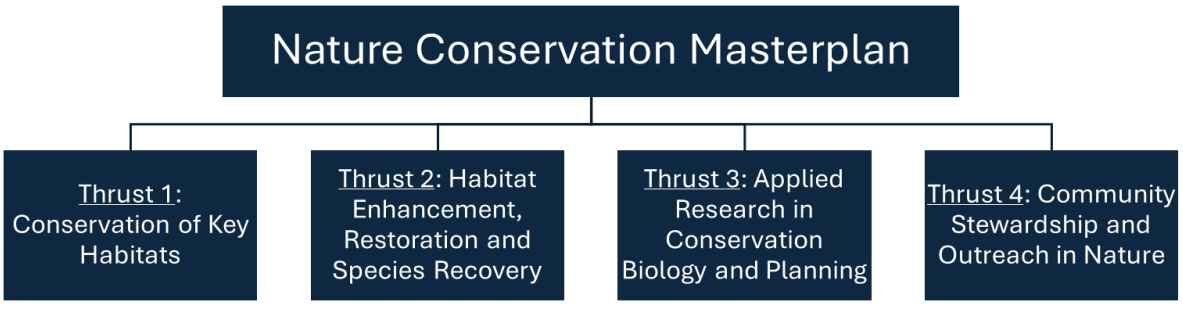
Introduction

Singapore is a small and highly urbanised island city-state with no hinterland and with one of the highest population densities in the world. Despite competing demands on the limited land and sea spaces, it is home to a rich variety of flora and fauna, with more than 2,000 native extant plant species, over 400 bird species, a third of the world's hard corals at over 250 species and 300 butterfly species, among others, recorded locally.

This biodiverse urban landscape reflects decades of sustained and deliberate greening efforts. Singapore's greening journey began in 1963 when the then-Prime Minister Mr Lee Kuan Yew planted a Mempat tree (*Cratoxylum formosum*) at Farrer Circus. While early efforts focused primarily on transforming Singapore into a city with abundant greenery and a clean environment, biodiversity conservation has since become a central pillar of Singapore's development approach, particularly from the late 2000s under the City in a Garden vision and further intensified under the City in Nature vision introduced in 2020.

As a Party to the Convention on Biological Diversity, Singapore launched the National Biodiversity Strategy and Action Plan (NBSAP) in September 2009, reaffirming Singapore's commitment to biodiversity conservation. Building on this, the Nature Conservation Masterplan (NCMP) was introduced in 2015 to provide a coordinated framework to guide biodiversity conservation efforts in Singapore over a five-year period.

Overview of the Original NCMP



The original NCMP comprised four thrusts:

1. Conservation of Key Habitats

This thrust focused on safeguarding Singapore's core biodiversity areas, including the four nature reserves – Bukit Timah Nature Reserve, Central Catchment Nature Reserve, Sungei Buloh Wetland Reserve, and Labrador Nature Reserve. Recognising the pressures of urbanisation, efforts were also directed at strengthening ecological resilience by securing and enhancing buffer areas around these reserves, including through the development of nature parks.

2. Habitat Enhancement, Restoration and Species Recovery
This thrust addressed both ecosystem-level and species-specific conservation needs. Habitat enhancement and restoration efforts aim to improve the habitat quality across our core biodiversity areas, buffers and other urban green spaces. In parallel, species recovery initiatives focus on targeted interventions to stabilise or increase populations of threatened species.

3. Applied Research in Conservation Biology and Planning
This thrust highlights the role of scientific research and data in supporting biodiversity conservation and informing land-use planning. Research efforts contributed to policy formulation, ecological modelling, and biodiversity monitoring.

4. Community Stewardship and Outreach in Nature
This thrust focuses on engaging the public through the Community in Nature (CIN) initiative, launched in 2011. It aims to foster greater public awareness, appreciation, and stewardship of Singapore's natural heritage through biodiversity-related events, activities and programmes organised by NParks and other nature interest groups or stakeholders.

Key Milestones in Singapore's Biodiversity Conservation Scene Since 2015

Since the launch of the original NCMP in 2015, biodiversity conservation in Singapore has gained increased prominence, supported by stronger community and stakeholder participation and collaboration in various NParks-led conservation and natural heritage activities and initiatives.

In April 2016, the **Friends of the Parks** initiative was launched as a ground-up initiative to promote stewardship and responsible use of parks and nature reserves. More details on this initiative can be found under Thrust 5.

In 2019, animal health, welfare and management functions from the former Agri-Food and Veterinary Authority of Singapore (AVA) were transferred to the newly formed **Animal & Veterinary Service (AVS),** a cluster of NParks. This strengthened coordination in addressing human-animal interactions and animal health matters.

In March 2020, NParks introduced the **City in Nature** vision to guide Singapore's progression as a greener, more livable and sustainable city for Singaporeans. To achieve this vision, five key strategies were identified:

1. Grow nature park networks – Our four nature reserves safeguard Singapore's key ecosystems and the ecosystem services they provide. To buffer these nature reserves from the impact of urbanisation and create complementary habitats, nature parks were established around them. Nature Park Networks connect these nature parks together to protect the nature reserves against edge effects and the impact of adjacent developments.

2. Naturalise gardens and parks – To bring nature closer to people, NParks is intensifying nature in our new and existing gardens and parks through habitat restoration and species recovery efforts which have enabled once-

rare species such as the Tiger Orchid (*Grammatophyllum speciosum*) and Oriental Pied Hornbill (*Anthracoceros albirostris*) to become regular features in our gardens and parks.

NParks is intensifying nature in both new and existing parks and gardens such as at Villa Verde Park (pictured) through habitat enhancement initiatives.

3. Restore nature in urban areas – Bringing nature closer to urban areas helps cool our surroundings, improve air quality, and provide therapeutic effects that a greener living environment provides. Our industrial estates have also been undergoing intensive greening efforts to bring the benefits of nature into our grey infrastructure.

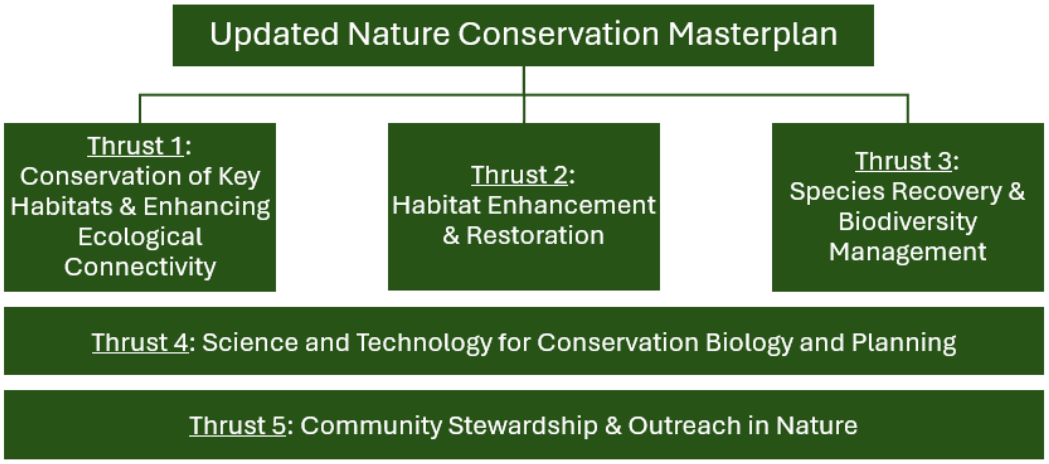
4. Connect green spaces – Purposeful planning allows the creation of ecological corridors that link nature reserves and nature parks to heartland gardens and public parks. These networks of ecological corridors help to connect people and nature.

5. Enhance veterinary care and animal management – Community animals play a vital role as our companions, and wildlife enriches the biodiversity of our urban ecosystem. Taking a one-health approach in veterinary care and animal management allows us to connect public health and well-being with that of animals in our community and ensuring a holistic approach in safeguarding public health.

In 2021, NParks initiated an island-wide **Ecological Profiling Exercise (EPE)** as part of Singapore's Long-Term Plan Review., This study supports a more comprehensive understanding of habitat distribution and ecological connectivity across the island using ecological models to predict wildlife movement. More details on the EPE can be found under Thrust 4.

Overview of the Updated NCMP

The updated NCMP reflects NParks' evolving priorities and expanded functions since 2015. It comprises five thrusts, including two cross-cutting horizontal thrusts:



1. Conservation of Key Habitats and Enhancing Ecological Connectivity
This thrust has been revised to reflect the increasing importance of enhancing connectivity among our key habitats to ensure their long-term resilience.

2. Habitat Enhancement and Restoration
This thrust has been revised to distinguish between initiatives that improve the state of entire ecosystems and more species-specific initiatives, which are now under a separate thrust.

3. Species Recovery and Biodiversity Management
This thrust has been revised to focus on species-specific initiatives. These initiatives range from the development of management strategies to ensure the long-term survival of threatened species to promotion of urban wildlife adaptation through monitoring and conflict management strategies.

4. Science and Technology for Conservation Biology and Planning
This thrust is now reflected as a horizontal thrust to acknowledge the key role of science and technology in supporting Singapore's biodiversity conservation efforts across all thrusts.

5. Community Stewardship and Outreach in Nature
This thrust is also reflected as a horizontal thrust to acknowledge the pivotal role Singapore's nature community and various stakeholders play in supporting our biodiversity conservation efforts across all thrusts.

2 THE NATURE CONSERVATION MASTERPLAN'S THRUSTS

Thrust 1 – Conservation of Key Habitats and Enhancing Connectivity

Singapore is a city-state with limited land and many competing development needs. Over the past two centuries, much of our original vegetation comprising primary rainforest, mangroves and freshwater swamps have been cleared as the country developed.

Despite these constraints, important pockets of biodiversity-rich habitats remain. These habitats, particularly within nature reserves and other key green and blue spaces, continue to support native species and ecological processes. Conserving these areas and strengthening connectivity between them is therefore essential to minimising the impact of habitat fragmentation and maintaining ecological resilience. Addressing this requires not only protecting core biodiversity areas but also enhancing ecological connectivity across the broader landscape.

Within Singapore's land constraints, this necessitates a carefully balanced approach that integrates biodiversity considerations upfront into land-use planning. The focus of this thrust is therefore to safeguard and strengthen our core biodiversity areas and complementary habitats, and to maintain and enhance ecological connectivity between them.

The Science of Habitat Conservation and Enhancing Connectivity

Singapore's core biodiversity areas – including its nature reserves – represent key refugia for a large proportion of the country's native biodiversity. These areas encompass a range of terrestrial and marine ecosystems and play an essential role in sustaining ecological processes.

Habitats that are separated by urban infrastructure are vulnerable to the effects of fragmentation. Habitat loss reduces the number of individuals that can be supported within a given area, while fragmentation further compounds this by restricting movement between habitat patches. This limits genetic exchange, increases vulnerability to environmental changes, and elevated mortality risks, for example through traffic accidents.

Fragmentation also increases the proportion of habitat edges, exposing ecosystems to altered conditions such as elevated temperatures and reduced moisture. These edge effects can further reduce habitat suitability for more sensitive species. Over time, isolated sub-populations within fragmented landscape patches face increased risks of inbreeding and local extinction.

Ecological connectivity refers to the "unimpeded movement of species and the flow of natural processes that sustain life on Earth" (Convention on Conservation

of Migratory Species of Wild Animals). It enables critical ecological functions such as pollination, seed dispersal and gene flow, while mitigating the negative impacts of habitat fragmentation.

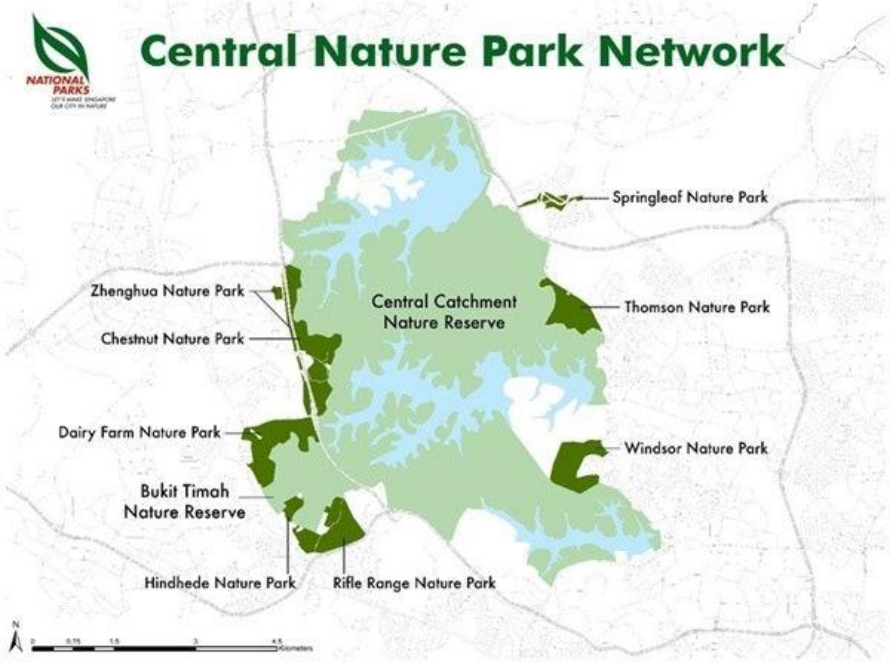
In Singapore's context, enhancing connectivity is thus a key component of maintaining long-term ecological resilience. At the same time, such efforts must be carefully integrated into a highly developed landscape, requiring coordination across planning, design, and conservation domains to balance development needs with nature conservation in land-use planning.

Strategies and Initiatives

Conservation of Key Habitats

The conservation of core biodiversity areas remains a foundational priority. Singapore's nature reserves safeguard a range of habitats including primary and secondary rainforests, freshwater streams and swamps, coastal forests and mangroves. These areas serve as strongholds for various endemic and threatened species. To reduce the impacts of surrounding urbanisation, buffer areas are established around them as nature parks. These parks provide complementary habitats for native flora and fauna that extend the ecological function beyond the reserves while offering alternative spaces for nature-based recreation. This helps to alleviate visitor pressure on more sensitive habitats within the nature reserves. Nature Park Networks further strengthen this approach by linking nature parks with nearby nature reserves, thereby forming larger, ecologically interdependent landscapes. To date, NParks has announced three Nature Park Networks:

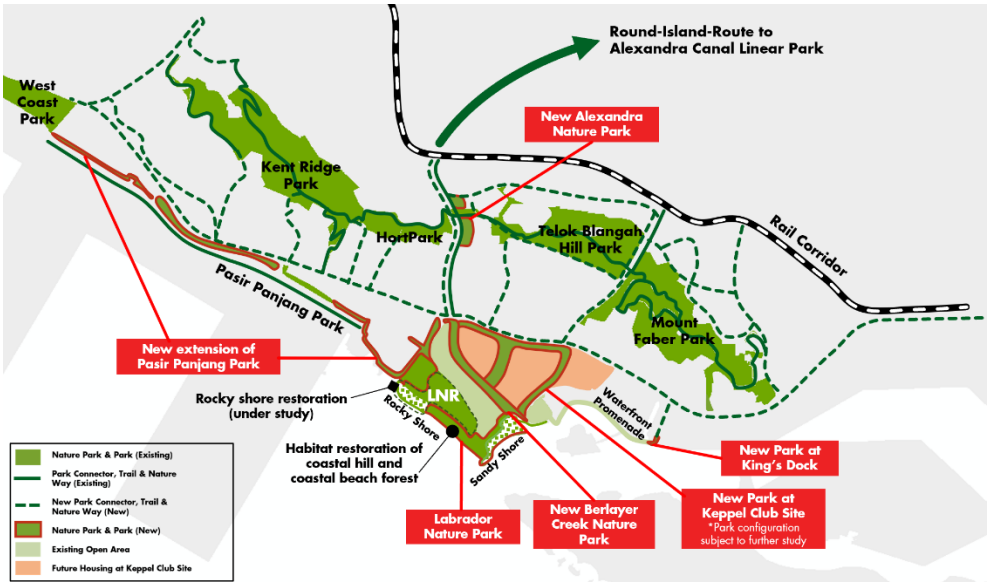
1. **Central Nature Park Network**, which supports ecological connectivity between Bukit Timah Nature Reserve and the Central Catchment Nature Reserve, while extending habitat linkages across central Singapore.



The Central Nature Park Network extends habitat linkages across central Singapore.

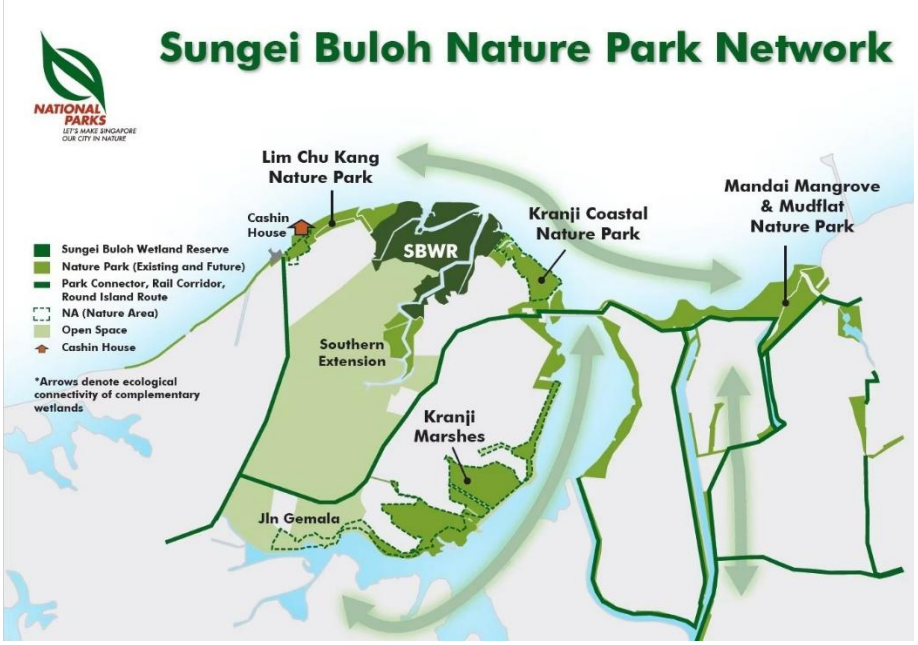
2. **Labrador Nature Park Network**, which integrates Labrador Nature Reserve with the Southern Ridges and other surrounding green spaces,

was developed based on the ecological profile of the area.



The Labrador Nature Park Network integrates Labrador Nature Reserve with the Southern Ridges and surrounding green spaces.

3. **Sungei Buloh Nature Park Network**, which buffers the Sungei Buloh Wetland Reserve with extensions to the east, west and south of the Reserve, as well as to Kranji Marshes, and the upcoming Mandai Mangrove and Mudflat Nature Park. Collectively, these complementary wetland habitats strengthen wetland conservation in northwestern Singapore.



The Sungei Buloh Nature Park Network buffers Sungei Buloh Wetland Reserve and strengthens the conservation of wetland biodiversity in Singapore.

Collectively, these Nature Park Networks enhance the resilience of key habitats while optimising limited land.

Enhancing Ecological Connectivity

To further strengthen the long-term resilience of our nature reserves and improve

connectivity between fragmented habitats, NParks has undertaken various initiatives to enhance ecological connectivity between these areas. Through the Ecological Profiling Exercise, NParks has identified ecological corridors around Bukit Batok, Clementi, Khatib, Kranji, Lim Chu Kang and Seletar. These corridors facilitate the movement of species between core habitats and complementary green spaces, enabling ecological processes to function across a wider landscape. To date, NParks has announced five nature corridors:

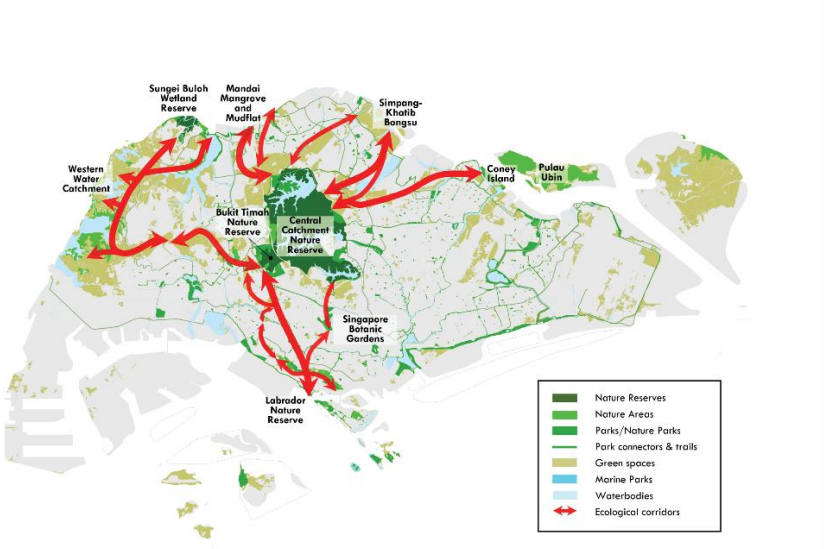
1. **Bukit Batok Nature Corridor**, which connects Bukit Timah Nature Reserve to forested areas within Tengah Town through a network of existing and new parks at Bukit Batok Hillside Nature Park and Bukit Batok Central Nature Park, trails that will serve as ecological connectors, Nature Ways and park connectors.

2. **Clementi Nature Corridor**, which comprises forested sites at Clementi, Toh Tuck, Maju and the Rail Corridor. It enhances the ecological connectivity between Bukit Timah Nature Reserve and the Southern Ridges.

3. **Khatib Nature Corridor**, which connects the Central Catchment Nature Reserve to the upcoming Khatib Bongsu Nature Park. It comprises a series of upcoming green spaces including Khatib Bongsu Nature Park, an extension to Springleaf Nature Park, Miltonia Nature Park, and an extension of Lower Seletar Reservoir Park.

4. **Kranji Nature Corridor**, which connects the Central Catchment Nature Reserve and the upcoming Mandai Mangrove and Mudflat Nature Park, with planned parks along Sungei Mandai, Sungei Pang Sua and Kranji Reservoir.

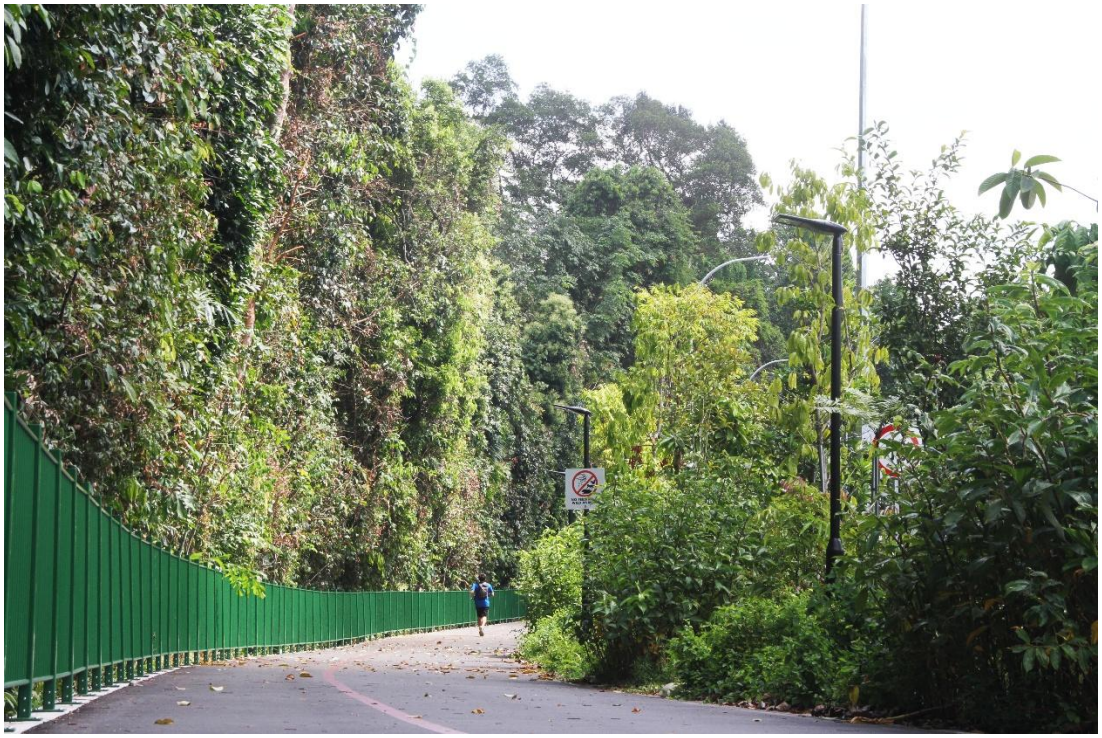
5. **Lornie Nature Corridor**, which buffers Central Catchment Nature Reserve by restoring forest edges and repurposing the old Lornie Road for greenery and recreation.



A map showing the ecological corridors identified through the Ecological Profiling Exercise.

Another key strategy is the Nature Ways initiative, which complement the larger-scale nature corridors by introducing ecological connectivity within urban areas. By embedding biodiversity-supporting features into streetscapes

and urban infrastructure, Nature ways extend ecological connectivity into the built environment, helping to bridge gaps between larger habitat patches. Nature ways are routes planted with specific trees and shrubs that replicate a multi-tiered vegetation structure that mimic natural habitats, incorporating native plants that support a range of local biodiversity, such as flowering plants for pollinators, fruit-bearing trees for birds and mammals, and host plants for butterflies.



Nature ways like Lornie Nature Way(pictured) provide habitats for birds and butterflies and support ecological connectivity.

Physical barriers such as roads can significantly disrupt wildlife movement. To address this, NParks has implemented a range of measures to facilitate safe crossings and reduce human-wildlife conflict. These include localised wildlife crossing structures such as rope bridges and culverts, which enable arboreal and terrestrial animals to move across fragmented landscapes without direct interaction with humans and traffic. This reduces the risk of human-wildlife conflict and traffic accidents. For example, rope bridges installed along Old Upper Thomson Road have improved connectivity for the Critically Endangered Raffles' Banded Langur (*Presbytis femoralis*) and other arboreal animals. Complementary measures, including road narrowing and reduced speed limits, further reduce risks to wildlife. This is augmented by the Roadway Animal Detection System (RADS) which uses sensors and video analytics to detect animal movement and alert motorists in real time. More details on RADS can be found under Thrust 4.

A larger-scale example that facilitates wildlife movement is the Eco-Link@BKE. Built in 2012, this 50-metre-wide bridge reconnects Bukit Timah Nature Reserve and Central Catchment Nature Reserve which were previously separated by the Bukit Timah Expressway. The bridge has since enabled species like the nationally threatened Lesser Mousedeer (*Tragulus kanchil*) and Sunda Pangolin (*Manis javanica*) to move safely between the two nature reserves, supporting genetic exchange and population resilience.

The Eco-Link@BKE connects the Bukit Timah Nature Reserve with the Central Catchment Nature Reserve.

Efforts to conserve habitats and enhance connectivity also extend to Singapore's coastal and marine environments. Established in 2014, the 40-hectare Sisters' Island Marine Park is Singapore's first marine park and protects a range of marine habitats including coral reefs, seagrass beds, and sandy shores. Building on scientific studies, including the marine Ecological Profiling Exercise, additional areas around Lazarus Island and Kusu Island have been identified for conservation due to their role in supporting larval dispersal and habitat connectivity. The designation of a second marine park in this area reflects a broader strategy to manage marine and coastal habitats as interconnected systems. By recognising and strengthening ecological linkages, these efforts support the long-term resilience of marine biodiversity within Singapore's coastal waters.

Thrust 2 – Habitat Enhancement and Restoration

Singapore's transformation into a City in Nature reflects a deliberate effort to integrate ecological function within a highly urbanised environment. Central to this is the enhancement and restoration of habitats across both natural and urban landscapes, reflecting Singapore's commitment to nature conservation and environmental sustainability.

Much of Singapore's remaining natural habitat – including the nature reserves and nature parks – continue to recover from past disturbance. These landscapes do not fully reflect their original ecological condition and therefore require active intervention to improve habitat quality and support a wider range of biodiversity. At the same time, Singapore's extensive network of urban green spaces presents opportunities to extend habitat function beyond traditionally protected areas. By enhancing these spaces, biodiversity can be supported more broadly across the island, complementing conservation efforts within core habitats. Within a land-scarce context, habitat enhancement and restoration form part of a broader strategy to optimise ecological value across the entire landscape.

This thrust delves into the main principles, strategies, and implementation of habitat enhancement efforts across Singapore's diverse ecosystems. These efforts are guided by science, taking an adaptive management approach.

The Science of Habitat Enhancement and Restoration

Habitat enhancement and restoration efforts in Singapore are guided by science-based principles and an adaptive management approach. As outlined in the 'Handbook on Habitat Restoration: General Principles and Case Studies in Singapore' (Chan *et al.*, 2023), these efforts follow a continuous cycle of planning, implementation, monitoring and refinement to improve habitat enhancement strategies. Singapore's approach is anchored in six key concepts, drawing from the *International Standards for Practice of Ecological Restoration* (McDonald *et al.*, 2016), and adapted to local conditions. These principles serve as the basis of Singapore's approach to habitat restoration and enhancement:

1. Restoration is based on an appropriate local native reference ecosystem, while accounting for environmental change.

2. Long-term goals and short-term objectives are guided by clear ecological targets defined by identifying key attributes of the desired ecosystems.

3. Natural recovery processes are assisted wherever possible, with interventions applied where necessary.

4. Restoration is undertaken as a long-term, progressive, and adaptive process.

5. Multiple sources of knowledge, including scientific and local expertise, are incorporated.

6. Early and sustained stakeholder engagement is recognised as critical to long-term success.

Central to these principles is the recognition that habitat enhancement and restoration is not about recreating a static historical snapshot. Instead, it focuses on guiding ecosystems towards functional and resilient conditions that can respond to ongoing environmental change. In Singapore's context, this requires a forward-looking approach that balances ecological objectives with the realities of urban development and land-use constraints.

Strategies and Initiatives

Singapore's contemporary native-dominated forests are primarily found within nature reserves, nature parks and the Singapore Botanic Gardens and strengthening the resilience of these forests is a key priority. The Forest Restoration Action Plan (FRAP), introduced in 2019, provides a structured framework for restoring forest ecosystems. It focuses on enhancing biodiversity, strengthening ecological processes, and improving connectivity between forest patches. Three main restoration approaches are applied, depending on site

conditions and restoration goals:

1. **Assisted Natural Regeneration** – This supports the natural recovery of forests by removing barriers to regeneration. It is typically applied in areas adjacent to existing mature forests, where natural seed sources are available. Interventions include the removal of invasive or weedy non-native plant species that compete with native vegetation. An example of how natural regeneration can be assisted is the Invasive Species Management (ISM) programme which removes introduced and weedy plant species such as *Dioscorea sansibarensis* in nature parks and nature reserves, allowing native plants to re-establish and natural ecological processes to resume.

2. **Framework Species Method** – This method involves planting a selected group of native tree species that perform complementary ecological roles. e.g., fast-growing pioneers that quickly establish canopy cover and suppress invasive plants, as well as species that provide food resources to attract wildlife. By drawing in seed-dispersing animals, this approach accelerates natural forest regeneration while reducing the need for further intervention.

3. **Maximum Diversity Method** – This approach aims to replicate the species richness and composition of mature forests at the point of planting. It is typically applied in more isolated sites where natural seed dispersal is limited. As such, it requires more intensive intervention, including soil preparation, planting of a wide range of species, and ongoing maintenance such as weeding and mulching. While resource-intensive, this method enables the establishment of ecologically complex habitats in areas where natural recovery would otherwise be slow or constrained.

Volunteers showcase their haul after a successful ISM event.

In line with the City in Nature vision, habitat enhancement efforts are also increasingly integrated into the Singapore's urban environment. Urban spaces

such as streetscapes, park connectors and skyrise greenery are designed to support biodiversity with the use of native plant species and habitat features. Butterfly trails, for example, incorporate host and nectar plants to attract and sustain butterfly populations. Complementing this, the Park Connector Network serves as green ecological corridors, linking parks and natural areas across the island, facilitating both human recreation and wildlife movement. The skyrise greenery initiatives, including rooftop gardens and vertical planting, further extend habitat opportunities within the built environment. These interventions contribute to urban biodiversity while also enhancing livability and environmental quality. By embedding ecological considerations into urban design, Singapore can maximise habitat value across a highly developed landscape.

Habitat enhancement efforts extend to Singapore's coastal and marine ecosystems as well. The restoration of mangroves, seagrass beds, and coral reefs is crucial for enhancing biodiversity, protecting coastlines, and ensuring the long-term health of Singapore's marine environment. Mangrove restoration projects, such as the successful initiative in Pulau Ubin, demonstrate the effectiveness of assisted natural regeneration. By removing invasive vegetation and restoring natural hydrological conditions, mangrove ecosystems have been able to recover with minimal intervention. Seagrass and coral restoration efforts are also underway, although these present additional challenges due to the complexity of marine ecosystems. The 100k Corals Initiative aims to plant 100,000 corals over a decade to enhance coral reef cover and resilience throughout Singapore's waters. This is the most extensive coral restoration effort in Singapore to date. Similarly, the OCBC Seagrass Restoration programme, led by NParks and researchers from the National University of Singapore, focuses on improving the understanding of seagrass reproduction and developing effective restoration techniques. These efforts contribute to strengthening marine ecosystems while supporting broader coastal resilience.

Adding coral fragments to existing artificial structures under the 100k Corals Initiative provides additional areas for coral reefs to develop.

Thrust 3 – Species Recovery and Biodiversity Management

This thrust focuses on species-specific conservation efforts and the management of biodiversity within a highly urbanised environment. It addresses two key groups, namely (1) endemic and/or threatened native species and (2) urban-adapted wildlife which increasingly interact with human populations.

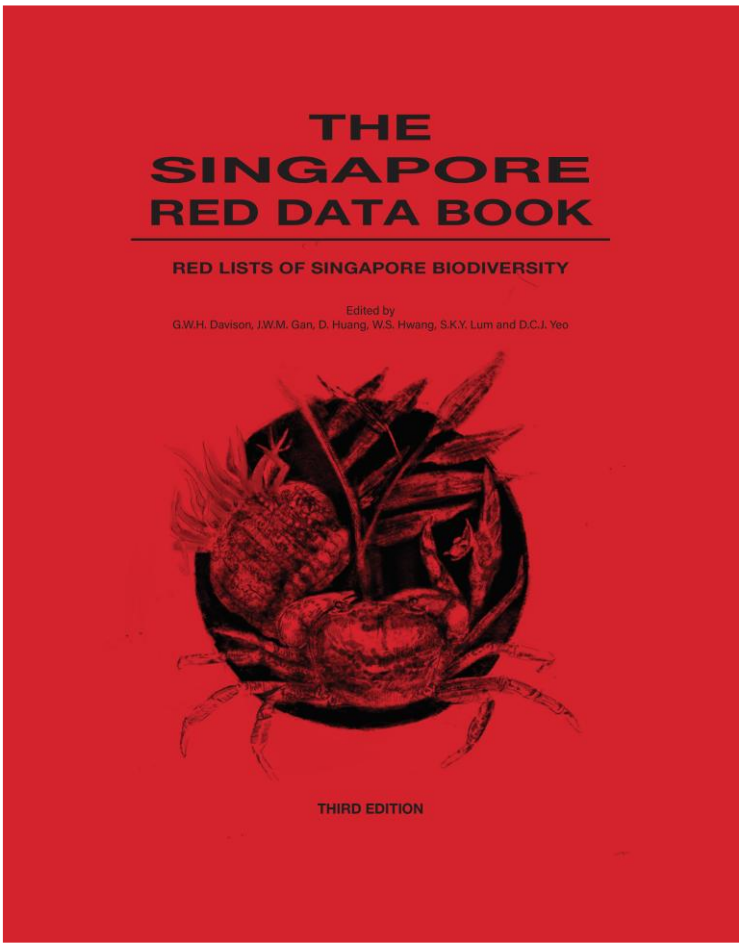
Singapore's land constraints and dense urban environment mean that biodiversity conservation cannot be separated from human activity. As such, this thrust reflects a dual objective: safeguarding species while managing the realities of human-wildlife conflict.

Species Recovery

Introduced in June 2015, the Species Recovery Programme focuses on conserving native flora and fauna by targeting locally endemic and threatened species through reintroduction, habitat enhancement and other protection efforts. Many of these species occur in small or isolated populations due to habitat loss, fragmentation, and broader environmental pressures, including climate change. The programme aims to stabilise or increase population sizes, strengthen long-term viability, and improve resilience to environmental change through a combination of *in-situ* and *ex-situ* conservation measures.

The Science of Species Recovery

Species selected for the programme undergo a prioritisation process based on factors such as their conservation status, distribution, ecological role, and the feasibility of intervention, with priority given to threatened, endemic or rediscovered species previously thought to be extinct. A key reference is the Singapore Red Data Book, which provides baseline data on individual species and identifies priorities for conservation action. The first and second editions of the Singapore Red Data Book were published in 1994 and 2008 respectively. The third and latest edition, published in 2024, significantly expanded the number of species assessed by more than three times to over 9,400 species, with many such species being assessed for the first time. This was made possible through the contributions of the 130 taxonomic experts, specialists and authors spanning the fields of academia, civil society such as the Nature Society Singapore, and government who contributed to this publication.



The third edition of the Singapore Red Data Book serves as an authoritative reference for species conservation in Singapore.

Initiatives and Success Stories

Several species have benefited from coordinated recovery efforts under the programme. One example is the Singapore Freshwater Crab (*Johora singaporensis*), a globally threatened species found only in Singapore, which has seen its population augmented through translocation and captive breeding efforts undertaken by the Freshwater Crab Conservation Working Group. This collaborative partnership between NParks, National University of Singapore and Mandai Wildlife Group was formed in 2014 and has established several new populations as well as brood and raise crablets in captivity to serve as an assurance population and facilitate future translocation efforts. Similarly, the Cinnamon Bush Frog (*Nyctixalus pictus*), which depends on rare tree cavity microhabitats for breeding, has been successfully introduced into suitable environments using artificial substitutes. Since its reintroduction into the Singapore Botanic Gardens Rain Forest in 2018, the species has established a breeding population and has expanded its local distribution.

The Queen Coral Bead and Singapore Freshwater Crab are two nationally threatened species that have benefited from recovery efforts under the Species Recovery Programme.

For plants, the Queen Coral Bead (*Nephroia orbiculata*) was presumed nationally extinct until the rediscovery of several male individuals at Coney Island in 2015 and several female individuals in remnant coastal forest in Changi in 2024. These rediscoveries enabled cross-pollination to produce seeds. By 2025, this species was reintroduced across multiple sites including Labrador Nature Reserve, Pulau Ubin, Singapore Botanic Gardens, Changi Beach Park, and East Coast Park. Seeds have also been deposited in the Singapore Botanic Gardens Seed Bank for long-term preservation and research. Another example is the Paku Raja (*Cycas edentata*), previously recorded only on offshore islands, which has benefited from *ex-situ* conservation measures like assisted pollination. Saplings have been introduced to suitable coastal habitats including Big Sister's Island, Pulau Ubin, and Sungei Buloh Wetland Reserve. Collected pollen have also been preserved at the Singapore Botanic Gardens Seed Bank for future conservation efforts.

Marine species are also included under the programme. In 2016, a turtle hatchery was established within the Sisters' Islands Marine Park to safeguard rescued eggs from at-risk nests of the globally threatened Hawksbill Turtle (*Eretmochelys imbricata*) that typically visit Singapore's shores between May and October to lay their eggs. Another example is the 100k Corals Initiative that was launched in 2024 with the goal to outplant 100,000 aquarium reared hard coral species like the locally rare *Trachyphyllia geoffroyi* and *Scapophyllia cylindrica* in the coming 10 years and beyond.

The Hawksbill Turtle (pictured here with a satellite tracker on its shell) and the hard coral Trachyphyllia geoffroyi are two marine species on the Species Recovery Programme.

Collectively, these efforts demonstrate the role of targeted, science-based interventions in supporting species persistence within a highly modified landscape. At the same time, outcomes vary across species, and long-term

success depends on sustained management and suitable habitat conditions.

Biodiversity Management

As Singapore continues to intensify greenery under the City in Nature vision, interactions between people and wildlife have become more frequent. A diverse range of species that have adapted to our urban spaces, including the Long-tailed Macaque (*Macaca fascicularis*), Wild Boar (*Sus scrofa*), Sambar Deer (*Rusa unicolor*), Estuarine Crocodile (*Crocodylus porosus*), Smooth-coated Otter (*Lutrogale perspicillata*), civets, snakes, monitor lizards, bats and urban birds among others have adapted to our urban environment and although their presence contributes to biodiversity and ecological function, they can also give rise to safety concerns and conflict situations. Biodiversity management therefore focuses on safeguarding public safety and maintaining ecological balance.

The Science of Biodiversity Management

NParks' adopts a science- and community-based approach to manage urban wildlife, guided by four key components:

1. **Population Ecology** – Surveys and research are conducted to understand species distribution, population dynamics and behaviour. This information supports the identification of hotspots and informs targeted management strategies.

2. **Population Management** – A range of measures are implemented depending on species and context. These include habitat modification, exclusion measures, regulation of anthropogenic food sources, and, where necessary, direct interventions such as translocation and sterilisation.

3. **Public Education** – Public behaviour plays a significant role in shaping human-wildlife interactions, and outreach and education initiatives are therefore critical in reducing conflict situations. Efforts focus on raising awareness about responsible behaviour such as not feeding wildlife, securing food waste, and understanding how to respond appropriately during encounters so that members of public can better understand and appreciate our urban wildlife.

4. **Community Stewardship** – Partnership and collaboration with community groups, academics and non-governmental organisations support outreach and engagement efforts. These collaborations help to build shared understanding and encourage collective responsibility in managing urban wildlife interactions.

Public engagement materials are used to raise awareness about the problems arising from feeding urban wildlife.

Species-Specific Management Approaches

Each wildlife species has distinct ecological needs, behavioural patterns, and urban adaptation strategies that require tailored management approaches specifically designed to address the unique challenges posed by each species.

For example, Long-tailed Macaques are managed through sterilisation programmes and public education; House Crows (*Corvus splendens*), an invasive species, are managed through population control measures; Sumatran Palm Civets (*Paradoxurus musangus*) may be managed through exclusion techniques; and snakes and monitor lizards are typically relocated when encountered in residential areas.

One of the most visible examples of urban wildlife adaptation is the Smooth-coated Otter, one of Singapore's most prominent urban wildlife success stories. This species has successfully recolonised our waterways and demonstrated considerable adaptability to both natural and anthropogenic environments. Following improvements in water quality and habitat conditions, otter populations have recovered across mangroves, coastal areas, canals, and reservoirs. However, while this reflects a conservation success, it has also introduced new challenges, including incursions into residential areas and associated impact on pet fish collections, and the establishment of holts (otter dens) in urban structures. NParks addresses these challenges through collaboration with the Otter Working Group (OWG) to monitor the population size and distribution of otters. The OWG is a multi-stakeholder coordinating body comprising representatives from government agencies, academia and the community, working together to understand otter population dynamics, track emerging issues, and respond to conservation and management matters through a multidisciplinary approach. Management strategies include advising property owners on exclusion measures, modifying holt habitats in high-conflict areas, and exploring long-term population management options such as sterilisation. These measures aim to balance conservation outcomes with social considerations, recognising that adaptation to urban wildlife requires both a science-based approach and public cooperation.

The otter exclusion toolkit outlines ways of excluding otters from private properties.

Thrust 4 – Science and Technology for Conservation Biology and Planning

Science and technology underpin Singapore's approach to biodiversity conservation. In a highly urbanised and land-constrained environment, decisions on land use, habitat protection, and species management must be supported by robust data and evidence-based analysis. This thrust functions as a cross-cutting enabler, supporting all other thrusts by strengthening understanding of ecosystems, informing planning decisions, and improving the effectiveness of conservation interventions.

Biodiversity Monitoring

A comprehensive understanding of Singapore's biodiversity and ecosystems is essential for identifying conservation priorities and knowledge gaps. NParks has led and coordinated several comprehensive biodiversity surveys across Singapore's terrestrial and marine ecosystems. These include the Comprehensive Marine Biodiversity Survey (2010 – 2015), Bukit Timah Nature Reserve (2015 – 2016) and the Southern Islands (2020 – 2022) in collaboration with researchers, students, academics and volunteers from the nature community. The findings contribute directly to conservation planning, particularly Thrusts 1 and 3 of the NCMP, by identifying areas of high biodiversity value, informing habitat protection strategies, and supporting the monitoring of species targeted under recovery programmes.

Research Programmes

NParks support a range of research programmes that contribute to long-term ecological understanding and conservation outcomes. One example is the Tropical Forest Ecology Research programme. Established in 2021, the programme focuses on coordinated research to inform the management and conservation of forests in Singapore and has anchor projects across key forest sites including Bukit Timah Nature Reserve, Central Catchment Nature Reserve and the Singapore Botanic Gardens Rain Forest. Permanent

research plots within these sites enable long-term forest ecological monitoring, while providing platforms for collaboration across research institutions. This approach maximises data-sharing and supports integrated analysis across diverse research projects and programmes.

In the marine domain, the establishment of a National Institute for Marine & Ocean Sciences in 2026 reflects a growing emphasis on coordinating and strengthening Singapore's marine science capabilities. The Institute aims to develop science-based approaches to support the development of adaptive management strategies that will support marine conservation efforts while also contributing to sustainable management of shared sea spaces. It will advance Singapore's blue economy by undertaking marine science research that can guide how we optimise and manage our limited sea space, and build local capabilities across policy, industry, and academia by developing a robust talent pipeline of marine experts who can drive innovation, inform decision-making, and provide specialised expertise for Singapore's expanding environmental sector. This will help ensure Singapore's continued ability to address complex marine challenges amid increasing pressures on our marine environment.

Ecological Profiling and Connectivity Modelling

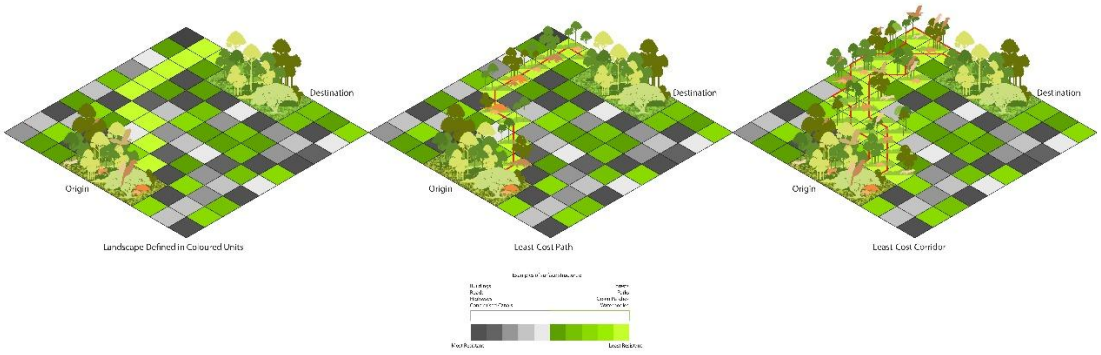
Recognising the need for a systematic, island-wide understanding of ecological networks, NParks initiated the Ecological Profiling Exercise (EPE) in 2021. The EPE adopts a science-driven approach to identify key habitats, assess their ecological status, and map connectivity pathways across Singapore. This extends our understanding of biodiversity beyond designated protected areas to include wider landscapes. The terrestrial EPE was developed in consultation with a scientific advisory panel comprising experts from academia and the nature community.

The modelling process involves three steps:

Step 1: Identification of core (source) habitats, based on habitat type and quality, species richness, ecological maturity, and species and habitat rarity.

Step 2: Mapping of buffer (complementary) habitat to mitigate edge effects and support core habitats.

Step 3: Identification of ecological corridors using least-resistance pathway models to predict wildlife movement between core habitats.



Least-resistance pathway models were used to predict wildlife movement between core habitats as part of the EPE.

This approach enables a more integrated understanding of how species move across fragmented landscapes, supporting the identification of priority areas for conservation and connectivity enhancements, which supports Thrust 1. Importantly, the EPE informs upstream planning under the Long-Term Plan Review by highlighting areas where biodiversity considerations should be incorporated into development decisions.

A similar approach has been applied to coastal and marine environments. Using an agent-based modelling platform that integrated ecological data with hydrodynamic models, connectivity between habitats such as mangroves, seagrass beds, and coral reefs were assessed, including the identification of potential corridors linked by a network of stepping stone habitats. These findings have contributed to the identification and subsequently the delineation of the boundaries of Singapore's two marine parks, demonstrating the role of science in guiding spatial planning.

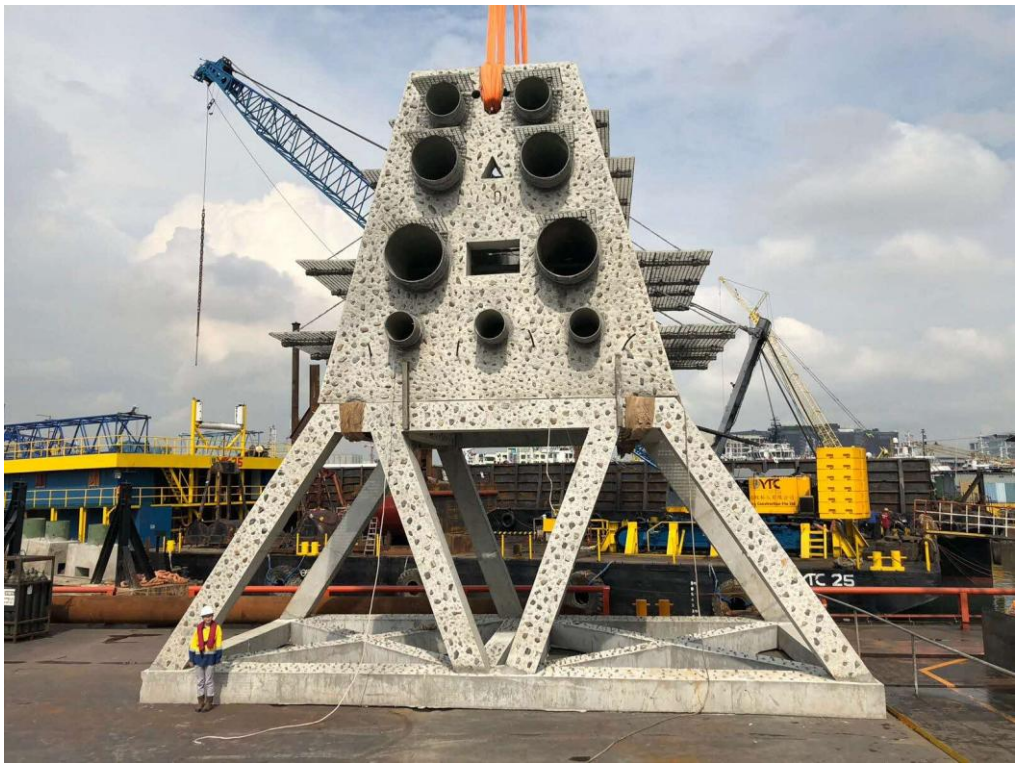
The EPE is a continuous iterative process that supports NParks' overarching research efforts to develop holistic and science-based strategies that inform upstream planning to achieve the City in Nature vision – where greenery and nature are woven into the built environment to support biodiversity conservation and allow our residents to enjoy the benefits of a healthy and biodiverse urban ecosystem.

Applied Research and Technology for Biodiversity Conservation

Technological innovation complements scientific research by improving the efficiency and effectiveness of conservation efforts. The Roadway Animal Detection System (RADS) is an example of how technology is applied to reduce human-wildlife conflict in support of Thrust 3 of the NCMP. Deployed along roads adjacent to our nature reserves, the system uses video analytics to detect animal movements and trigger warning signals to alert motorists to reduce their speed, thereby reducing the likelihood of wildlife-vehicle collisions.

The RADS is an example of how NParks uses technology to protect Singapore's wildlife by reducing instances of traffic accidents involving wildlife.

In the marine environment, technology has also been used to support habitat enhancement and species recovery efforts. Artificial reef structures installed at the Sisters' Islands Marine Park in 2018 provide additional substrate and micro-habitats for corals and other marine biodiversity to occupy and thrive. Tagging and tracking species like the Hawksbill Turtle further contribute to understanding their regional movement patterns and habitat use, enabling the development of targeted conservation strategies.



NParks and JTC Corporation collaborated to construct eight artificial reef structures at Sisters' Islands Marine Park to create additional habitats for coral reefs to develop. Image credit: JTC Corporation

Together, these applications demonstrate how technology can complement ecological knowledge, particularly in a context where efficiency and precision are critical.

Thrust 5 – Community Stewardship and Outreach in Nature

Transforming Singapore into a City in Nature is a shared endeavour that requires broad-based participation and sustained stewardship. This thrust focuses on the key strategies that guide NParks' community outreach and stewardship approach:

1. **Active Stewardship Pathways for Action** – enabling meaningful participation in conservation and stewardship activities.

2. **Raising Awareness** – building understanding, appreciation and connection with nature across a broad and diverse segment of the community.

3. **Meaningful Collaborations with Stakeholders** – empowering communities to initiate, lead and co-create solutions alongside NParks and partners.

These strategies ensure that community engagement supports both conservation and social outcomes in a coherent and progressive way that help shape Singapore's biodiversity conservation efforts.

Active Stewardship Pathways for Action

NParks recognises that communities can actively contribute to conservation and facilitates this by creating diverse and accessible pathways for involvement in citizen science, habitat enhancement and nature education, which collectively support multiple thrusts of the NCMP.

Citizen science initiatives, such as biodiversity watches and self-organised bioblitzes, exemplify how members of the public can be empowered to contribute data that supports biodiversity monitoring and management, while deepening their understanding of local flora and fauna. Over time, experienced volunteers step up to mentor and train new participants, reinforcing a culture of peer-led stewardship. The number of CIN citizen scientists undertaking these activities has grown steadily, from 400 in 2015 to over 10,000 in 2025. The data they collect helps NParks monitor our biodiversity and habitat enhancement efforts.

Citizen scientists conducting a bird survey as part of the Garden Bird Watch programme.

Community participation in the OneMillionTrees movement – tree planting, sapling care and invasive species management – demonstrate how action-oriented engagement can deliver tangible ecological outcomes while fostering a sense of ownership over shared green spaces. As of April 2026, over 870,000 trees have been planted across Singapore involving over 150,000 community participations. These initiatives show how conservation action can sustained through regular community participation. One example is our long-term partnership with the NUS Toddycats, where trained leaders and experienced members mentor newcomers through the planting process and return to conduct weeding and sapling maintenance activities. This increases sapling survivability for more effective habitat enhancement outcomes, while fostering a sense of ownership among the community for the habitats they have co-created.

NUS Toddycats conducting tree planting in collaboration with NParks.

Nature education provides an important foundation in building an understanding of our natural heritage. Programmes such as Greening Schools for Biodiversity illustrate how awareness, action and leadership development can be integrated within a single programme. Through planting native species, conducting post-planting biodiversity surveys and sustained habitat care, students and educators engage not only in learning, but also applied stewardship and collaborative action over time.

Students from Greendale Primary School conduct planting as part of the Greening Schools for Biodiversity programme.

Raising Awareness

NParks uses a combination of broad-based programmes that serve as an accessible entry point to introduce large numbers of participants to our local biodiversity, and more intensive pathways to nurture the emergence of community leaders who can steward our natural heritage for generations to come. Initiatives such as Biodiversity Week for Schools and Every Child a Seed play an important role in building a broad foundation of awareness and early connection with nature. These programmes complement formal education efforts by providing hands-on and experiential learning opportunities, helping to normalise biodiversity awareness as part of everyday life. NParks also works with committed individuals and groups to nurture leaders who can champion conservation efforts within their own communities. Examples include community-led initiatives where trained volunteers step up to organise activities, mentor others, drive thematic areas of work, and work with educators across different schools to bring nature into their classrooms. These examples demonstrate how stewardship efforts mature over time, moving from participation towards leadership and co-ownership.

Community in Bloom Ambassador and teacher Jacob Tan educates new generations of environmental stewards at Commonwealth Secondary School.

Meaningful Collaborations with Stakeholders

Working Closely with the Nature Community

NParks works closely with nature groups as partners in education, research, monitoring and public engagement, leveraging their specialist knowledge, networks and longstanding commitment to conservation. Some groups partner with NParks in our Comprehensive Biodiversity Surveys outlined under Thrust 4, species recovery programmes under Thrust 3 and various citizen science programmes.

Platforms such as the Festival of Biodiversity and the Biodiversity Friends Forum strengthen the nature community in areas of outreach and partnership. These initiatives create space for sharing knowledge, co-developing outreach, and inspiring new advocates through a combination of talks, field immersion and self-led action. Collectively, they help sustain an engaged and informed community that can support biodiversity conservation in Singapore.

Youths participating in a check-in session for the Biodiversity Friends Forum programme.

Bringing Diverse Stakeholders Together

It is important to build inclusive platforms that bring together diverse stakeholder groups with shared stewardship interests to support Singapore's biodiversity conservation initiatives. NParks facilities this by empowering communities to take an active role in shaping outcomes whilst providing support and guidance. The Friends of the Parks (FotP) initiative exemplifies this by enabling local communities and interest groups to co-create programmes that respond to the specific contexts of different parks and habitats. Through park-based FotP groups, stakeholders ranging from neighbourhood residents to nature advocates can initiate projects in areas such as conservation, outreach and responsible park etiquette.14 FotP groups have been established as of 2026, with one example being the Friends of Marine Park which supports stewardship of Singapore's marine environment through public outreach on marine conservation, while fostering collaboration among agencies, specialists and volunteers.

A Friends of Marine Park engagement booth at the Asia Dive Expo, an annual event that attracts over 30,000 visitors.

Reaching New and Under-served Audiences

NParks is also making a deliberate effort to reach out to audiences who are not yet involved in nature activities through initiatives that are accessible, relatable and embedded within daily life. Launched in 2023, the Nature Kakis Network illustrates this by working through community-based chapters to co-deliver City in Nature activities in their local neighbourhoods. NParks has established 29 Nature Kakis chapters in the network as of 2026, with over 360 stewards that have helped to organise over 470 City in Nature activities that engaged more than 30,000 participants. By framing

biodiversity and nature stewardship in familiar and local contexts, such programmes help engage individuals who may not otherwise participate in formal conservation initiatives, thereby expanding the base of stewardship support.

Pasir Ris Central Nature Kakis leads residents in intertidal clean-up activities, combining community environmental action with coastal ecosystem education.

Looking Ahead

NParks will continue to strengthen and enhance science communication, expand pathways for participation and leadership, and invest in capacity building to support long-term volunteer and partner development. Through sustained collaboration with communities, nature groups, schools and other stakeholders, we hope to nurture a society where citizens are not only aware of biodiversity but are confident and committed stewards of Singapore's City in Nature.

3 CONCLUSION

The NCMP is the cornerstone of NParks' commitment to strengthen biodiversity conservation in Singapore. Building on a decade of progress since the original 2015 plan, the updated NCMP comprises five thrusts and reflects NParks's evolving priorities and expanded functions.

Looking ahead, NParks will continue to safeguard and strengthen the resilience of our core biodiversity areas by enhancing ecological connectivity among our key habitats through initiatives such as nature corridors and nature ways. This will be complemented by habitat enhancement and restoration initiatives that improve habitat quality, combined with species-specific initiatives ranging from species recovery efforts that target threatened species to conflict management strategies for managing urban wildlife. Science and technology will play a greater enabling role, with tools like ecological modelling informing planning decisions and improving the outcomes of conservation actions. NParks will also work more closely with communities, nature groups, schools and other stakeholders to nurture a society where citizens are confident and committed stewards of Singapore's City in Nature.

Collectively, these initiatives will strengthen biodiversity conservation efforts in Singapore's highly urbanised environment.

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