

National Species Action Plan

Straw-headed Bulbul (*Pycnonotus zeylanicus*)

2024-2028



Image by: Francis Yap

Straw-headed Bulbul Working Group



Straw-headed Bulbul
Working Group

Foreword (National Parks Board)

Singapore is a small, densely populated city-state with a population of more than five million people. Despite our land use challenges, we are one of the greenest cities in the world and home to a rich diversity of flora and fauna, with over 2,100 recorded species of plants, 80 species of mammals and more than 400 species of birds. As part of our City in Nature vision, NParks has also been expanding our nature park networks and restoring nature in our existing parks and gardens, with a view to extend our natural capital beyond our nature reserves to bring nature closer to people.

Overlaying this effort is our Species Recovery Programme, which seeks to protect rare native plants and animals from the impact of urbanisation and climate change, through a combination of habitat enhancements and targeted species recovery measures. For example, the Straw-headed Bulbul is a globally Critically Endangered species that has benefitted from our conservation efforts and strong enforcement stance on poaching. Our strict laws with heavy penalties and constant vigilance against poaching, such as surveillance for poaching activities at hotspots, have proved to be strong deterrents to local poachers. Today, Singapore is the only known global stronghold for this species, supporting about one third of its global population.

To ensure that the Straw-headed Bulbul continues to thrive in Singapore, the Straw-headed Bulbul Working Group (SHBWG) was set up in 2021. It is co-chaired by NParks and the Nature Society Singapore and comprises members from a range of backgrounds and affiliations, including academics and both local and international non-governmental organisations. This body of work by the SHBWG will guide local conservation actions in the years ahead that will benefit both the Straw-headed Bulbul and other local biodiversity.

Ryan Lee

Group Director (National Biodiversity Centre)

National Parks Board

Foreword (Nature Society Singapore)

Singapore is a tiny city-state of 734 square kilometres, the smallest country in Southeast Asia, and by the United Nations criteria, is defined as 100% urbanised. It is probably the last country in the world where one would expect to find the biggest population of one the world's Critically Endangered bird species. However, a surprising twist of fate has given Singapore the honour of being the last remaining bastion of the Straw-headed Bulbul (*Pycnonotus zeylanicus*).

With this accolade however comes great responsibility. It is now imperative that Singapore preserves the status of the Straw-headed Bulbul (SHB) locally, not only to ensure the species' survival globally, but also to generate scientific knowledge and sustainable practices which will benefit the bird's population not just in Singapore but elsewhere in Southeast Asia as well.

I congratulate the Straw-headed Bulbul Working Group (SHBWG) on this impressive Species Action Plan (SAP). It explains how Singapore became a SHB stronghold because of a mix of factors. Ongoing bird trade practices, poaching and increasing habitat loss in Southeast Asia has meant that the population of SHBs in many countries have been dissipated, with extinction a distinct possibility in a couple of countries. In contrast, Singapore's conservation efforts and effective enforcement actions, coupled with the Straw-headed Bulbul's tolerance for secondary forest and forest-edge habitats, has ensured its continued survival and well-being.

More importantly, the SHBWG SAP provides an action plan for what needs to be done in Singapore over a 5-year period to monitor and conduct both research and outreach on the SHB based on the latest scientific evidence. The plan includes the engagement, education, and participation of the Singapore public - a sustainable world will come about only if everyone does their part.

The Nature Society of Singapore is honoured to participate in this important SHBWG SAP project together with the National Parks Board and other stakeholders. Complex issues of biodiversity and species preservation, habitat protection and sustainability can only be understood and solved with a multi-disciplinary and multi-stakeholder approach, as part of a whole-of-nation effort.

Dr Yeo Seng Beng

President

Nature Society Singapore

Acronyms and abbreviations

ACRES	Animal Concerns Research & Education Society
ASTSG	IUCN SSC Asian Songbird Trade Crisis Specialist Group
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DSTA	Defence Science and Technology Agency
HDB	Housing & Development Board
INTERPOL	International Criminal Police Organisation
IUCN	International Union for Conservation of Nature
IUCN SSC	IUCN Species Survival Commission
JTC	Jurong Town Corporation
MINDEF	Ministry of Defence
MND	Ministry of National Development
MN	Mandai Nature
MWG	Mandai Wildlife Group
NBC	National Biodiversity Centre (under NParks)
NGO	Non-governmental organization
NParks	National Parks Board
NSS	Nature Society Singapore
NUS	National University of Singapore
NTU	Nanyang Technological University
SHB	Straw-headed Bulbul
SHBWG	Straw-headed Bulbul Working Group
URA	Urban Redevelopment Authority
WMD	Wildlife Management Division (under NParks)

WWF

World Wildlife Fund

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SUMMARY

Straw-headed Bulbul *Pycnonotus zeylanicus* (Gmelin, 1789)

Family:	Pycnonotidae.
Geographic range:	Myanmar, Thailand, Malaysia, Indonesia (Sumatra, Java, Kalimantan), Brunei, Singapore. Likely extirpated in Thailand, Myanmar, and the Indonesian islands of Java and Sumatra.
Current status of taxon:	
Global	Critically Endangered (IUCN).
National	Endangered (Singapore Red Data Book 2022).
Habitat critical for survival:	Lowland forest, particularly forest edges near water bodies, as well as mangroves and cultivated areas.
Species Action Plan objective:	To ensure the long-term survival of Straw-headed Bulbul population in Singapore.
Species Action Plan leader:	Straw-headed Bulbul Working Group
Subgroup priorities:	
Monitoring and ecology	Identify occupancy, dispersal patterns, and home range of Straw-headed Bulbuls Understand behaviour, breeding, and feeding ecology of Straw-headed Bulbuls Monitor local populations trends in the long run Conduct population assessments at poorly understood sites
Genetics and conservation breeding	Collating data from captive populations to learn more about the species' biology and general needs Understanding the genetic diversity of the population in Singapore and its provenance Genetic research to be able to distinguish different populations of Straw-headed Bulbul across its range Population and habitat viability analysis through the use of genomic data to conduct modelling with environmental factors and some summary statistics to assess the inbreeding and genetic diversity of the wild population

Community engagement

Public perception survey across a range of age groups on the awareness of the global plight and local population of Straw-headed Bulbuls

Engaging media platforms to highlight the importance of Singapore being a stronghold for Straw-headed Bulbuls

Engagement with government agencies especially those involved in urban planning to stress the importance of Straw-headed Bulbuls through the conservation of secondary forest fragments and fringe habitats

Education and raising awareness of the Straw-headed Bulbul at targeted events through both physical and online opportunities/platforms

Engage educational institutions to understand existing education programmes that can be leveraged on in opportunities for collaboration/student engagement relating to Straw-headed Bulbul conservation

Conservation

Improve monitoring of the Straw-headed Bulbul trade in Singapore

Maintaining vigilance against poaching

1. INTRODUCTION

The Straw-headed Bulbul *Pycnonotus zeylanicus* is one of the most trapped species in the Southeast Asian bird trade (BirdLife International 2016a, 2016b). In Singapore, the Straw-headed Bulbul is a frequently encountered species during citizen-science surveys and is familiar to most local naturalists. They occur widely in patches of secondary forest and woodland across the country (Wells 2006, Lim 2009, Lim et al., 2020), some of which are outside the protected area network in Singapore. Within the short span of two years, the Straw-headed Bulbul was uplisted from Endangered to Critically Endangered in the International Union for Conservation of Nature (IUCN) Red List (BirdLife International, 2021) – a reflection of its drastic decline throughout its wider Southeast Asia range, including likely extirpation in places such as Thailand and the Indonesian islands of Sumatra and Java. Much of this has been caused by illegal trapping for the regional songbird trade, exacerbated to some extent by habitat loss. Singapore is the only location where the population of this species appears to be increasing (BirdLife International, 2021), making the country an important global stronghold for the species.

In recognition of this situation and Singapore's importance to the species at the international level, the Nature Society Singapore (NSS) organised a conservation action planning workshop for the species in 2019 in collaboration with Birdlife International and the Oriental Bird Club (Sin et al., 2019). The workshop involved both local and international stakeholders, paving the way for the formation of the multi-stakeholder Straw-headed Bulbul Working Group (SHBWG) in 2021. This species action plan is underpinned by the discussions and review of the species' status and outlines the working group's plans for the next five years to ensure that the Straw-headed Bulbul population continues to thrive in Singapore.

2. SPECIES OVERVIEW

2.1 History and taxonomic relationships

The Straw-headed Bulbul was first described by Johann Friedrich Gmelin in 1789. Its proonyms include *Sturnus zeylanicus* and *Turdus ochrocephalus*, suggesting confusion on its taxonomy then (Dickinson et al., 2002). It is a member of the bulbul family Pycnonotidae and its most speciose genus, *Pycnonotus*, which also contains most of the bulbul species in Singapore. The Straw-headed Bulbul is a monotypic species (Gill et al., 2022).

2.2 Description

The Straw-headed Bulbul is the largest bulbul in tropical Asia, measuring around 29cm in length and weighing more than 80g (Strange, 2000; Singapore Birds Project, n.d.; Yong et al., 2017; Fishpool et al. 2020). Adults have a golden-yellow forehead, crown, lores, and ear-coverts, with prominent black eye lines and submoustachial stripe (Kumar, 2018; Singapore Birds Project, n.d.; Yong et al., 2017; Figure 1). They also have a whitish throat and greyish-brown nape, mantle, upper back, and breast, with whitish streaks – a pattern that continues down to the abdomen, where the streaks become paler and less striking. Their wings, tail, and rump are olive-green, though the colour is more pronounced in the outer webs of the wing and the upper-tail coverts. Both legs and claws are black.



Figure 1. An adult Straw-headed Bulbul in Singapore. Image by: Francis Yap

Straw-headed Bulbuls are not sexually dimorphic (Kumar, 2018; Lim et al., 2020), though females are on average smaller and lighter than males (Wells, 2006). Juveniles are duller, with weaker streaking and paler brown crown (Figure 2). Additionally, they lack a pronounced eye stripe. Adult features will develop after about a year (Kumar, 2018). Another indicator of age is their eye colour.

Straw-headed Bulbul chicks have black irises for about six months, before turning dull grey, dull brown, and eventually bright red after about a year and a half (Kumar, 2018).



Figure 2. A 15-day old juvenile Straw-headed Bulbul at Singapore’s Jurong Bird Park. Image by: T.Manoj Kumar

Straw-headed Bulbuls are a vocal species that can be heard throughout the year in captive environments (Kumar, 2018). Their typical songs are usually described as “a bubbly trill” and “resonant warbles” (Yong et al., 2017) which include descending and ascending notes like “trr-trr-trr” and “hu-tiu-tiu-tiu” respectively (Kumar, 2018). Though the songs typically last only one or two seconds, they can be repeated several times, with two or more individuals singing in chorus to produce a continuous song (Kumar, 2018; Wells, 2006). They have also been observed to produce a more monotonous and rhythmic call, potentially for contact and alarm (Chow, 2013; 2022). Mating pairs that are bonding well have also been known to call together in an antiphonal duet (Kumar, 2018)

2.3 Distribution, population, and habitat

The geographic range of the Straw-headed Bulbul includes the Thai-Malay Peninsula, from peninsular Thailand and Myanmar (Tanintharyi), south to Peninsular Malaysia, Singapore, and the islands of Borneo, Sumatra, and Java (BirdLife International, 2021; Yong et al., 2017). It is likely to be either extirpated or close to extirpation in Thailand, Myanmar, and Sumatra (Eaton et al., 2015; Shepherd et al., 2013; van Balen, 1999; Figure 3) and is extinct in Java. The species may persist in small and declining populations in Malaysia and Indonesian Borneo (Chiok et al., 2019; Shepherd et al., 2013; Puan et al., 2020). Its population size in Brunei is unknown (Shepherd et al., 2013) but is suspected to be undergoing significant decline (J. Lee, pers. comm., 27 February 2023).

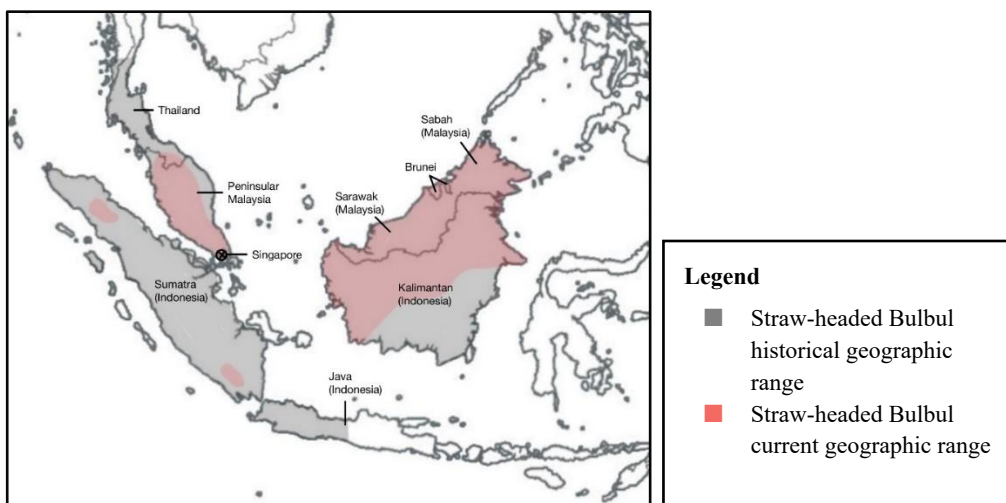


Figure 3. Historical and current distribution of the Straw-headed Bulbul (based on Birdlife, 2022).

Singapore is the only location where the population is known to be increasing, and the species is classified as an uncommon resident breeder (National Parks Board, n.d.a; Singapore Birds Project, n.d.; Wang & Hails, 2007). From 2000 to 2016, the Straw-headed Bulbul subpopulation on the main island of Singapore was shown to be stable, while that of the northeastern off-shore island, Pulau Ubin, was shown to be increasing at a rate of 3.69% ($\pm 1.21\%$) annually (Yong et al., 2017). A conservative estimate of the total Straw-headed Bulbul population in Singapore in 2016 was a minimum of 202 individuals (Yong et al., 2018). That number has since been updated to 573 (± 185) individuals in 2020, comprising 22.9% - 57.3% of the global population then (1,000 - 2,499 individuals) (Chiok et al., 2020), though the methodology used to derive the estimate differed between both studies. Straw-headed Bulbuls in Singapore can be found in various nature parks fringing the Bukit Timah and Central Catchment Nature Reserves. Another important area for the species is the Western Catchment Area, a military area that holds extensive stands of secondary woodland that is off-limits to members of the public (Yong et al., 2018).

Their preferred habitat includes woodland, regenerating forest, and forest edges, especially in edge interfaces abutting waterbodies such as rivers and streams (BirdLife International, 2021; Davison et al., 2008; Strange, 2000; Yong et al., 2017). The species is also known to occur in mangroves, cultivated areas, and shrubland (Davison et al., 2008; Yong et al., 2017, Lim et al., 2020). Though typically found in lowlands (Strange, 2000), they have been occasionally recorded at elevations of up to 1,600m (BirdLife International, 2021).

2.4. Ecology and behaviour

Straw-headed Bulbuls are more often heard than seen, due to their shy but vocal nature (Wells, 2006). They are particularly vocal at dawn and before dusk (Singapore Birds Project, n.d.). They fly at low levels from tree to tree and may perch on low branches above water bodies, but rarely in exposed areas (Strange, 2000; Singapore Birds Project, n.d.). They are also gregarious (Davison et

al., 2008; Singapore Birds Project, n.d.) and frequently observed in pairs or small groups of up to five individuals (BirdLife International, 2021; Yong et al., 2017). Little is known about their breeding ecology in the wild, with most of the associated behavioural observations made in captive environments (Kumar, 2018).

Foraging has been observed to take place among fruiting trees at forest edges (Yong et al., 2017), as well as on the ground in captivity (Kumar, 2018). Straw-headed Bulbuls have an omnivorous diet that includes fruit like berries and figs, as well as small invertebrates such as river-dwelling snails, spiders, beetles, and cockroaches (Kumar, 2018). They have been observed feeding on the fruits of plants such as the Bandicoot Berry (*Leea indica*), Alexandra Palm (*Archontophoenix alexandrae*), Kenidai (*Bridelia tomentosa*), Pink Lime-Berry (*Clausena excavata*), Simpoh Air (*Dillenia suffruticosa*) (The Biodiversity of Singapore, n.d.).

Straw-headed Bulbuls are known to breed from January to September, with nesting observed during two periods in captivity: March-April and June-July (Kumar, 2018). They construct cup-shaped nests in the mid-canopy, using twigs, grass, and epiphytic ferns such as *Pyrrosia piloselloides* (Kumar, 2018; Wells, 2006; Yong et al., 2017), and typically lay a clutch of two eggs (Kumar, 2018; Wells, 2006).

2.5. Conservation status

First listed as Near Threatened in the IUCN Red List in 1988, the Straw-headed Bulbul was subsequently reclassified as Vulnerable in 1994 and Endangered in 2016 (BirdLife International, 2021). The subsequent sharp decline in Straw-headed Bulbul populations across its range due to trapping for the songbird trade and habitat loss quickly led to the most recent reclassification to Critically Endangered in 2018 based on criterion A2. (BirdLife International, 2021; Chiok et al., 2019; Leupen & Shepherd, 2018). In Singapore, the species is listed as Endangered in the second edition of the Singapore Red Data Book (Davison, 2008) and has retained this status following the recent update of the Red List for Singapore's birds in 2022 (National Parks Board, n.d.a).

3. THREATS

3.1 Trapping for songbird trade

The trapping and trading of birds is widespread in communities across Southeast Asia, driven by long-standing traditions of keeping birds as pets and participating in songbird competitions, particularly in Indonesia (Chng et al., 2015; Jepson & Ladle, 2005; Nash, 1993; Shepherd, 2006). Such traditions have led to the establishment of the illegal and unsustainable bird trade involving various species of songbirds including the Straw-headed Bulbul – a popular songbird due to its uniquely melodious calls (BirdLife International, 2021; Jepsen & Ladle, 2005; Nash 1993; Shepherd et al., 2004). Regionally, the highest demand for the bird has been attributed to Indonesia where the species is highly sought after in the bird trade (Shepherd et al., 2013, Chiok et al., 2019), with supply largely coming from illegal trapping elsewhere in the region such as Sumatra, Kalimantan, and Malaysia (Bergin et al., 2018; Nash, 1993; Shepherd et al., 2004).

In Singapore, market surveys by Eaton et al. (2017) found one Straw-headed Bulbul, compared to a historical market survey by Nash (1993) which found 500 of these birds. Its decline in popularity is substantiated by surveys among songbird owners in Singapore which found this species to be unpopular in recent years (Chiok et al., 2022).

3.2. Habitat loss

Southeast Asia has one of the highest deforestation rates in the world (Achard et al., 2002), with land use change and exploitation of the region's tropical forests being a top driver for native biodiversity loss (Sodhi et al., 2004). From 2000 to 2010, lowland forests of insular Southeast Asia – including Brunei, Indonesia, Malaysia, and Singapore – have decreased by an average of about 1.2% per year (Miettinen et al., 2011). Globally, Indonesia exhibited the largest absolute forest loss year on year, from under 10,000 km² per year in 2000 to over 20,000 km² per year by 2012 (Hansen et al., 2013). The loss of habitat due to clearance of lowland forest and riparian forest in the region pose a secondary threat to the species, exacerbating effects posed by poaching and trade (Eaton et al., 2015; Shepherd et al., 2013). Apart from the direct impact of habitat loss, deforestation and land use change also render the Straw-headed Bulbul more accessible and vulnerable to poachers (BirdLife International, 2021).

In Singapore, this threat remains relevant as several Straw-headed Bulbul subpopulations have been detected by recent surveys in unprotected areas of woodland that are likely to be impacted by future housing development (Yong et al., 2018; Sin et al., 2019). However, the impact to the species from the loss of these remnant woodland patches may be mitigated by the larger areas of habitat secured under Singapore's protected area network and improving connectivity of these patches to adjacent forest remnants. In addition, Singapore's military training areas remain relatively undisturbed and support subpopulations as well.

3.3. Inbreeding depression

The relatively small size of Singapore may make the local Straw-headed Bulbul population susceptible to inbreeding depression (Chiok et al. 2020; Yong et al., 2018). For example, there is some concern that although the Straw-headed Bulbul is presently doing well on Pulau Ubin, the species might be reaching carrying capacity on the island and is otherwise unable to disperse to the surrounding areas due to habitat loss (Sin et al., 2019).

3.4. Introduced bird species

In Singapore, the Straw-headed Bulbul may also be threatened by introduced species, such as the White-crested Laughingthrush *Garrulax leucocephalus*. Such birds may compete with the Straw-headed Bulbul for food (Yong et al., 2018).

4. RELEVANT STAKEHOLDERS

The Straw-headed Bulbul Working Group (SHBWG) spearheading this species action plan comprises members from the National Parks Board (NParks) – particularly the Wildlife Management Division (WMD) and National Biodiversity Centre Division (NBC) – Nature Society Singapore, National University of Singapore (NUS), Mandai Wildlife Group (MWG), Mandai Nature, World Wildlife Fund (WWF) and BirdLife International.

Other local stakeholders include Nanyang Technological University (NTU), Ministry of Defence (MINDEF), Defence Science and Technology Agency (DSTA), and Animal Concerns Research & Education Society (ACRES). Other potential regional or international parties include Oriental Bird Club, Malaysian Nature Society, Conservation International, IUCN Species Survival Commission (SSC) Asian Species Action Partnership, IUCN SSC Asian Songbird Trade Specialist Group (ASTSG), TRAFFIC, and Wildlife Conservation Society (WCS).

The exact means by which these parties will be involved in the implementation of this plan will be detailed in Section 6.

5. SPECIES ACTION PLAN OBJECTIVES

5.1. Vision and current objectives

This species action plan serves to ensure the long-term survival of Straw-headed Bulbuls in Singapore, through the accumulation of necessary scientific knowledge to guide the development and implementation of concerted conservation actions to monitor, protect, and manage a healthy, self-sustaining Straw-headed Bulbul population.

To achieve this vision, the SHBWG has four key objectives:

- To understand the ecology of Straw-headed Bulbuls in Singapore and ensure sufficient suitable habitat and resources for the species
- To establish ex-situ conservation strategies for captive husbandry and breeding
- To promote awareness and advocate for the conservation of Straw-headed Bulbuls
- To maintain vigilance against poaching and the illegal trade in Straw-headed Bulbul

5.2. Evaluation

SHBWG will carry out annual reviews and/or workshops to document the progress of achieving the deliverables of this species action plan, detailed in Section 6, throughout the 5-year duration. Any changes in priorities, action plans, and management will be documented as well.

5.3. Existing conservation measures

5.3.1. Worldwide

Internationally, the commercial trade of Straw-headed Bulbuls is now banned following its uplisting in 2022 to Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All countries within the species' geographic range are Parties to CITES (CITES, n.d.).

In Malaysia and Thailand, the Straw-headed Bulbul is a fully protected species, though they are likely already extirpated in Thailand (BirdLife International, 2022; Shepherd et al., 2013). In Indonesia, a “zero-harvest quota” prohibition makes the harvest and trade of wild Straw-headed Bulbuls illegal (Leupen & Shepherd, 2018) although the species is not explicitly protected under national legislation (Kementerian Lingkungan Hidup dan Kehutanan, 2018). However, traders have been noted to sell wild-caught individuals under the guise of being captive-bred (Leupen & Shepherd, 2018).

Straw-headed Bulbul populations have declined to the point that it may now be locally extirpated in most protected areas in Indonesia (Kalimantan, Sumatra), Malaysian Borneo (Sabah, Sarawak) and Brunei, but the species is known to be extant in some protected areas, such as Taman Negara and Endau Rompin in Peninsular Malaysia, Danum Valley Conservation Area and Kinabatangan Wildlife Sanctuary in Sabah, and Ulu Temburong National Park in Brunei (BirdLife International, 2022; Chiok et al., 2019; Eaton et al., 2015).

The species has also been identified by the IUCN SSC Asian Songbird Trade Specialist Group as one of its top priority species most threatened by trade and in need of population surveys, trade monitoring, and greater protection efforts (Lee et al., 2016).

5.3.2. Singapore

Implementation and enforcement of CITES in Singapore is written into national legislation in the form of the Endangered Species (Import and Export) Act (2006) (Government of Singapore, n.d.a). Straw-headed Bulbuls are a protected species in Singapore under the Wildlife Act (1965), which makes it illegal to kill, trap, or offer the bird for sale or export (Government of Singapore, n.d.b). Straw-headed Bulbul populations in the nature reserves and other NParks-managed areas are also afforded a degree of protection from trapping and habitat loss under the Parks and Trees Act (2005) (Government of Singapore, n.d.c).

Apart from the in-situ protection mechanisms in place, Mandai Wildlife Group has been spearheading ex-situ conservation of Straw-headed Bulbuls for about a decade, with the first successful captive breeding recorded in 2017 (Kumar, 2018; Yeo, 2021). They have published the first edition of European Association of Zoos and Aquaria Best Practice Guidelines for captive breeding of Straw-headed Bulbuls (Kumar, 2018). The project continues to be a work in progress, with sustainable captive breeding deemed not yet possible (Sin et al., 2019), as more research is needed on several aspects, such as behaviour in the wild, breeding system, and life expectancy (Kumar, 2018).

The formation of the SHBWG in 2021 marks the starts of concerted, species-specific efforts towards conserving and supporting the growth of the Straw-headed Bulbul population in Singapore (National Parks Board, n.d.b).

6. SUBGROUP PRIORITIES

Following the themes of its four key objectives, the SHBWG is split into four subgroups: 1) Monitoring and Ecology, 2) Genetics and Conservation Breeding, 3) Community Engagement, and 4) Conservation. Each subgroup has identified key priorities and actions for the next five years to protect the Straw-headed Bulbul populations in Singapore.

6.1. Monitoring and Ecology

6.1.1. Current situation

As the Straw-headed Bulbul does not require pristine habitat for persistence, it can be found in secondary forest patches across Singapore and can be observed more easily in the nation than elsewhere in the region. In contrast to neighbouring countries, the stable Straw-headed Bulbul population in Singapore provides a rare opportunity to study its behaviour and local habitat preferences, as well as to supplement the limited body of literature on this species.

To date, there have been at least four studies covering population estimates and trends of Straw-headed Bulbuls in Singapore. The earlier two studies were unpublished dissertations by Ho (2001), which estimated 64 individuals on Pulau Ubin, and Tan (2001), which estimated 84.6 ± 8.15 individuals on Singapore island, adding up to a population size of 148 individuals in 2001. More recently, Yong et al. (2018) reviewed and modelled data from past literature, including Tan (2001) and annual bird censuses conducted in Singapore and derived a population estimate of 202 individuals in 2016. The latest study by Chiok et al. (2020) involved distance sampling surveys across Singapore and concluded that the population size of Straw-headed Bulbuls in Singapore was 573 ± 185 individuals in 2019. With a global estimate of 600–1,700 mature individuals (BirdLife International, 2021), there is an urgent need to secure the population in Singapore, particularly on Pulau Ubin, which on its own already holds a significant percentage of the global population.

Currently, there is little to no information on various aspects of Straw-headed Bulbul ecology, such as their mortality rate, movement and dispersal patterns, specific habitat preferences and interactions with other bulbuls, with only limited data available on its local distribution as well as breeding behaviour mainly based on studies involving captive individuals (Kumar, 2018; Wells, 2006). Additionally, while the Straw-headed Bulbul is relatively well studied in Singapore, the regular monitoring of local populations can be improved.

6.1.2. Subgroup focus

This subgroup aims to establish proper monitoring frameworks for Straw-headed Bulbuls in Singapore, identify research priorities and undertake analyses in relation to the ecology of the species. It also aims to facilitate coordination among stakeholders to ensure that relevant ecological information can be shared and applied towards the conservation of Straw-headed Bulbuls. The priorities of the subgroup are grouped under four main areas:

- Habitat and occupancy modelling
- Population management and monitoring
- Movement and dispersal
- Breeding and mortality

6.1.3. Priority actions

Proposed Actions	Timeline for Completion	Deliverables	Parties Involved
1a. Identify occupancy, dispersal patterns, and home range of Straw-headed Bulbul			
1.1. Occupancy modelling based on visual encounters/acoustic methods/vegetation surveys to estimate Straw-headed Bulbul occupancy and interactions with other bulbuls, through random sampling across Singapore [High priority]	3 years	Map of preferred vegetation, habitats utilised by Straw-headed Bulbuls. Straw-headed Bulbul occupancy map Internal report Publication of peer-reviewed paper	Government agencies (NParks) NGOs (NSS) Research institutions (NUS, NTU)
1.2. Conduct long-term monitoring through ringing of birds with metal and coloured rings at Pulau Ubin, Sungei Buloh Wetland Reserve, and other sites across Singapore to	Ongoing	Internal report Internal database of ringing records	Government agencies (NParks)

track movements and mortality rates of individual Straw-headed Bulbuls			Research institutions (NUS, NTU)
1.3. Study the size of Straw-headed Bulbul home ranges through various means (radio telemetry, coloured rings, population genomics) and identify key corridors/habitats to be conserved or restored	3–5 years	Internal report Publication of peer-reviewed paper	Government agencies (NParks) NGOs (NSS) Research institutions (NUS, NTU)
2. Understand behaviour, breeding, and feeding ecology of Straw-headed Bulbuls			
2.1. Compile and synthesise information on behaviour of Straw-headed Bulbuls, including their breeding and feeding ecology through observational surveys and review of existing literature/data	2 years	Internal report	Government agencies (NParks) NGOs (NSS, MN, WWF) Zoological institutions (MWG) Research institutions (NUS, NTU)
3. Monitor local Straw-headed Bulbul population trends in the long run			
3.1. Conduct Straw-headed Bulbul monitoring through existing programs such as the Annual Bird Census and Mid-year Bird Census	Ongoing	Database of NSS census data	NGOs (NSS)
3.2. Develop and implement a systematic framework and	1 year	Internal report	Government agencies (NParks)

survey methodology for the long-term monitoring of Straw-headed Bulbul while incorporating citizen science elements [High priority]			NGOs (NSS, WWF) Research institutions (NUS, NTU)
4. Conduct population assessments at poorly understood sites			
4.1. Liaise with government agencies to conduct Straw-headed Bulbul surveys at restricted areas such as Western Catchment Area and Pulau Tekong	5 years	Internal report	Government agencies (NParks, MINDEF, DSTA) NGOs (NSS) Research institutions (NUS, NTU)

6.2. Genetics and Conservation Breeding

6.2.1. Current situation

A Straw-headed Bulbul genome has been sequenced and assembled and population genomic analyses are underway. Samples from Singapore and the region have been sequenced as well to determine the population structure of the species across its range.

Mandai Wildlife Group has successfully bred nine Straw-headed Bulbul chicks. The best practice breeding guidelines with details on the breeding ecology for the species have been compiled and made available online (Kumar, 2018).

6.2.2. Subgroup focus

This subgroup focuses on determining the genetic diversity and structure of the current Straw-headed Bulbul population, ensuring an insurance population is maintained in captivity for the survival of the species, as well as building an understanding of its breeding ecology. The information collected will complement the work done by the Monitoring and Ecology subgroup.

6.2.3. Priority actions

Proposed Actions	Timeline for Completion	Deliverables	Parties Involved
1. Collating data from captive populations to learn more about the species' biology and general needs	Ongoing (long-term)	Update best practices guidelines every 2 years	Zoological institutions (MWG)
2. Understanding the genetic diversity of the population in Singapore and its provenance	3 years	Publication of peer-reviewed paper	Government agencies (NParks) Zoological institutions (MWG) Research institutions (NUS in collaboration with NParks)
3. Genetic research to be able to distinguish different populations of Straw-headed Bulbul across its range	3 years	Publication of peer-reviewed paper	Research institutions (NUS) Zoological institutions (MWG)
4. Population and habitat viability analysis using genomic data to conduct modelling with environmental factors and some summary statistics to assess the inbreeding and genetic diversity of the wild population	5 years	-	Government agencies (NParks) NGOs (NSS) Research institutions (NUS)

6.3. Community Engagement

6.3.1. Current situation

There is currently a lack of awareness about the Straw-headed Bulbul among Singaporeans, making conservation efforts difficult. Hence, there is a need to raise awareness of this species among stakeholders here to strengthen conservation efforts.

6.3.2. Subgroup focus

The Community Engagement subgroup is focused on engaging the community and people of Singapore through a variety of methods and occasions, to promote and develop a healthy respect and appreciation for the Straw-headed Bulbul. Through a network of educational institutions, government agencies, media channels, corporates, and other organisations, the subgroup will carry out outreach efforts to all groups of our country's demographic to develop and shape positive attitudes and behavior towards the species and nature in general.

6.3.3. Priority actions

Proposed Actions	Timeline for Completion	Deliverables	Parties Involved
1. Public perception survey across a range of age groups on the awareness of the global plight and local population of Straw-headed Bulbul (Min. 1000 responses). This will help us understand what and how much do people already know and care about the bulbuls which will help us plan for and target future community engagement activities. [High priority]	1 year	Internal report	Government agencies (NParks) NGOs (NSS)
2. Engaging media platforms to highlight the importance of Singapore being a stronghold for Straw-headed Bulbuls [High priority]	18 months as a targeted activity; to continue if resources allow	News articles and infographics. Mostly targeted online.	Media organisations

<p>3. Engagement with government agencies especially those involved in urban planning (e.g. URA, HDB, JTC) to stress the importance of Straw-headed Bulbuls through the conservation of secondary forest fragments and fringe habitats.</p>	<p>2 years targeted activity; to continue in the future if resources allow</p>	<p>Nature walks and sharing sessions for staff of government agencies (e.g. MND)</p>	<p>Government agencies (NParks) NGOs (NSS)</p>
<p>4. Education and raising awareness of the Straw-headed Bulbul at targeted events (e.g. Festival of Biodiversity, Ubin Day, Earth Day) through both physical and online opportunities/platforms of the major threats to the species, and the solutions that the public can contribute to (e.g. NParks hotline to report incidences of poaching).</p> <p>[High priority]</p>	<p>3 years</p>	<p>Social media posts, brochures, focus booth and activities at events, online and in-person talks</p>	<p>Government agencies (NParks) NGOs (NSS, MWG, MN, WWF, Birdlife International) Educational institutions (NUS and NTU, primary and secondary schools)</p>
<p>5. Engage educational institutions to understand existing education programmes (e.g. RI's Ecological Literacy Programme) that can be leveraged on in opportunities for collaboration/student engagement relating to Straw-headed Bulbul conservation</p> <p>[High priority]</p>	<p>3 years</p>	<p>Publication, school resource</p>	<p>Educational institutions</p>
<p>6. Follow-up public perception survey (Proposed Action 1) to measure success of awareness raising effort (Min. 1000 responses)</p> <p>[High priority]</p>	<p>2 years</p>	<p>Internal report</p>	<p>Government agencies (NParks) NGOs (NSS)</p>

6.4. Conservation

6.4.1. Current situation

The Straw-headed Bulbul has been heavily trapped for the songbird trade and hence, extirpated throughout much of its range in Southeast Asia (Chiok et al., 2019; Birdlife International, 2022). To confer greater protection to the species and other native wildlife in Singapore, legislation protecting species such as the Straw-headed Bulbul have been recently amended as follows:

- Wildlife Act (1965) – amended in 2020 to mete out stiffer penalties against the poaching and keeping of protected species (including the Straw-headed Bulbul)
- Endangered Species (Import and Export) Act (2006) – amended in 2022 to increase the penalties for illegally traded species protected under CITES, and to align the penalties for domestic illegal trade of CITES-listed species with international trade

Although there is adequate legislation to protect this bulbul species in Singapore, illegal sourcing and trade may still occur occasionally.

6.4.2. Subgroup focus

This subgroup coordinates work on the conservation of the Straw-headed Bulbul through identifying a list of key actions for trade-related matters and advancing the implementation of these actions. This subgroup also works to strengthen enforcement and surveillance of the songbird trade through partnerships with local, regional, and international stakeholders. International stakeholders include CITES, INTERPOL, and conservation organisations working regionally on the wildlife trade. A key objective of the subgroup was achieved with the uplisting of the bulbul to CITES Appendix I during the CITES 19th Conference of Parties in 2022 (Hughes & Gill, 2022).

Locally, there is also a need to raise more public awareness on how to report poaching incidents even though there is low poaching pressure. Additionally, some sites that support Straw-headed Bulbuls are located close to residential areas. Residents living in these areas could thus play an important role in deterring poachers by reporting such incidents to the relevant authorities.

The priority actions of this subgroup can be grouped under two main themes:

- Monitoring the trade in Straw-headed Bulbul in Singapore
- Maintaining vigilance against poaching

6.4.3. Priority actions

Proposed Actions	Timeline for Completion	Deliverables	Parties Involved
1. Improve monitoring of the Straw-headed Bulbul trade in Singapore			
1.1. Engage government authorities from other range states and researchers to create a wildlife forensics genetic toolkit to understand the provenance of Straw-headed Bulbuls confiscated or sampled in the trade in Singapore through molecular approaches.	Ongoing (long term)	DNA reference library and toolkit	Government agencies (NParks) NGOs (BirdLife International, NSS) Research institutions (NUS and other local collaborators)
1.2. Regular monitoring of local bird shops and bird farms to ensure no commercial import of Straw-headed Bulbuls following CITES uplisting	Ongoing (long term)	Internal reports following bird shop visits	Government agencies (NParks)
2. Maintaining vigilance against poaching			
2.1. Engagement targeted at residential areas close to known locations of Straw-headed Bulbul (e.g. private estates adjacent to woodland containing Straw-headed Bulbuls) on how to report poaching incidents	2 years	Social media, in-person engagement sessions with residents A 24-hr hotline is presently available for reporting of poaching incidents	Government agencies (NParks) NGOs (NSS)

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Appendix -SHBWG Members & Affiliations

Monitoring and Ecology	Genetics and Conservation Breeding	Community Engagement	Conservation
Dillen Ng (Sub-Group Lead & Steering Committee Member) (NParks)	Gabriel Low (Sub-Group Lead) (NParks)	Albert Liu (Sub-Group Lead) (NSS)	Malcolm Soh (Sub-Group Lead)
Geoffrey Davison (NParks)	Frank Rheindt (NUS)	Shelby Wee (Birdlife International)	Yong Ding Li (Steering Committee Member) (NSS + Birdlife International)
Wong Chung Cheong (Co-Chairman) (NSS)	Anais Tritto (Mandai Wildlife Group)	Anuj Jain (Birdlife International)	Cheryl Lao (NSS)
Movin Nyanasengeran (NUS)	Low Bing Wen (Co-Chairman) (NParks)	Lee Ee Ling (Steering Committee Member) (NSS)	Trixie Tan (NSS)
Keita Sin (NUS)	Elize Ng (University of Queensland)	Shreeyaa Subra (NSS)	Jessica Lee (Mandai Nature)
Lam Jia Jun (WWF)		Kee Jing Ying (NUS)	Benjamin Lee (Independent)
Mayjean Nieves (NUS)		Jayasri Narayanan (WWF)	



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