



**LOST**

**Garnet pitta**  
The shy bird was last recorded in 1949. It thrives in swampy lowland forests, a habitat type that is now very rare in Singapore. The bird is extremely territorial. Globally, the bird is near-threatened.



**Red giant flying squirrel**  
The squirrel was common in Changi during the earlier part of the 20th century. The nocturnal animal can grow up to about half a metre in height and its tail extends up to 60cm long. It survived on fruit, leaves and shoots. The critter was last seen in the Central Catchment Nature Reserve in 1986. It can still be found in other parts of Asia like Thailand and Pakistan.



**Green dragonail butterfly**  
The butterfly with transparent wings was usually found near forest streams, a rare habitat in urban Singapore. It likely went extinct with the loss of the *Illegia trifoliata* vine that its caterpillars feed on, said ecologist Anuj Jain. The butterfly was last seen before 1926. It can still be found in Malaysia.



**Malayan tiger**  
One of the world's smallest tigers once prowled the rainforests of Singapore. As forests were cut down for plantations in the 19th century, tiger attacks became increasingly common. The killing of these tigers was encouraged, and the last wild tiger here was shot in 1930 in Choa Chu Kang. Today it is estimated that only a few hundred of them remain in the wild globally.



**Orange-and-black stingless bee**  
The loss of these bees is troubling because they provide forests with the key ecosystem service of pollination, says entomologist John Ascher, one of the world's leading bee specialists. The species was last recorded in Bukit Timah in 1965.



**Blood python**  
Despite its name, the non-venomous reptile can come in shades varying from yellow to brown. Much of what we know about the scarlet snake in Singapore is gleaned from only nine specimens collected before 2008. It can measure up to 1.4m long and weigh up to nearly 4kg. The reptile can still be found in Indonesia, Thailand and Malaysia.

# Tracing Singapore's history of extinction

How did Singapore lose most of its original forests over two centuries? The Straits Times looks at key chapters of the island's natural history, as well as the animals that disappeared during its development, some of which have been spotted again years later.

## Study finds loss of biodiversity here less than it was estimated

Ang Qing

For years, scientists thought that the loss of nearly all of Singapore's original forests over the past two centuries had wiped out about two-thirds of its biodiversity. Following the founding of modern Singapore in 1819, swathes of lush forest and their natural inhabitants were cleared to make way for people, plantations and buildings.

But a recent report has revealed that 37 per cent of the city-state's flora and fauna species had vanished during this period of deforestation and urbanisation. While it is a significant amount, it is less than previously estimated. In fact, it is nearly half of the estimated extinction rate of 73 per cent in a well-cited 2003 paper.

The latest study, which involved 27 experts and junior researchers and used novel mathematical models, was published in the scientific journal *Proceedings of the National Academy of Sciences* in December 2023.

Notably, the decade-long research led by theoretical ecologist Ryan Chisholm from the National University of Singapore (NUS) developed statistical methods that accounted for dark extinctions – the unknown number of plants and animals that died out before they were discovered.

Globally, these silent extinctions have posed a problem for scientists looking to chart the true scale of human-driven extinction.

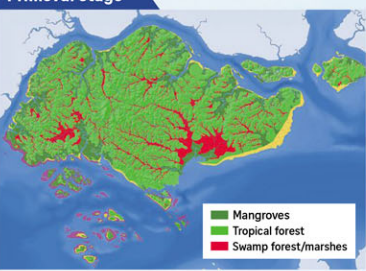
"The findings are significant for Singapore," said Associate Professor Chisholm, who conceived the research idea in 2012.

"(The study) gives more accurate estimates of extinctions than past studies, and it identifies large and charismatic species as having been particularly vulnerable to extinction here."

Charismatic species are fauna and flora that garner

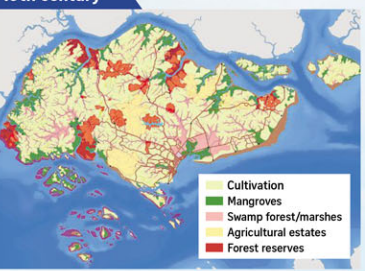
### How the island lost its forests

**Primeval stage**



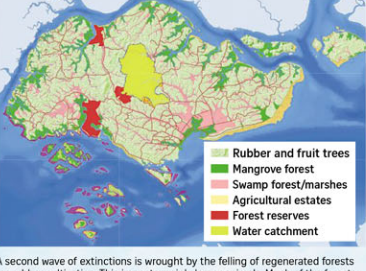
Most of the island is covered in rich, pristine forest. Wildlife is broadly similar to that in southern Peninsular Malaysia. Human occupation before the British founded modern Singapore in 1819 is thought to have been restricted to some settlements within key estuaries like the Kallang River and Malay fishing villages along the shoreline.

**19th century**



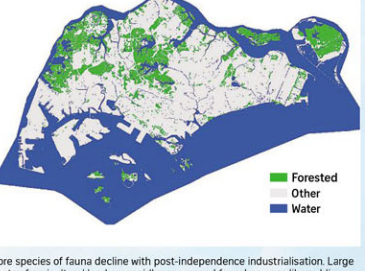
The first wave of extinctions occurs when swathes of forest are cleared for logging and agriculture, such as gambier and pepper plantations. Native plants and insects are hit the hardest by deforestation. In 1884, the British created Singapore's first few forest reserves, including today's Bukit Timah Nature Reserve, to tackle deforestation.

**Early 20th century**



A second wave of extinctions is wrought by the felling of regenerated forests for rubber cultivation. This impacts mainly larger animals. Much of the forests of today's Bukit Timah Nature Reserve remains intact due to legal protection. Forests in today's Central Catchment Nature Reserve are also recovering as the area is protected as a water catchment.

**Middle to late 20th century**



More species of fauna decline with post-independence industrialisation. Large tracts of agricultural land are rapidly repurposed for urban uses like public housing and industry. Butterflies and some birds are especially affected by the tree clearance. Extinctions taper off by the late 20th century. Only 4.3 per cent of Singapore's land area today is covered by primary forest and older secondary forest that can support a diverse ecosystem of native species.

### Biodiversity by the numbers

- 37%** Total extinction rate in Singapore over two centuries
- 18%** Species that South-east Asia is expected to lose by 2100
- More than 50,000** Number of flora and fauna observations
- More than 3,000** Number of species assessed
- 1796** Date of oldest record

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**FOUND**

**Oriental pied hornbill**  
The raucous bird was thought to have vanished in the mid-19th century, due to hunting and the loss of suitable habitat. In 1994, a pair was sighted in Pulau Ubin, spelling hope for the species' revival. Artificial nest boxes were set up by researchers to boost breeding. Today, the adaptable omnivorous bird is a fairly common sight in urban areas.



**Beaked cloak-and-dagger bee**  
The bright blue bee had not been collected for 95 years until it was trapped at New Soon Swamp Forest in 2015. It behaves like a cuckoo bird by laying its eggs in the nests of other bee species.



**Greater mousedeer**  
The animal is neither mouse nor deer. It is one of the world's smallest hoofed mammals. Owing to the lack of specimens and recorded sightings since 1921, the greater mousedeer was once deemed extinct here. That changed in 2009, when a breeding population was confirmed on Pulau Ubin.



**White-tipped baron butterfly**  
The butterfly is often mistaken for other baron species, according to Dr Jain. Both sexes from this species have a luminescent bluish sheen on their forewings. The species was rediscovered in the early 2000s. It is listed as nationally endangered.



**Selangor mud snake**  
The reptile was spotted swimming in a concrete drain near New Soon Swamp Forest in 2020. The only other record of the snake was at a rubber plantation in Bukit Sembawang in 1914. Respectively, the aquatic species typically found in forest streams is also quite rare.



**Half-banded kuhli loach**  
The freshwater fish once swam in the north and west of Seletar Reservoir. It can grow up to 10cm. The fish is most often found in calm, shallow blackwater areas like streams and swamps. It is unclear when exactly the fish went extinct, as samples were collected from the 1930s to the 1950s.

# Overall extinctions have slowed: Study

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est study's researchers said.

Given the differences in scale, Singapore may originally have been home to as few as one-fifth of the species found in similar habitats across Peninsular Malaysia, they said.

Using Singapore's experience as a guide, they predicted in the study that if deforestation continues in South-east Asia, the region could lose about 18 per cent of its species by 2100.

Said Prof Chisholm: "Despite Singapore being an imperfect window into the future, it is the best one we have."

"It is, to date, the world's most detailed study of tropical extinctions following deforestation."

The researchers likened the future landscape of South-east Asia to that of Europe, where the majority of plants and animals will live in human-dominated landscapes of the region, and extinctions are expected to be concentrated among large charismatic species.

In the light of these findings, researchers recommended shifting conservation messaging away from high extinction projections and towards conserving land-

## BASIS FOR PROJECTIONS

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**ASSOCIATE PROFESSOR RYAN CHISHOLM**, a theoretical ecologist from the National University of Singapore.

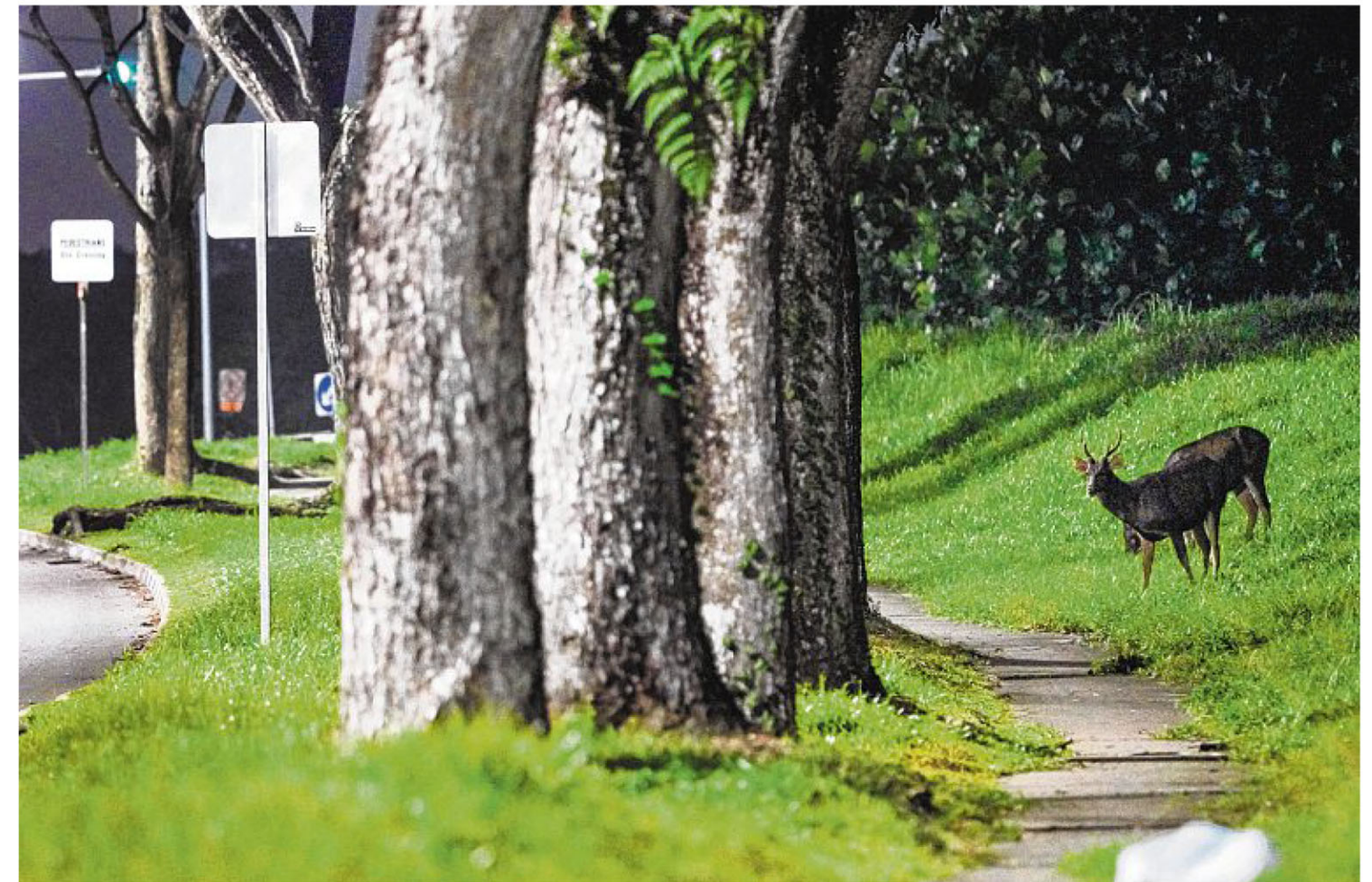
scapes like forest reserves that can protect these large charismatic species.

Said Prof Chisholm: "Adopting this approach not only benefits other species but also aligns with other conservation goals, such as the protection of carbon stocks, which is crucial in mitigating climate change."

In Singapore and other developed cities, small to medium-sized species that can persist in urbanised landscapes with conservation should be prioritised, the researchers said. An example is the tree-dwelling Raffles banded langur.

On a positive note, the team found that overall extinctions appear to have slowed or ceased in most animal and plant groups by the 21st century. In fact, some species have already recovered or have naturally spread from nearby Malaysia to Singapore.

National Parks Board (NParks) senior researcher Chong Kwek Yan, who was a co-author of the study, said the slowdown in extinction rate can be credited to low poaching rates – a key driver of extinction elsewhere – and the existence of secondary forests in nature reserves like the Central Catchment Nature Reserve that



Wild sambar deer by the roadside in the Central Catchment Nature Reserve in December. A research team found that overall extinctions in Singapore appear to have slowed or ceased in most animal and plant groups by the 21st century. In fact, some species have already recovered or have naturally spread from nearby Malaysia to Singapore. PHOTO: LIANHE ZAOBAO

have long records of protection since the colonial days.

"These areas have had the opportunity to mature and can serve as refugia," he said, referring to a safe haven that species can go to survive changing environmental conditions.

However, the researchers also cautioned that populations of some remaining species confined to small forest remnants could still disappear due to their small numbers. These include some forest-

dependent songbirds.

It remains to be seen whether poaching rates will drop across other South-east Asian countries as they develop – if not, species targeted by poachers will be lost at higher rates than extrapolations from Singapore would suggest, the researchers wrote.

Lauding the study, Dr Shawn Lum, a senior lecturer at Nanyang Technological University's Asian School of the Environment, who was not involved in the research,

said: "(The) approach allows scientists to accurately estimate possible extinction rates under a 'business as usual' land-use scenario anywhere, and gives policymakers, land managers, non-governmental organisations, and the entire conservation and development ecosystem a chance to find realistic and pragmatic solutions to hold, and ultimately reverse, the extinction curve."

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