WILDLIFE MATTERS

10 YEARS OF CONSERVATION IN SINGAPORE

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Wildlife Reserves Singapore
Conservation Fund

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Designed and produced by Epigram

Published by Singapore Zoological Gardens

Editorial by Hedgehog Communications

National Library Board, Singapore Cataloguing-in-Publication Data

Name(s):	Wildlife Reserves Singapore.
Title:	Wildlife Matters: 10 Years of Conservation in Singapore.
Description:	First edition. | Singapore: Published by Epigram for Wildlife Reserves Singapore, 2019.
Identifier(s):	OCN 1105730501 | ISBN 978-981-14-2177-8 (hardback)
Subject(s):	LCSH: Wildlife conservation—Singapore. | Nature conservation—Singapore. | Animals—Singapore.
Classification:	DDC 333.95416095957—dc23

Printed in Singapore

First edition, July 2019.

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Praying for the next meal.
Photo by David Tan / Wildlife Reserves Singapore.

MacRitchie Reservoir Suspension Bridge, 2017. Photo by Luiz Cent. Licensed under Creative Commons Attribution-ShareAlike 4.0 International.

Foreword

MS CLAIRE CHIANG, CHAIRPERSON
Wildlife Reserves Singapore
Conservation Fund

In the last two centuries, Singapore has gained so much, and lost so much. A city state held up as a shining example of rapid economic success, we've seen much of our natural heritage whittled away. Today, only 5% of our original forests remain. 28% of our wild species have vanished. The pressure on our natural resources only grows along with our population and its needs.

The entrusted responsibility of safeguarding our limited natural resources is a serious commitment, for the biodiversity in our waters, pockets of forest and even urban neighbourhoods is still astonishingly rich; it is an asset of the nation, worthy of respect and deserving of preservation.

Mr Lee Kuan Yew, the man who spearheaded Singapore's development, was appreciative of our natural heritage. He was a frequent visitor at Wildlife Reserves Singapore attractions with his children and grandchildren, and we saw a man well aware of the fragile balance between economic development and environmental preservation. Of Singapore Zoo, Mr Lee said in 1993, "It symbolises the kind of effort Singapore has to make if it is going to remain what it has been."

Such effort is now exigent. The work to support our vulnerable species in the face of urbanisation, global climate change and ecological damage must gain momentum, before habitat loss becomes irreversible. Ten years ago the WRSCF received its mandate as an independent fund to conserve threatened native wildlife. We were one of the pioneer funds which supported a community of green champions, extending them the means to turn their convictions into action. These are our tireless heroes, bringing their talents and abilities to the aid of locally endangered species.

With a modest start-up budget, we began with just one project, on the Raffles' banded langur. Today, over $1.75 million has been disbursed to more than 40 projects covering a range of species and habitats. We have empowered over 40 researchers and engaged and shared the conservation message with close to 100,000 individuals through 70 workshops, symposia and community engagement and education programmes.

We have partnered responsible organisations who share our values and are willing to step up to the task of protecting and revitalising our natural environments. From government ministries and statutory boards, across academia and businesses, to non-profit entities and volunteers from all walks of life, all are making a difference. Their work may be hidden from plain sight, but we applaud their dedication in caring for our native ecosystems.

In this book commemorating WRSCF's 10th anniversary, we bring you 13 of the projects we have supported. Through the stories and lush photographs that celebrate the wonderful diversity right here at home, we hope you appreciate how precious and how fragile our natural heritage is, and join us in protecting it.

My gratitude goes to the passionate team at WRSCF. Their unflagging commitment to the cause we serve gives me every reason to be hopeful that our wild citizens will have a home for generations to come.

Enjoy this book, and may you fall in love with wildlife in Singapore!

Stewardship, commitment and responsibility converge at WRSCF. Photo by David Tan / Wildlife Reserves Singapore.

The Wildlife Reserves Singapore Conservation Fund

The mouse deer is one of Singapore's shy natives. Photo by David Tan / Wildlife Reserves Singapore.

When the Wildlife Reserves Singapore Conservation Fund (WRSCF) was created a decade ago, local ecologists and nature enthusiasts sat up with interest. Here was a fund offering flexible grants, accessible to anyone wanting to contribute towards the conservation of native wildlife species. A financial avenue to support their cause was opening, amidst a growing concern over disappearing natural spaces.

It was also a significant milestone for the Fund's custodian, Wildlife Reserves Singapore (WRS). Already recognised internationally for its research and conservation work, WRS' impact on the conservation of local wildlife would be strengthened with the WRSCF. As Chairperson Ms Claire Chiang put it, "Our passion for conservation found expression in the move to put our money where our mouth is."

WRS pledged $0.20 from every admission ticket to its attractions—Jurong Bird Park, Night Safari, Singapore Zoo and, when it opened, River Safari—for the Fund. More came in from sponsors and donors, both corporate and individuals, reflecting an awakening public pride in Singapore's natural heritage.

WRSCF was officially launched on 10 July 2009 by the sixth President of Singapore, Mr SR Nathan. With a stated purpose "to fund projects which make a pragmatic, substantial and long-lasting contribution to native wildlife research and conservation", we have become a great enabler. Through us, research has been conducted which has deepened the understanding of local fauna and informed urban development; effective measures are being implemented to protect local species and their habitats; public education in Singapore's biodiversity is strengthening. From field work to conferences to festivals, every effort has made an impact.

Reviewing grant applications is an independent Specialist Panel with scientists and academics taking their place alongside representatives from government agencies. It comprises professionals from various organisations: the Agri-food and Veterinary Authority of Singapore (AVA), National Institute of Education (NIE), National Parks Board (NParks), Nature Society of Singapore (NSS), National University of Singapore (NUS) and the Raffles Museum of Biodiversity Research (RMBR).

These partners are just some of the many WRSCF collaborates with daily. We count global bodies and overseas institutions among our associates as well, joining in the work to protect the world's biodiversity. We have supported 40 field scientists and their conservation and research projects for the protection of local species. We have also supported the development of three national conservation strategies and hosted high-profile strategy meetings of the International Union for Conservation of Nature (IUCN).

WRSCF has contributed much to the rising awareness at home of the natural world around us. Singaporeans are learning to value our wildlife, even as the debate over development versus conservation builds, and an answer to human-animal conflict is sought. In bringing the conservation message to the people, we hope to foster a sense of ownership and inspire community action.

RIGHT
Habitat loss has led to the depletion of much of our local fauna. Photo by David Tan / Wildlife Reserves Singapore.

Singapore's Rich Biodiversity

EST. NUMBERS OF SPECIES WORLDWIDE	23,000–28,000	
SPECIES PRESENT WITHIN SINGAPORE	Amphibians	30 (25 native)
	Reptiles	117 (102 native)
	Mammals	69 (61 native)
	Freshwater fish	86 (37 native)
	Birds	403
	Butterflies	336
	Odonates	132

Macaque mother and baby savouring a precious moment. Photo by David Tan / Wildlife Reserves Singapore.

Ours to Treasure

Once upon a time, Singapore's wildlife was so abundant that Sang Nila Utama was instantly captivated by one of its native creatures.

As the story goes, he named the island after the animal he saw, though now we know for sure it wasn't a lion!

Singapore was still pristine when the British arrived centuries later. John Crawfurd, the second British Resident, recorded in 1830: "…the whole island may be described as having been covered with one universal mighty forest."

The British grew the island into a prominent trading post, but with the establishment of the port came people, by the hundreds and thousands. The natural environment succumbed to their needs and activities—by the end of the 19th century, almost all of Singapore's original forest was gone. The scale of loss was unprecedented, and till today, few countries in the world have seen such shrinkage in so short a time.

The rate of development only accelerated in the next hundred years. From clearing habitats for housing and industry, Singapore went to reclaiming land from the sea. Who today would have thought that our virtually flat landscape was once hilly country? We can only imagine how many plant and animal species were sacrificed in the transition.

What we do know is that with 99% of the original mangroves and terrestrial vegetation obliterated, at least a third of previously recorded species has vanished. Of those that are

left, 77% are considered under threat of extinction, based on the IUCN regional listing criteria.

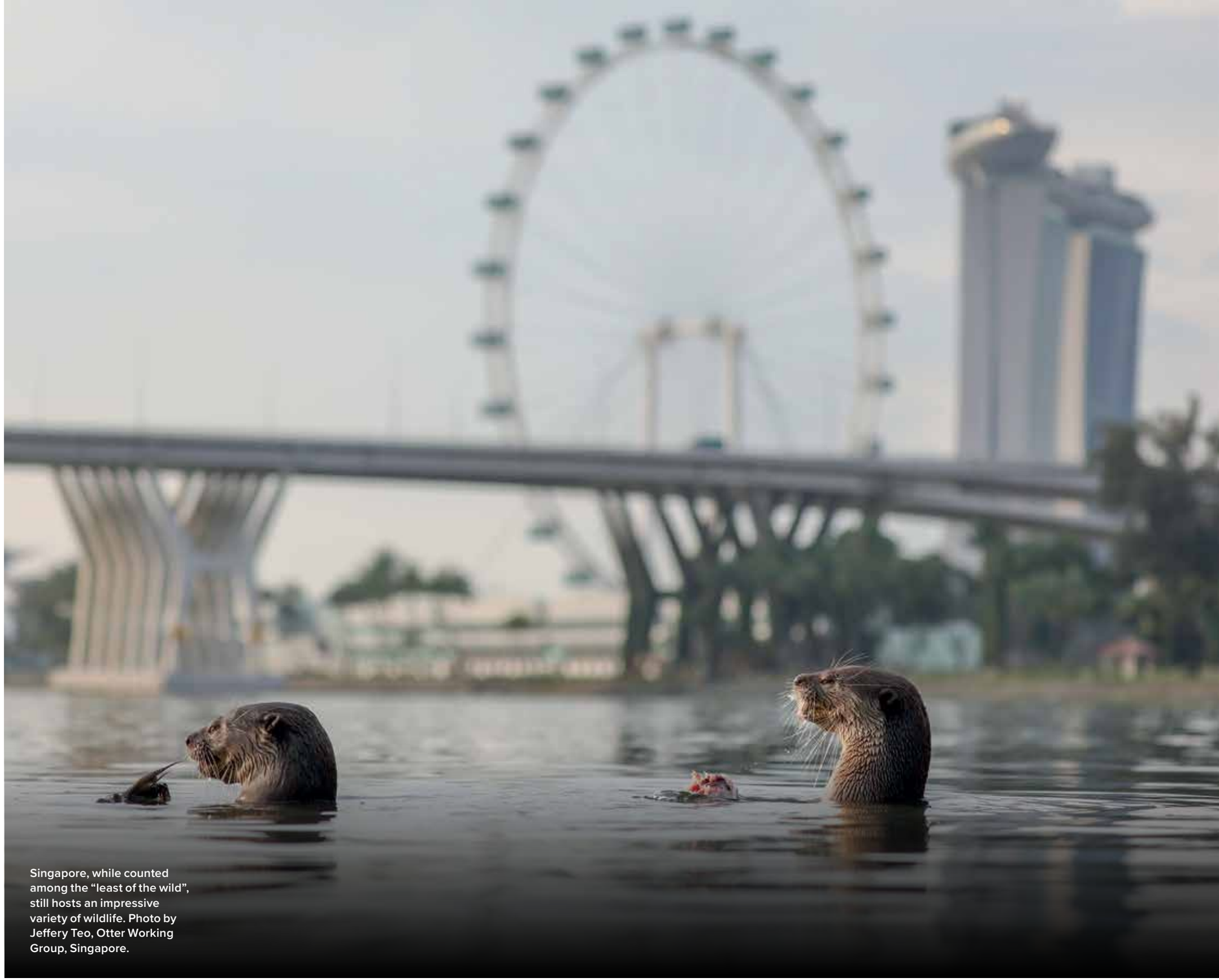
That is not to say that Singapore's natural environment alone is imperilled. Around the world, some 60% of wildlife has been wiped out since 1970, and habitats in South and Southeast Asia are among the most vulnerable.

Ecologically intact landscapes and seascapes now occupy only 5% of the earth—and are where half the world's biodiversity survives. On the other hand, half the human population resides in cities, the number of which is set to grow as the world's population balloons. These urban habitats, though, still offer some respite for biodiversity.

Conservation authority Dr Cristián Samper calls this contrast "the last of the wild" and the "least of the wild".

Singapore, now the third most densely populated country in the world and still leading the pace in urbanisation and technology, is one of these "least wild" places.

Yet, our small size belies the rich native biodiversity within. Our protected natural habitats include primary dryland forest, tall secondary forest, freshwater swamps, rocky shores, mangroves, mudflats, seagrass beds and coral reefs. Gazetted nature reserves, which make up only 0.25% of Singapore's land area, are home to more than half the local fauna. The unexpectedly varied native wildlife includes an estimated 1,173 species of terrestrial and freshwater organisms.



Singapore, while counted among the "least of the wild", still hosts an impressive variety of wildlife. Photo by Jeffery Teo, Otter Working Group, Singapore.

Like anywhere else in the world, though, threats to their existence persist: climate change, habitat encroachment and modification, invasive species, neglect, human-wildlife conflict. These are universal concerns charging a global debate that is growing more serious and more urgent by the day, for the world's biodiversity provides important ecosystem services crucial to our own survival.

Amidst the heightened conversation, WRSCF was established. Stepping up to support those who care enough to act before it is too late, our entrance was considered by local conservationists as timely.

From efforts directed at preserving species endemic to Singapore and found nowhere else on earth, to facilitating better understanding and tolerance towards those that share our spaces, our work has influenced local, even regional, conservation strategies broadly.

Our grants allow researchers to carry on the work that began centuries before, when British naturalists such as Stamford Raffles, William Farquhar and Alfred Russel Wallace began documenting the rich biodiversity here. We put modern methods and technology within reach of a new generation of scientists.

We have funded surveys which recorded new species in Singapore, and some rediscovered ones once thought locally extinct.

We have fostered conversations about why it is critical to conserve Singapore's biodiversity, and how we can achieve that. We have paved the way for inter-agency collaborations as Singapore strives to reach the fragile balance between development and conservation.

We have inspired a host of environmentalists and engaged an army of volunteers in citizen science.

To many of our recipients, WRSCF stands for staunch support for the work of conservation; we stand for a proactive approach to saving biodiversity; we stand for an appreciation and respect for nature.

Most of all, we stand for hope, for Singapore's people and her wildlife.

In 1884, the penalty for the unlicensed killing, wounding or taking of any other wild bird not on an allowed list was a fine of less than $2 for each bird or a jail term not exceeding 14 days, or both. Stiffer penalties of a fine up to $50 or a jail term not exceeding one month, or both, were imposed for procuring and instigating others to kill, wound or take wild birds. These provisions suggest that the legislators recognised the need to curb the demand for such trade altogether, as opposed to only punishing the offenders. For context, $1 was a day's earnings for a rickshaw puller then.

A Straw-headed Bulbul. Singapore is recognised as one of the few strongholds of this species. Photo by David Tan / Wildlife Reserves Singapore.

Unsung Heroes

Commitment

They may occasionally pop up in the news, but the corps behind Singapore's conservation work mostly beaver away out of sight, prowling the forests at night or hiding away in laboratories. Sometimes, drawn out by the need to give wildlife a voice, they do so with the full force of their conviction, rallying the public behind the creatures whose survival they fight for.

They are the champions for our biodiversity, working relentlessly to help a multeity of species, taxa and ecosystems. They are advocates for otters and ants, hornbills and fish and everything in between—from the charismatic to the unnoticed, the beautiful and the plain. It is their belief that all deserve to call Singapore home, whether they live in secret places or right amongst us, inhabiting our waters, our skies, our forests and even our urban neighbourhoods.

Having mentored, supported and propelled their crusades, WRSCF celebrates our conservation heroes as much as we celebrate Singapore's biodiversity itself. Our commitment to supporting them stands as part of our commitment to saving our natural heritage.

Brett Scheffers with fellow researchers on the job, 2011. Courtesy Brett Scheffers.

"Plans are only good intentions unless they immediately degenerate into hard work."

PETER DRUCKER, FOUNDING FATHER OF MODERN MANAGEMENT STUDIES

Lost and found—Singapore's rediscovered leopard cats. Photo by Marcus Chua.

Discovery and Recovery

Nothing beats the thrill of recording the first live individual of a species believed already extinct. It is what stirs the imagination and spurs urgently-needed conservation work.

"The enigmatic glance of the leopard cat seems to hold so much within. During the course of research, I often subconsciously try to examine the world through the eyes of the leopard cat."

Marcus Chua, mammal researcher with the Lee Kong Chian Natural History Museum, is clearly entranced. Little wonder, for someone who recorded an animal previously thought extinct in mainland Singapore.

The last of the wild cats after the tigers were wiped out, leopard cats were still common in the jungles of 19th-century Singapore, but only till the 1920s. That the last recorded sighting was 50 years ago never fazed Marcus. There had been hints—in 1997 one was caught in a fishing net on Pulau Ubin and two were identified in road kills in the next decade; then during a survey of pangolins, a population was revealed on Pulau Tekong.

Marcus says, "In the larger sense of the field, I was lucky that there was a body of research on leopard cats and other wild cats that I could draw on. But my mission was to chart what had not been done, and how to go about doing it." Till then, no local studies on the biology and ecology of native leopard cats existed.

Marcus, then a Masters student, set out to take a snapshot of how the wild cats were doing.

"The aims of WRSCF were a good match with what I hoped to achieve," he remem-

bers. With its support, Marcus and his team conducted almost 9,000 days of camera trapping and covered hundreds of kilometres in 303 night spotlighting transects.

The researcher relates, "For many months into the project, we were out in the forest in the nature reserve at night searching for signs of leopard cats, but there were none. I was thoroughly convinced our surveys would inform us that leopard cats did not exist in the Central Catchment Nature Reserve any more. Then, on April Fools Day, the very first one appeared."

It was not the only success. For the first time in the world, a population was also recorded on reclaimed land, in Pulau Tekong. "I remember telling my survey team, 'We are just going to put up cameras and do transects to prove they are not here'," he laughs. It turned out that leopard cats had colonised the new land with its secondary vegetation. "Resilient little beasts," he says affectionately, happy to be proven wrong.

Marcus' study confirmed aspects of the ecology of leopard cats that had been previously implied, such as their ability to thrive in human-modified landscapes, with forest, agricultural, reclaimed and urban elements. After all, the leopard cat was once locally referred to as "a notorious chicken-thief"!

While Marcus is satisfied to have answered the basic ecological questions of the elusive species, they are still on the brink of national extinction and need safeguarding. On Pulau Tekong, neither the population nor its habitat have legal protection from development. Elsewhere in Singapore, their scant numbers challenge their survival. There is a need, Marcus stresses, for a long-term conservation effort, and to find a way for them to live alongside us. "We are fortunate to retain these living examples of our natural heritage," he says.

His own efforts to champion the leopard cats are tireless. Ever eager to impart his knowledge about these "fantastic creatures", Marcus maintains a popular blog about them. It's titled, of course, *Through the Eyes of the Leopard Cat*.

Leopard cats are found throughout South and East Asia. While globally they are not an endangered species, in Singapore they are critically so. We need to protect the forested habitats that they depend on—not just the nature reserves—because we now know most of the leopard cats in Singapore live outside the nature reserves.

A real beauty, this leopard cat is one of the few remaining in Singapore. Photo by Marcus Chua.

Leopard Cat

SPECIES (SINGLE SPECIES)
Prionailurus bengalensis

FAMILY (MULTI-SPECIES)
Felidae

HABITAT
Primary and secondary forest, scrubland and plantations

EST. NUMBERS IN THE WILD
~21 adults on Pulau Tekong (2012); probably less than 20 are found in Singapore

THREAT STATUS
Critically Endangered in Singapore

LOCATION(S)
Singapore: Sungei Buloh Wetland Reserve, Pulau Tekong, Pulau Ubin, Western Catchment Area and Central Catchment Nature Reserve

BELOW
Picture of an elusive leopard cat, caught on one of Marcus Chua's camera traps. Photo by Marcus Chua.

RIGHT
Researcher Marcus Chua servicing a camera trap in the field. Photo by Kelvin Lim.

"Despite my best efforts in conjuring metaphors and managing expectations, a common refrain from many of my field assistants after seeing one is 'I thought it would be slightly bigger'. Makes me feel slightly hurt."

MARCUS CHUA

A Brown-banded bamboo shark keeping a wary eye on the fishing industry. Photo by David Tan / Wildlife Reserves Singapore.

Diving in with Sharks in the Industry

From a garden to the ports of Singapore, what do sharks, luminous kitchen gloves and disgruntled drivers have in common? It's all in a day's work for two WRSCF beneficiaries investigating the fishing industry.

When a friend slipped a shark into his garden pond, marine biologist Naomi Clark-Shen was not impressed. She not only released it, but enlisted fellow shark-activist Kathy Xu to check out the local port where it was bought. What they saw—piles of the elasmobranchs brought in with other fish—induced them to delve deeper into an industry as complex as it is controversial.

Saving sharks is more than just saying no to sharks fin soup, they would have us know. After all, Naomi points out, we may still be eating other seafood from fisheries that catch thousands of sharks too. Instead, they point to the non-discriminatory nature of the fishing gear which catches anything that swims by, landing some of the sharks in local ports. "If we have zero tolerance for practices that threaten nature, then suppliers will have to change their ways," she says.

Changing the ways of those in the trade, to Kathy, means giving them an alternate means of earning a living. A former schoolteacher who would screen the movie *Shark Water* for her students, she ultimately gave up her career to set up The Dorsal Effect, engaging the shark fishermen of Lombok in eco-tourism.

And so, from classroom to tourist beach to port. Kathy and Naomi received funding from

Early morning at the Singapore port. Photo by Roopali Raghavan / Wildlife Reserves Singapore.

“People only care about sharks when they become vulnerable, but sharks only become vulnerable when people don’t care.”

NAOMI CLARK-SHEN

Wedgefish, Rays and Sharks

FAMILY (MULTI-SPECIES)	Wedgefish: Rhinidae Rays: *Dasyatidae & Gymnurida* Sharks: *Carcharhinidae & Hemiscylliidae*
HABITAT	These sharks and rays are predominantly coastal species, found close to shore, such as on coral reefs.
EST. NUMBERS IN THE WILD	Unknown. For small coastal species like the ones Naomi and Kathy check on, there are no global population numbers. It is difficult to estimate numbers of sharks and rays in the wild, and ‘conservation status’ is frequently based on declines in catches at fisheries as opposed to surveys of remaining wild ones, as the ocean is too vast.
THREAT STATUS	Singapore; Unknown
LOCATION(S)	The majority of what was surveyed in the project did not come from Singapore but Indonesia and Malaysia.

Marine biologist Naomi Clark-Shen and shark activist Kathy Xu find space in the busy SIngapore port to carry out their research, gloveless. Courtesy Naomi Clark-Shen.

WRSCF to launch a monitoring programme, which AVA suggested to include the oft-overlooked rays.

Keeping tabs entailed bi-monthly traipses to the Jurong Fishery and Senoko Fishery ports in the middle of the night for a year. "Here comes my *ang moh* girlfriend again, watch how she waves and smiles at me," Kathy would overhear the workers tell each other in Chinese. An unsuspecting Naomi would invariably smile and wave obligingly.

Having to work without getting in the busy merchants' way proved tricky. The ladies can now joke about the faux pas they made when

they started—wearing bright green kitchen gloves ("There went our street cred!")—and about clutching at each other to avoid slipping and falling in among the fish, but it was mainly a long, hard slog. They identified and measured thousands of the elasmobranchs individually, and interviewed dozens of fishermen about their catch's provenance.

The results were immediately sobering. Despite constructive advances in import regulation, some trade-controlled species were spotted, including one shark species with a significant number of immature specimens, implying that they were fished from waters where they breed.

"Illegal, unregulated and unreported fishing is responsible for the death of around 60 million sharks a year," Naomi shares. "Developing traceability in supply chains, so only legal products are sold, is vital to end this."

Kathy adds that longer-term research at the port is needed. It is not their aim to put fisheries out of business, they stress, but to increase the sustainability of the industry and to preserve the sharks. Can fisheries move to different grounds, or change their methods or machines? Improved transparency and traceability will go a long way towards helping consumers be confident and comfortable, knowing the catch was caught responsibly.

Engaging fisheries here and in the region (over 70% of the catch is from Indonesia) is but a small step, though, because the fishing, consumption and trade of sharks is a global challenge, involving almost 30 countries in every continent.

Perhaps surprising news to the average Singaporean, sharks around the world are traded more for their meat than for their fins. As one of the cheapest seafood sources, it has become important for the most vulnerable sections of society, and as the human population swells, so seafood production is expected to intensify. Naomi warns, "If sharks are under pressure now, what does the future hold? It is not just sharks, but all seafood stocks, that face an uncertain future.

"The solution to saving sharks and rays is not black and white," she says; "There is no 'one solution that fits all'." Instead, she believes in taking time to understand the nature of individual fisheries, because as long as those whose lives are dependent on the industry are not taken into consideration, conservation efforts will not work.

For Naomi and Kathy, things don't move fast enough—science-based conservation measures take time, and the solutions they might develop now may not be realistic a few years down the road. Still, it will not stop them from trying, they say. If their work succeeds, "It will be a win-win for the ocean and society." At the end of the day, it makes putting up with unhappy private hire drivers who scold them all the way home for smelling like fish, worthwhile.

Lower Peirce Reservoir, Singapore. Photo by David Tan / Wildlife Reserves Singapore.

Common Palm Civet. Photo by David Tan / Wildlife Reserves Singapore.

Twin Interests Deliver Double

It is a happy thing when a talent in science coincides with a passion for nature; and when WRSCF steps in, great plans can be put in motion.

For Fung Tze Kwan, being able to meld her twin loves for science and wildlife as an ecologist is exciting, and WRSCF funding has allowed her to really spread her wings. It was with the help of one of its grants that Tze Kwan broke new ground with the first use of GPS telemetry to study a mammal species in Singapore.

Tze Kwan is interested in civets. For years, she has been studying the nocturnal creatures, becoming the go-to local expert and championing their conservation. Of the four species that call Singapore home, the Common Palm Civet is the only one that shares our urban environment, nesting in vegetation amongst us or even in roof spaces. These natives are shy, which explains why they are hardly known—barely a handful of ecological studies over the last 50 years exist.

Tze Kwan is also interested in restoring our forests. The last refuges for Singapore's rich fauna are a wonder for the biodiversity specialist who enjoys exploring nature, but also give her work some urgency because of how they are dwindling away.

Working on a project bringing the two together was, for her, obvious. A firm believer in an interdisciplinary approach to conservation, Tze Kwan wanted to learn more about the civets and their place in the ecosystem.

Towards this end, the WRSCF grant provided a material boost.

Tze Kwan's ambitious study involved two years of intensive field surveys on scat collection, camera trapping, animal trapping, GPS and radio telemetry, as well as experiments on gut passage time and seed germination.

Being a pioneer in employing GPS to track the civets meant a steep learning curve. "There was no local expertise for GPS telemetry and *in situ* sedating and collaring of wild mammals then," she recalls. A lot of effort was spent assembling and training a team. Vets, more than 50 volunteers, WRS, Outward Bound Singapore and NParks were all roped into the exercise. "We had to review and revise the trapping and sedation protocol many times, with multiple dry runs," Tze Kwan recounts. It took the field team six months before they collared their first wild civet on Pulau Ubin. By the end of the project, they had succeeded with six, and also tracked a translocated Common Palm Civet.

"Understanding the frugivorous diet of the Common Palm Civet, its movements and role as an effective seed disperser has shown us how to aid habitat restoration. It has also given us a lead as to rehabilitating civets back into the wild," she says, adding that with strategic planting of key plant species such as the fishtail palm, we can enhance ecological connectivity and food resources.

Other findings from the project show how well the civets have adapted to living in urban areas. It was with delight that the NUS Common Palm Civet Research and Educa-

The Common Palm Civet is adept at finding its way around both urban and forested landscapes. Photo by David Tan / Wildlife Reserves Singapore.

Common Palm Civet

SPECIES (SINGLE SPECIES)	*Paradoxurus musangus (Paradoxurus hermaphroditus)*
FAMILY (MULTI-SPECIES)	Viverridae Recent taxonomic revision has suggested splitting *Paradoxurus hermaphroditus* into three distinct species, with the Singapore population placed in the group that occurs in Southeast Asia, including Sumatra and Java—*Paradoxurus musangus* (Veron et al., 2014)
HABITAT	Primary forests, secondary forests, mangroves, suburban, urban
EST. NUMBERS IN THE WILD	No population study in Singapore so far.
THREAT STATUS	Even though the Common Palm Civet is the most commonly observed civet species in Singapore, it is regarded as uncommon at the national level. (Baker & Lim, 2008) Globally, due to its wide distribution and adaptability, the Common Palm Civet is listed as Least Concerned by the IUCN.
LOCATION(S)	Singapore: Nature Reserves, Nature Parks, parks, estates, Pulau Ubin and Sentosa

RIGHT
Fung Tze Kwan collaring a Common Palm Civet with vets Dr Shannon Heo and Dr Angeline Yang. Photo by Lee Chuen Ling.

OPPOSITE
Civet scat with germinating false olive seeds. Photo by N. Sivasothi.

The Common Palm Civet is locally known as musang or the toddy cat. Its signature scent is remarkably like pandan, so if you smell the plant without seeing it, you are probably not far from a civet.

tion Team (NCRT), which Tze Kwan is part of, discovered the animals in our neighbourhoods—crossing rooftops to reach forest patches, even taking advantage of drainage systems and old pipelines to navigate their way. Despite posing no danger to humans, though, conflict still exists. Threats from fast cars, animal traps and pets have left the species vulnerable, while urban development and the removal of green pockets have decimated their natural habitat.

"Rigorous science can teach us about the biology and ecology of the species and the ecosystems," Tze Kwan advocates, "but we also need to communicate the findings and reach out to the public and stakeholders to raise awareness."

That is just what Tze Kwan and the NCRT are doing, with support from WRSCF. They conduct walks, talks and civet rescues, and maintain a civet blog, Facebook page and public sightings record—all part of a holistic action plan to save the civets.

"They live amongst us," Tze Kwan reminds us. "We can do our part to coexist peacefully."

Coral fragments, once grown to suitable size in coral nurseries, are transplanted onto degraded reefs with the use of adhesives such as marine epoxy. Over time, the fragments grow over the adhesives and cement themselves onto the substrate, ultimately contributing essential ecosystem services to the reef. Photo by Lionel Ng.

Catching Up with the Past to Ensure a Future

WRSCF funds provide the means for projects to succeed. These, in turn, establish a good foundation for others that come after.

Coral reefs, home to myriads of exotic aquatic life, fascinate everyone, particularly those who dive as a hobby. Amid the beauty beneath the waters, though, divers also find signs of a habitat in distress—bleached corals, sedimentation and pollution. It leads some, like Dr Toh Tai Chong and Lionel Ng, to question what is happening in our waters, and whether there is a way to make a change. It is why they dived next into the world of marine research.

While a plethora of reef restoration projects have been attempted in decades past, the science behind restoration is still in its infancy. WRSCF support was a lifeline and a welcome resource for the two NUS researchers determined to pursue a science-based approach. Tai Chong says, "The grant came at a time when I had run out of money for my project—I might not have completed my PhD if not for it!"

It certainly did not help that corals grow slowly and studies can take a long time. Tai Chong's project, examining if enhanced nutrition for juvenile corals boosts transplant survival rates, was far from straight-forward. The long and finicky procedure entailed collecting mature corals from reefs off Kusu Island and catching the new moon every month when the corals release their larvae. The juvenile corals were reared with great care before being transplanted back to the reef, with regular monitor-

ing along the way. Then, in a heart-stopping moment two years later, it all ground to a halt with a ship-grounding accident at the transplant site.

Still, Tai Chong, who is the local coordinator for the Global Coral Reef Monitoring Network, was able to fill key knowledge gaps in coral juvenile feeding biology, and his work resonates today throughout both aquaculture and reef restoration efforts globally. As an unexpected plus, the project spawned a reef rehabilitation framework as well, which he calls AME.

Going forward a couple of years, Tai Chong's laboratory colleague Lionel, too, became a WRSCF recipient. With intensive field work to evaluate past reef restoration works (including Tai Chong's), Lionel proved the importance of following up on restoration initiatives. His studies have found relevance not just for coral reefs but also with other marine scientists. Realising the value in long-term monitoring, more have started to employ such techniques.

Lionel believes WRSCF provided an important stepping stone from which more projects have taken off. "There is a lot of collaboration among stakeholders to safeguard the future of our reefs," he says, praising a tripartite approach involving researchers, government agencies and the community. The AME, which links scientific and management concepts and has a worldwide application, is being expanded. More Singaporeans are being engaged through volunteer dives and other outreach efforts.

Caulifower Coral

SPECIES (SINGLE SPECIES)	*Pocillopora acuta*
FAMILY (MULTI-SPECIES)	–
HABITAT	Coral reefs
EST. NUMBERS IN THE WILD	Undetermined
THREAT STATUS	Least concerned
LOCATION(S)	Singapore; Various locations in southern islands

"Even businesses are interested in enhancing biodiversity," Lionel marvels. He relates how ONE°15 at Sentosa found corals growing naturally in the marina and are now working with scientists to maintain them. "As marina owners they are being aware, proactive, and responsible." It is progress like this that keeps Tai Chong and Lionel optimistic.

A decade-old Reef Enhancement Unit (REU) that has been naturally colonised by sponges, hard corals and algae. The artificial reef structure functions as a stable platform for non-mobile organisms to recruit and grow. Photo by Lionel Ng.

RIGHT
A damselfish has made its home within an REU. Fish eggs can also be seen as small specks on the interior walls of the REU. Photo by Lionel Ng.

OPPOSITE
Young marine enthusiasts catch Toh Tai Chong's zeal for corals at an exhibition in Sentosa, 2018. Courtesy Toh Tai Chong.

Coral reefs are complex ecosystems; the marine life they host and the coastal protection they afford are vital to some 500 million people, especially in Southeast Asia. The seas here support the richest reef biodiversity in the world. In Singapore, the last half century witnessed a loss of over 60% of our coral reefs. Rapid coastal development resulted in chronic sedimentation—where once water visibility was over 10 metres in the 1960s, today it is less than two metres. Add to that the damaging effects of global warming, and Tai Chong says it is essential that we adopt a proactive stance before we lose our reefs altogether.

“

…looking down into the coral covered depths below, which on a calm day seemed like a fairy forest, the coral having a most tree-like appearance and of every variety of tint from deep red to the most delicate green. Fish of all sizes and colours were swimming about in every direction far down in these charming water woods.”

DOUGLAS HAMILTON, ON KAYAKING IN SINGAPORE WATERS IN 1842

Some corals that naturally settled on the REUs have grown and become sexually mature, able to seed other reefs. Here, egg bundles (white and shaped like capsules) are revealed from the branch of an Acropora colony that was sampled prior to a mass spawning event in 2014. Photo by Lionel Ng.

Singaporeans should fall in love with that puppy-like face, instead of shunning our local bats, says Joanna Coleman. Photo by David Tan / Wildlife Reserves Singapore.

Going to Bat for Urban Wildlife

In Singapore, wildlife isn't just found in the wilderness. Some of our wild friends have adapted to living in modern, urban environments along with their human inhabitants. WRSCF supports those who lead the way towards a peaceful coexistence.

It is dusk. A small shadowy figure swoops down from a building and flits across the street. A pedestrian shudders and quickens her steps. "Bats," she thinks. "So dirty." She hopes she doesn't pick up any diseases it may have spread.

If Dr Joanna Coleman had her way, Singaporeans would take a closer look at that puppy-like face and fall in love with one of Singapore's more resilient natives instead.

The ecologist and conservation biologist specialises in urban-ecology research. One of her areas of interest is how people connect with nature, including what we know and feel about bats. "I want to make people aware that we rely on them," she says. For example, durian-loving locals may appreciate that certain species of bats are the only known pollinators of the king of fruits. "Rarely have we encountered members of the general public who are aware of how bats serve the ecosystem or of the threats they face."

She bemoans the fact that "people are eating and persecuting our way through nature", warning that we must be careful not to let bats disappear, lest we end up erasing our ability to grow food and protect crops from pests and ourselves from insect diseases. "We need

to preserve elements of nature that help," Joanna urges.

Bats are animals that receive little conservation attention. In Southeast Asia, they are among the least-known, and most disliked—"undeservedly maligned creatures", Joanna calls them.

In Singapore, dramatic changes in land use have caused the loss of over 50% of bat species, which, Joanna argues, makes it critical to conserve what is left. Despite being highly urbanised, our city-state is still home to some 20 species, the lesser Dog-faced Fruit Bat being one of those more commonly seen.

While bats generally respond negatively to urbanisation, this may not be the case with this species in Singapore. Not being very fussy about where it roosts or what it eats has probably helped the Dog-faced Fruit Bat thrive here. Joanna has even found it roosting under fluorescent lights.

Because the species is known to disperse seeds of many plants, Joanna wanted to investigate whether it plays the same important role in cities as in forested areas. This became the basis for a long-called-for study on ecosystem services and disservices by urban bats, the first systematic one anywhere.

"One of the best things about the WRSCF is that it places considerable emphasis on conservation-based research and the types of research that are meaningful," the NUS Senior Lecturer acknowledges.

The Dog-faced Fruit Bat is a model animal for peaceful human-wildlife coexistence. Photo by David Tan / Wildlife Reserves Singapore.

Dog-faced Fruit Bat

SPECIES (SINGLE SPECIES)	*Cynopterus brachyotis*
FAMILY (MULTI-SPECIES)	Pteropodidae
HABITAT	Terrestrial, Urban
EST. NUMBERS IN THE WILD	—
THREAT STATUS	Common
LOCATION(S)	Singapore; everywhere

RIGHT
Bat having its wing examined. Photo by Lee Sui Kei Rachel.

BELOW
Joanna Coleman in action. Photo by Grady Semmens.

Bats are animals that receive little conservation attention. In Southeast Asia, they are among the least-known, and most disliked—"undeservedly maligned creatures".

Under her supervision, final-year Environmental Studies student Angela Chan spent four months sorting through everything that bats at nine sites across the island pooped, chewed and spat out. By cleaning and isolating seeds and germinating them, she could then identify the plant species the bats had eaten. WRSCF specifically funded DNA barcoding, which offered greater resolution.

As it turns out, an urban bat's diet is no less rich than its rural cousins', largely including natives like the Tembusu (a heritage tree), various figs and the sea almond, as well as Tiuptiup, a common species in secondary forests. In addition, the bats' foraging activities implied movement between urban patches and forest, which suggests the key role they could play in forest restoration.

Joanna sees much potential in the finding. With Singapore already paying close attention to greening the city, there is scope to plant more strategically, especially near forest fragments, and take advantage of the bats to buffer endangered plant populations. "We can work together with wildlife and nature to shape what our city looks like," she exhorts.

Only 1% of original vegetation remains in Singapore, but Joanna is sanguine about the future of native plants. Still, she cautions, "Not all that is green is equal." Urban planners need to be better informed, she believes, so that they will be convinced that biodiversity is something to be preserved, rather than serving up a sanitised version. She points to plans for large reclamations that will remove existing forests. "It is important that residents in highly urbanised environments like Singapore get back to nature," she says, "That's how you boost the motivation to conserve nature."

As for the Dog-faced Fruit Bats, Joanna remains optimistic. Given its ubiquity and proximity to humans in Singapore ("not to mention its relatively cute appearance," she adds), she sees it being used as a model animal to spark meaningful conversations on how humans can co-exist peacefully with wildlife.

An adult male White-rumped Shama getting ready to swell its song. Photo by Tan Hui Zhen.

Birds in the Hand and Birds in the Bush

WRSCF unlocks the latest technology for researchers. With better tools come better understanding and better strategies to save our wildlife from illegal trade.

Birds were never meant to be in cages, believes researcher Elize Ng, but free to fly in their natural habitat. However, Singapore's bird-singing culture, with its roots dating back a hundred years, is as much a part of our national heritage as the birds are a part of our natural heritage.

Among the most popular and prestigious of songbirds here is the White-rumped Shama, beloved for its dulcet tunes and wide repertoire. While bird hobbyists have a genuine passion for the species and take assiduous care of their pets, it may be that same ardour that caused their native population to plummet after intensive poaching. "Songbirds are threatened like no other animal group, all because they sound nice," says Dr Jessica Lee, from the Conservation & Research team at WRS and coordinator of the IUCN SSC Asian Songbird Trade Specialist Group. "Their melodious calls are also their curse, and many songbirds are on the brink of extinction—this is the silencing of a symphony!" By the 1970s, the White-rumped Shama was considered extinct in the wild on mainland Singapore, though at the turn of the millennium anecdotal evidence suggested they had repopulated. Elize wondered, was this a result of conservation efforts for the endangered species, or were more caged birds, imported from the region, going free? The then-undergraduate set out to discover their status.

"The downside of working with a threatened species is that finding them in the wild is really tough," she says. It took her a while to become familiar with the bird's varied songs in order to track it, and was elated when she finally recognised a call. She recounts, "I followed the bird for a good 20 minutes before it finally showed itself, but it turned out to be a Greater Racket-tailed Drongo mimicking a call of the shama!" Over the months, Elize eventually found only three individuals in the nature reserves.

A specific aim of hers was to detect if there were White-rumped Shamas from the cage-bird trade in local wild populations, whether amongst the limited numbers inland or the stronger populations on our peripheral islands. As imported birds originate from elsewhere in Southeast Asia, she could do this by searching for the genetic differences between them and the natives. Elize thus conscientiously collected samples from various museums from Laos to Borneo, eager to embark on new research employing the latest molecular methods.

It was funding from WRSCF that permitted the young researcher access to state-of-the-art genome-wide single nucleotide polymorphisms (SNPs) technology, developed around that time. Getting both the laboratory and bioinformatics up to speed was then just a small bump in the novel, more efficient process.

Being able to tap up-to-date technology procured a fine-scale resolution that Elize says "is just not possible with traditional markers".

The White-rumped Shama is beloved for its dulcet tunes and wide repertoire. Photo by David Tan / Wildlife Reserves Singapore.

White-rumped Shama

SPECIES (SINGLE SPECIES)	*Copsychus malabaricus*
FAMILY (MULTI-SPECIES)	–
HABITAT	Broadleaved evergreen primary and secondary rainforest
EST. NUMBERS IN THE WILD	~500
THREAT STATUS	Critically endangered
LOCATION(S)	Singapore: Nature parks and reserves and on Pulau Ubin and Pulau Tekong

Genetic Differentiation

- Refers to traits certain individuals within a population or species may have, e.g. the ability to resist a particular disease.
- A genetically homogenous species could be wiped out by a single change in the ecosystem.
- Wide genetic differentiation allows species to be resilient to changes in the environment.

Genetic Integrity

- Refers to maintaining the traits that set one species apart from another.
- The genetic integrity of local Singaporean lineages may be jeopardised by the introduction of other genetically distinct lineages.
- We need to be mindful of consequences, and not casually release wildlife into our nature areas.

Among the most popular and prestigious of songbirds here is the White-rumped Shama...While bird hobbyists have a genuine passion for the species and take assiduous care of their pets, it may be that same ardour that caused their native population to plummet after intensive poaching.

Through it, she found that the birds from the reserves had much more in common with those from Selangor, 320km from Singapore, than with those from Pulau Ubin and Pulau Tekong, not even 10km from the main island of Singapore. This supported her hypothesis that many of the shamas found on the main island could formerly have been caged birds.

She muses that this may not be undesirable from a conservation perspective. Shamas, she says, were in the past inadvertently introduced from peninsular Malaysia to Singapore, and may have had a positive effect on the original population by diversifying it genetically. It made the population as a whole viable.

Furthermore, given how the prized bird has already gone extinct across wide swathes of Southeast Asia, she sees hope for the species here. Singapore, as the only Sundaic country with strict enforcement of poaching bans, might well be their last safe haven—"An insurance population", Elize dubs it.

Today, the research assistant in NUS' Avian Evolution Lab continues the conservation work she started those years ago with the WRSCF grant. Her studies have also been used by the Asian Songbird Trade Specialist Group, and her research has been applauded by international conservation groups as "exactly the kind of work we need more of".

Elize Ng scanning the tree canopy for the elusive shamas. Photo by Tan Hui Zhen.

White-rumped Shama.
Photo by David Tan / Wildlife Reserves Singapore.

“The insatiable demand fuelling the unsustainable and illegal songbird trade is recognised as a key threat for many species. Songbirds are singing the call of extinction—if nothing is done to protect them, our forests will fall silent forever.”

JESSICA LEE, WILDLIFE RESERVES SINGAPORE

In its earlier stages of life, the Malayan Horned Froglet is no bigger than a Singapore 10-cent coin. Photo by David Tan / Wildlife Reserves Singapore.

Life in a Layered Cake

The delicate balance in our forest ecosystems is at risk. One researcher explores the nuances of forest life and makes it relatable for Singaporeans.

Dr Brett Scheffers has a somewhat different perspective of climate change from most people—one from 40 metres above ground, that is. The ecologist has clambered up the large dipterocarp trees of Singapore's forests, looking for the frogs and reptiles that live in the canopy as part of the complex rainforest community.

Brett compares life in the tropical rainforest to a layered cake. From the ground to the tops of the trees, unique sets of species are found in each "layer". His work confirmed this layering is widespread in the habitat, but what he also discovered along the way surprised him.

"My research showed how sensitive this layering of animals is to changes in temperature and rainfall. When the forest begins to dry out, animals shift down out of the trees towards the ground—I call this 'forest flattening'," Brett explains. As global warming inflicts its damage, he predicts this flattening will become more common, causing the "layered cake" to collapse. Canopy animals would then meet the ground animals, causing new species interactions with possible harmful impacts, he warns.

"Think about it in this way: you have a business in a tall skyscraper in Singapore consisting of 30 floors; each floor of the building is occupied by workers; then due to some disturbance or malfunction on the upper floors of the building, all workers are asked to move to the ground floor.

So now you have 30 floors of people all trying to work and live together on just one floor."

His disquieting illustration may well resonate with urbanites here, highlighting another point that Brett wants to make: that society is not taking climate change and its long-term impact on nature and civilization seriously enough. "We cannot continue as if it's business as usual," he asserts.

Doing so would only be cataclysmic for both wildlife and people. For Singapore, which is landlocked and flat, Brett sees the only remedy and defence against certain climate warming as keeping our primary rainforests intact. Unspoiled, they are a buffer against extreme climates and can protect biodiversity. It should be a priority for Singapore's conservation management, he feels, to keep our core habitat areas undisturbed.

He says, "Those old forests of the Central Catchment Nature Reserve and Bukit Timah are part of Singapore's legacy and natural history—they are the libraries of an amazingly complex world."

As for the 11 species of amphibians and 20 reptile species that were found during his forest study, Brett only hopes that in the years to come, they can have their cake and eat it too.

LEFT TO RIGHT
Malayan Horned Frog, Common Greenback and Malayan Giant Frog. Photos by David Tan / Wildlife Reserves Singapore.

	Malayan Horned Frog	Common Greenback	Malayan Giant Frog
SPECIES (SINGLE SPECIES)	*Nyctixalus pictus*	*Rhacophorus cyanopunctatus*	*Pelophryne brevipes*
FAMILY (MULTI-SPECIES)	Rhacophoridae	Rhacophoridae	Bufonidae
HABITAT	Arboreal, Forest and Terrestrial	Forest, Terrestrial	
EST. NUMBERS IN THE WILD	Unknown		
THREAT STATUS	Rare, Critically Endangered (CR)		
LOCATION(S)	Singapore; Central Catchment Nature Reserve, Bukit Timah Nature Reserve	Central Catchment Nature Reserve	Bukit Timah Nature Reserve

“

I am so grateful for the support from WRSCF, which made this research possible while I pursued my PhD. Case in point is that I am now an Assistant Professor of Wildlife Ecology and Conservation at the University of Florida in the USA, leading a research group of post-doctoral fellows, graduate and undergraduate students. They are all focused on the theme of how climate change impacts tropical forests, and their work spans the Americas, Africa, Asia and Australia. Thus the influence of WRSCF funding and support has extended well beyond that initial study and is being applied on a global scale.”

BRETT SCHEFFERS

Brett Scheffers takes aim at global warming. Photo by Pierre Honore.

Enabling Partnerships

Stewardship

No single group on its own is able to resolve the complex problems that loom over our wildlife, but when we bring people together, great things ensue.

WRSCF's stewardship comprehends more than the crucial financial aid we offer; we also provide a unifying platform for those in the field to collaborate. Never static nor localised, the multi-layered dynamics in conservation require an integrated tactic that calls for communication, resourcefulness and responsibility. Government agencies, non-government organisations, the private sector, academia, the public and international organisations all have a place at the table. They may have different objectives, but they share the same end goal of saving our natural heritage. Call it a synchronisation of information, innovation and operation, if you will.

Bridging gaps, facilitating policymaking, sourcing solutions—the WRSCF acts as steward, steering stakeholders towards the best possible outcome for biodiversity.

Otter watching has become a leisure and educational activity in Singapore. Here, young biologists and friends of biodiversity groups are out to observe the otters. Photo by Jeffery Teo, Otter Working Group, Singapore.

"The history of the world will, one day, be defined by the people who witnessed the tragedy of impending extinction and were able to turn humanity's destructive patterns into creative solutions."

JENNIFER SKIFF, *RESCUING LADYBUGS: INSPIRATIONAL ENCOUNTERS WITH ANIMALS THAT CHANGED THE WORLD* (2018)

Singapore Freshwater Crabs are invisible to the casual observer. Photo by David Tan / Wildlife Reserves Singapore.

Bridging the Gap, with a Gentle Human Touch

Singapore's natural heritage is unique, but some of its iconic species are critically endangered. WRSCF puts its weight behind efforts to reverse the decline and has seen some happy results.

Few people realise it, but Singapore is home to several species which are not found anywhere else in the world. Take the tiny Singapore Freshwater Crab: an important nutrient recycler in stream ecosystems, invisible to the casual observer in its hill-stream habitat—and critically endangered. That it bears our country's name, says Dr Daniel Ng, manager at NParks' National Biodiversity Centre, only emphasises the need for Singapore to save it from extinction.

Traditionally, conservation planning is carried out in parallel by different groups, but alone, each can only achieve so much. When the Singapore Freshwater Crab Working Group was formed in 2014 to bring all stakeholders together, therefore, hopes and expectations were high. Comprising representatives from the National Parks Board (NParks), the National University of Singapore, Wildlife Reserves Singapore and others, the Working Group collaborated on a formal conservation strategy, making ambitious plans to restore the endemic species. However, Daniel and his colleagues were hampered by the fact that so little was known about the crabs.

"The WRSCF funding was timely," Daniel notes. It is estimated that only a few hundred mature individuals remain in the wild. With

more fieldwork made possible as well as more detailed research in the lab, the project started to move along. "We were able to make recommendations backed by sound science, and found considerable success," he beams.

Success, though, had not come easily. The group had developed a pilot captive breeding programme, but again and again, the crabs were unable to brood. The initial WRSCF-sponsored *in situ* and *ex situ* studies built their understanding of the species' ecology; the group soon learnt to recognise the very narrow range of conditions which suited the creatures, allowing NParks to replicate their natural environment in a specially created breeding facility. Eventually, their perseverance paid off, and over 40 crablets hatched in early 2018, the first successful hatching in captivity of the *Johora singaporensis*.

Professor Peter Ng, Head of the Lee Kong Chian Natural History Museum, who discovered and named the species in 1986, quipped, "I am heartened to know NParks has managed to get these animals to cooperate—it's good news."

More than 150 crablets have since hatched in captivity and been distributed among various facilities run by the working group to be nurtured.

In the meantime, others were busy looking for a new home for the crustaceans. There is little natural hill-stream habitat left undisturbed in Singapore, but careful surveys led to the identification of a potential site.

A week after National Day in 2018, NParks released a small cohort of juvenile captive-bred Singapore Freshwater Crabs into a freshwater hill stream in the Bukit Batok area. It was a significant milestone, bringing with it the hope of establishing new populations in the wild.

The alliance of the working group has been vital and the targeted efforts of many working in tandem have borne fruit, reversing a sharp decline in the Singapore Freshwater Crab population. Daniel is pleased to announce that "the future of this species is more secure than it was a decade ago." While the work continues and much remains to be done, a pivotal achievement has moved us closer towards ensuring the species' survival for generations to come—an achievement of national significance.

The *Johora singaporensis* is not the only freshwater crab species found exclusively in Singapore. We are also home to Johnson's Freshwater Crab and the Singapore Swamp Forest Crab, both of which are threatened endemic native species.

Singapore Freshwater Crab

SPECIES (SINGLE SPECIES)
Johora singaporensis

FAMILY (MULTI-SPECIES)
–

HABITAT
Hill streams

EST. NUMBERS IN THE WILD
A few hundred mature individuals

THREAT STATUS
Globally critically endangered

LOCATION(S)
Only known in a few hill streams in Singapore
(Only found in Singapore)

A pair of *Johora singaporensis* mating in captivity. Photo by Daniel Ng.

RIGHT
Daniel Ng leaves no stone unturned in his research. Photo by Daniel Ng.

OPPOSITE
The crab that bears our country's name: the Singapore Freshwater *Johora singaporensis*. Photo by Joel Sartore / National Geographic Photo Ark.

“

Measuring around 3cm in size, the Singapore Freshwater Crab plays an important role as a nutrient recycler in the hill stream ecosystems. It is found nowhere else in the world other than in a few hill streams in Singapore. We will work together to ensure that the surviving populations of this crab are protected and their habitats conserved.”

DANIEL NG

Conservation action scales up for the Sunda pangolin. Photo by David Tan / Wildlife Reserves Singapore.

Scaling Up Conservation Action

WRSCF's logo is a Sunda pangolin, the most heavily-trafficked mammal in the illegal wildlife trade, and one of the most threatened species on this planet. Singapore has been a tiny sanctuary, home to about 200 pangolins. Dr Helen Nash talks about what is being done to protect them, with WRSCF's support.

You have been working full-time with pangolins since 2012. What is it like?
Pangolins are wonderfully charismatic. We have loved following them around all sorts of unexpected places. But going to children's playgrounds, back gardens, industrial sites and busy roads has shown us that we need to consider unusual challenges, such as what to do when a pangolin uses a pipe to lower itself into a deep drain but then can't climb back out. Or how we can prevent pangolins from zig-zagging back and forth across roads, causing havoc for drivers and endangering themselves.

You're part of the Singapore Pangolin Working Group (SPWG), established in 2014 to strategise and implement conservation action. Who else make up the team, and what are some of the ways you work together?
We are a varied assembly, coming from WRS, Animal Concerns Research and Education Society (ACRES), Agri-food and Veterinary

Authority (AVA), Conservation International (CI), Lee Kong Chian Natural History Museum (LKCNHM), National Parks Board (NParks), Nature Society (Singapore) (NSS), The Pangolin Story, Wildlife Conservation Society (WCS) and universities, along with other researchers and volunteers.

In September 2018, we launched a National Conservation Strategy and Action Plan for Sunda pangolins in Singapore, tapping WRSCF funding.

It is wonderful how the public has been motivated to care about the pangolins. When people find one needing rescue, they give ACRES or NParks a call, and it is brought to WRS for veterinary attention. Once it is rehabilitated, NParks, WRS and I coordinate its release into a safe, natural and confidential location. A couple of volunteer field assistants, usually from NSS and WRS, and I monitor the pangolins by various means. Through this we have been able to better understand the ecology and behaviour of our local pangolins.

Has there been much progress?

Initially, very little was known about even the basic ecology and behaviour of pangolins, which limited the effectiveness of conservation interventions. WRSCF funding gave us the chance to unearth a lot of novel behaviours which were not previously documented. We discovered pangolins sleeping beneath six lane highways, and using drains and culverts to move across the

The future of pangolins hitches on progress made now. Photo by David Tan / Wildlife Reserves Singapore.

Sunda Pangolin

SPECIES (SINGLE SPECIES)
Manis javanica

FAMILY (MULTI-SPECIES)
Manidae

HABITAT
Primary and secondary tropical forest, plantations, grassland, peri-urban areas

EST. NUMBERS IN THE WILD
Possibly more than 200 in Singapore

THREAT STATUS
Critically Endangered

LOCATION(S)
Singapore; Nature reserves, gardens, university campuses, roadsides, drains and military areas

RIGHT
Tipping the scales in favour of pangolin survival. A rescued pangolin being rehabilitated at WRS.

OPPOSITE
Helen Nash conducting post-release monitoring using radio tracking.

Photos by David Tan / Wildlife Reserves Singapore.

country. The urban ecology was very surprising. Based on our findings, several national planning agencies are now incorporating pangolin-friendly features into new developments. Old Upper Thomson Road, for example, will soon include subterranean wildlife passages and other features to help pangolins exit drains and culverts. The Public Utilities Board (PUB) has also been thinking about ways to help pangolins since we found drains and canals to be important wildlife corridors. In addition, we have seen several private developers opt for wildlife shepherding techniques to relocate pangolins to safe areas when land has to be cleared.

It does seem as though an increasing number of people are interested in and excited about pangolins and willing to help them. We have had more and more call-outs to rescue pangolins at risk.

There has been increased media attention, and we have even had students request mentoring for their pangolin projects and awareness raising events. We also give talks in universities, schools, public libraries, government agencies and local nature societies, and the response has been fantastic.

How optimistic are you about the future of this species in Singapore?

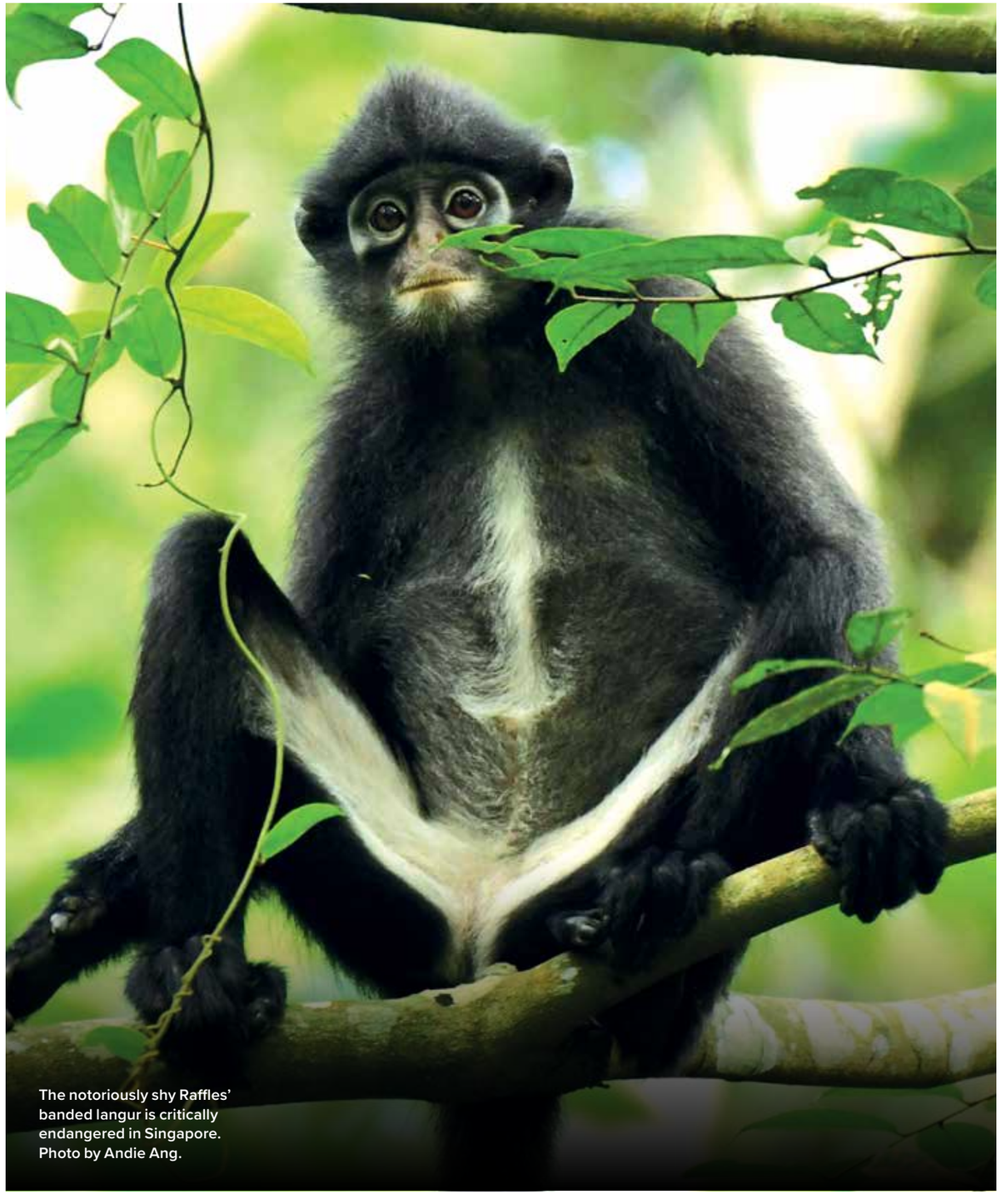
There is tremendous opportunity for pangolins and people to co-exist in Singapore. Singapore is one of the only countries in the world that has been able to successfully minimise local poaching, so we could have an important stronghold of pangolins here. With further research and adaptive management, we can ensure that pangolins survive in the long-term—Singapore could be a leading example and a model of biodiversity conservation in densely populated cities. I think with good communication and collaboration across agencies and other stakeholders we can achieve that.

“

Sunda pangolins are one of the most evolutionarily distinct and globally endangered species that exist on earth. We are really lucky to have them in Singapore and if we all work together to help protect them, we should be able to maintain a healthy, viable population in the wild. Everyone can make a difference, even if it just a small gesture, like telling your friends and family about pangolins and asking them not to buy or use pangolin products in any country.”

HELEN NASH

Tagging a Sunda pangolin for release. Photo by David Tan / Wildlife Reserves Singapore.



The notoriously shy Raffles' banded langur is critically endangered in Singapore. Photo by Andie Ang.

First Project goes Further Afield

WRSCF's modest investment in its first project proved to be a launchpad for bigger things. In connecting people and mobilising more, it put in motion a rescue that has grown beyond our shores.

"The Raffles' banded langur thrives in intact rainforest, ranging freely in viable, connected populations, widely appreciated and well-understood…" This, unfortunately is not fact, but a vision for Singapore's and Malaysia's little-known native colobines. It is a vision that took shape when WRSCF chose to support Dr Andie Ang and her research, making possible a roundtable discussion with those who shared a common hope for the species.

The Raffles' banded langur is a leaf-eating monkey, Singapore's largest primate aside from her human inhabitants. The first-ever specimen was collected in 1822 right here in Singapore, and scientifically described in 1838. Notoriously shy, the langurs have largely eluded close scientific study since then. What is known is that by the 1990s, barely 20 individuals remained, putting it on the locally critically endangered list of species.

Andie says, "In 2016 when we convened the strategic workshop, all the stakeholders were aligned in what we wanted—to preserve our natural heritage." 15 organisations, ranging from Malaysian and Singaporean government agencies to conservation bodies and universities here and abroad, sent 31 representatives for the session, which was facilitated by the

IUCN SSC Conservation Breeding Specialist Group.

Allied by a desire to secure a future for the Raffles' banded langur in the region, they formed a working group, and importantly, a Species Action Plan.

"WRSCF funding has made a huge difference," Andie discloses. It has afforded two researchers studying the langurs full-time, for one thing. Andie shares, "We now know how the population is doing because we're tracking its growth and development. It allows us to intervene at the right time, such as NParks planting the langurs' food plant species, nearly half of which are also locally threatened."

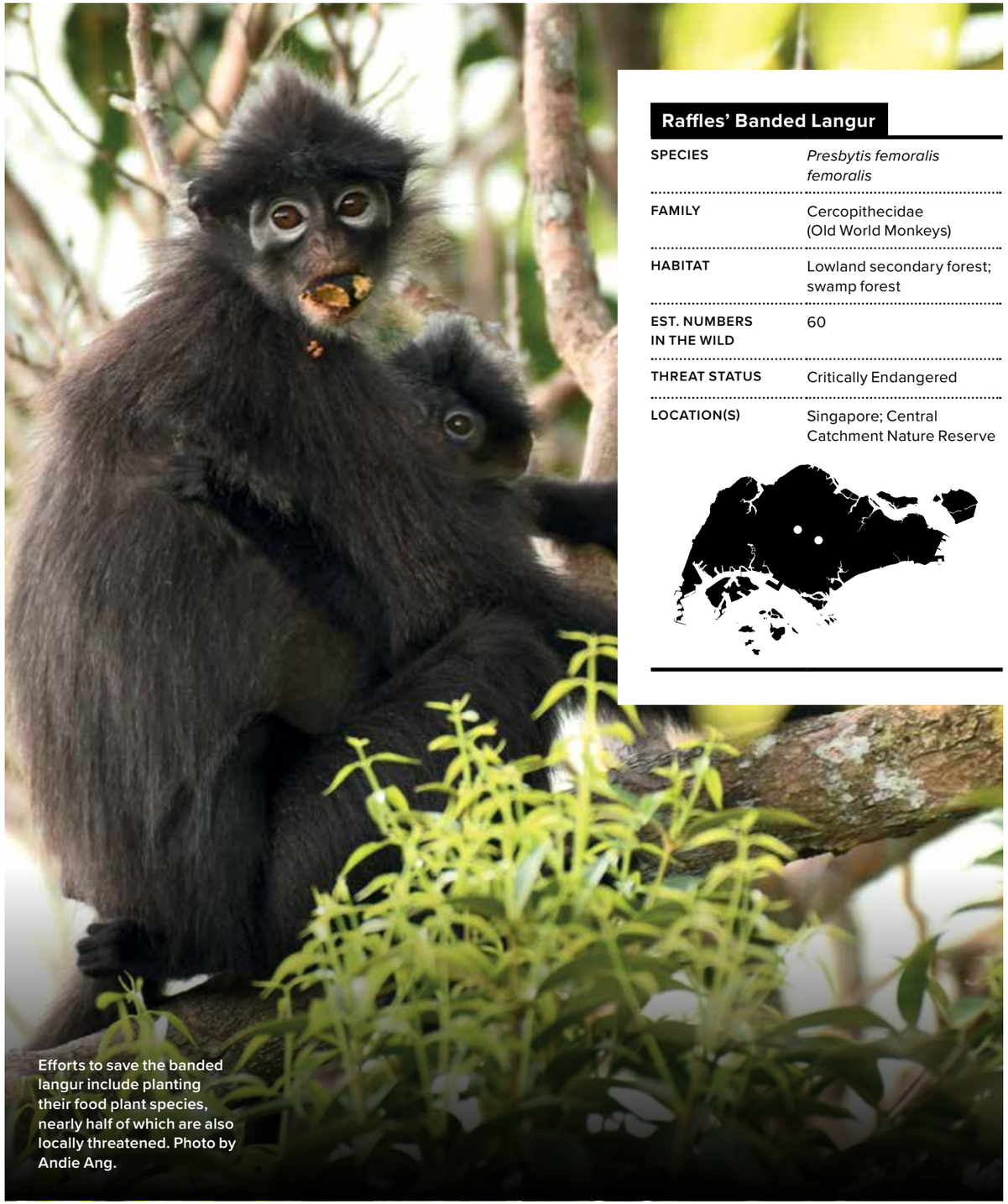
Besides partnerships with local agencies to safeguard habitats and enhance forest connectivity, there were also the tie-ups with DataKind and Google Inc. to develop a langur facial recognition app; studies carried out with Indonesia and Thailand; and an ambitious plan with Malaysian counterparts to explore conservation translocation prospects. Further branches of cooperation extend to an army of over 230 citizen science volunteers, who were drawn through the project's education and outreach efforts. Professor Tommy Koh, Singapore's Ambassador-at-Large and the project's patron, calls these "timely collaborations" in the face of rapidly depleting wildlife populations.

The Raffles' banded langur population in Singapore currently stands at 60 individuals. This extremely small population exhibits low genetic variability due to inbreeding, which puts their survival at risk. As for their cousins across the Causeway, whose numbers are unknown, their habitats are severely threatened by deforestation as industrial oil palm plantations take over.

Andie, who chairs the working group, wants to ensure that the collaboration between Singapore and Malaysia continues in the long term, towards a successful exchange of langur individuals for conservation translocation.

Until then, she remains grateful to the WRSCF, which has enabled the project to develop. "We've achieved what we wanted to achieve for the first phase," she says with satisfaction. "The langurs are being watched over."

The Raffles' banded langur could be found in many forested areas in Singapore until the 1920s, such as in Changi, Tuas and Tampines. As the country developed, the langur population declined until only a few small groups remained in the Central Catchment Nature Reserve and Bukit Timah Nature Reserve. The last of the Bukit Timah population was killed by dogs when it came down from a tree. It is now displayed in the Lee Kong Chian Natural History Museum.



Raffles' Banded Langur

SPECIES	*Presbytis femoralis femoralis*
FAMILY	Cercopithecidae (Old World Monkeys)
HABITAT	Lowland secondary forest; swamp forest
EST. NUMBERS IN THE WILD	60
THREAT STATUS	Critically Endangered
LOCATION(S)	Singapore; Central Catchment Nature Reserve

Efforts to save the banded langur include planting their food plant species, nearly half of which are also locally threatened. Photo by Andie Ang.

“My relationship with WRS started in 2007 when I conducted my first primate research project at the Zoo. Following that, I began studying banded langurs with my first research grant, the inaugural WRSCF project. My current research and now long-term project on the banded langurs is only possible through WRSCF. WRSCF has been pivotal in building my career in primatology and conservation, and I continue to be grateful for their kind and generous support.”

ANDIE ANG

An adult langur keeping watch.
Photo by Andie Ang.

The Main Otteraction

The patriarch of Singapore's most famous otter family, the Bishan family, watches over his brood in the water. Photo by Jeffery Teo, Otter Working Group, Singapore.

The WRSCF often acts as a catalyst. In 2016, a locally-organised congress renewed the motivation of an international band of otter specialists, and sparked a revival of interest in the region.

Splashed across the media are otters: otters crashing a wedding proposal, otters facing off crocodiles, otters having pups. Singaporeans can't get enough of them, it seems. There are a couple of things, though, that N. Sivasothi, the educator and biologist more often known as Otterman, wants people to know.

First, that the otters are not here by accident. They had left decades ago, and it took major effort and will from the government to clean and green our waterways before they came back. During Singapore's developing years, they were fortunate to find a suitable refuge with our neighbour Malaysia.

And so his second point, that we must not make the mistake again, of short-sightedly eliminating areas important for diversity. The researcher points to the forests adjacent to nature reserves, the "leftover from settlements", which have been earmarked for new towns and industries. "We need to rethink how to treat these areas properly," Sivasothi urges. "You cannot mimic a habitat. A 50-year-old forest is a far cry from what you find in the reserves."

It is a problem that the four species of otters found in Southeast Asia all face, along with that of illegal trade. Listed variously as Vulnerable, Near Threatened or Endangered on the IUCN

Red List, they have all experienced precipitous population drops; yet are all poorly studied—an issue Sivasothi is working to address with WRSCF support. In 2016, WRSCF funding was extended to bring in biologists, NGOs and students from all over South Asia to discuss it.

The 40-year-old IUCN Otter Specialist Group had decided to hold a conference in Singapore, its first in Asia, and Sivasothi, a long-time IUCN member, thought, "Oh good, it will be nice to be able to attend and see what is going on. Little did I know that I had been assigned to organise it!"

It seemed meet that this conference was to be held here. Over the last decade, various community groups had been helping the smooth-coated local otters to assimilate in Singapore's urban environment. From the NUS Toddycats volunteer entity, to ACRES (Animal Concerns Research & Education Society), to OtterWatch, these local groups have chipped in to educate the public, handle human-animal conflicts, rescue otters in trouble and campaign for their homes. The Otterman, largely instrumental in either setting them up or inspiring and mentoring those involved, believes, "Their voice expresses what a civilised people desire for their cities."

These stewards do not act alone. A network of collaboration has formed with WRS, NParks, the Public Utilities Board, and a host of others to help the otters cope in a green urban environment, help the public understand ecology, and look for ways for us to coexist. Indeed, it was this cohesiveness amongst the public, academia and government agencies that caught the IUCN's attention.

It took a lot of work, but Sivasothi galvanised his team, and the WRSCF-funded 2016 International Otter Congress in Singapore was, by all accounts, a huge success.

The edition boasted a strong Asian presence, and lots of young people. "Electric," he describes the atmosphere. Field trips were arranged to Marina Bay, Pasir Ris and Sungei Buloh, so that the participants could observe otters in both urban and natural settings. The mammals are usually a secretive species, but the Singaporean families have adapted to living in the city-state and tolerate people at close range.

"So there we were," Sivasothi recalls, "Veteran experts with decades of tracking experience and young researchers side by side, all watching otters together in Singapore." The rest of the carefully planned itinerary for the day was thrown out of the window. To actually see otters in action—playing, feeding, snoozing—felt like a reward in itself. They watched in perfect contentment. For the specialist group, it was as if they had had a vision of their end goal, seeing wild otters comfortably living in modern environs.

In Singapore, brought together through the WRSCF, they found a perfect reminder of why they all do what they do, for the otters.

Smooth-coated Otter

SPECIES (SINGLE SPECIES)	*Lutrogale perspicillata*
FAMILY (MULTI-SPECIES)	Lutrinae
HABITAT	Wetlands and waterways
EST. NUMBERS IN THE WILD	80
THREAT STATUS	Critically Endangered (CR)—Singapore Red Data Book 2008
LOCATION(S)	Singapore; Singapore River, Kallang River, Marina Basin, Pasir Ris Park, Pulau Ubin, Sungei Punggol, Sungei Serangoon, Coney Island and Sungei Buloh Wetlands Reserve

Singapore's otters aren't shy around their human compatriots. Photo by David Tan / Wildlife Reserves Singapore.

ABOVE
These eight-week old pups are still reliant on their parents and elder siblings when it comes to food, mobility and survival. Here, they get a little help on the way back to their resting holt.

RIGHT
At nine weeks, these pups are slowly being weaned off milk as their parents introduce fish into their diet.

Photos by Jeffery Teo, Otter Working Group, Singapore.

After disappearing from Singapore in the 1960s, otters returned in 1998. They gained prominence with high-profile sightings at Marina Bay in 2014 and the birth of pups in Ang Mo Kio-Bishan Park a year later. Singapore is now home to 10 otter families, with a total population of about 60. Up until a few years ago, research was generally based in South America, and little was known about the species in Asia.

The Harlequin Rasbora is native in the streams of the Sunda region. Photo by David Tan / Wildlife Reserves Singapore.

In Deep Water

How do you conserve what you don't know exists? WRSCF allows researchers to take that crucial first step of discovering and recording the breadth and depth of fauna in our midst.

"So little time, so many fish," proclaims an American research paper that Dr Tan Heok Hui came across early in his career. It has since become his own lament. The ichthyologist is part of an international effort to explore the earth's rich aquatic biota, and the amount of work to be done is staggering.

Paradoxically, for a planet covered mostly by water, earth has surprisingly little freshwater—just 0.01% of all that's available—and in these freshwater habitats live an astounding diversity of fishes. Those in the Americas have long claimed the interest of scientists, but here in Southeast Asia, even the number of species is unknown. Yet, our abundance of islands and vast coastlines mean that every survey of these sites yields new species, often highly unusual ones.

These are exciting times for researchers, but Heok Hui notes "a big question mark hanging over Sunda (Peninsular Malaysia, Sumatra, Borneo and Java)". There is the dearth of knowledge about freshwater fish in the region. There is also the rapid modification of natural habitats as cities develop. The threat of permanently losing our native species even before we get to know them looms large and near.

In situations like this, the IUCN as a guiding authority plays a central role. It maintains a Red List of Threatened Species, indicating the

status of and risks to wildlife around the world. Heok Hui says, "Getting the Sundaic freshwater fish assessed is a matter of urgency; we need at least to know which environments are most vulnerable and act to save them."

In 2016, the WRSCF provided the means for this immense work to begin, by hosting the Sundaic Freshwater Fish IUCN Red List Workshop, organised jointly by WRS, NUS and the Lee Kong Chian Natural History Museum. Tapping the Fund allowed a group of 10 international and local freshwater ecology and fish experts to come together, bringing their individual specialisations and field experience to the table.

For the young scientists in the group it was also a learning opportunity, "Like learning a new language," Heok Hui commented. The main impact, though, was that the process woke the participants up to the realisation how much work needs to be done.

Heok Hui explains, "There are so many maps and so little information. We zoomed in on species which are "data deficient"—meaning we don't know enough about them to assess their status—and ended up with a working list of about 1,300 fish species for the Sundaic region."

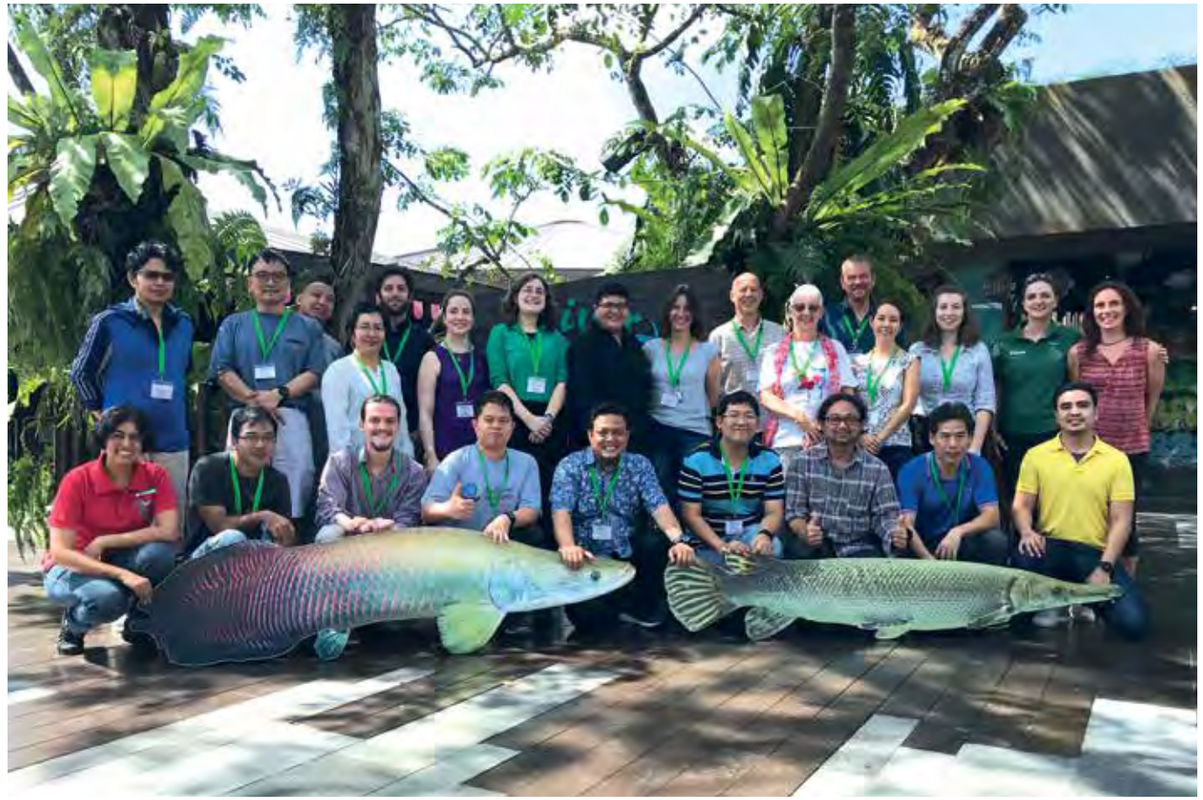
The biologist is worried for their future, with habitats being wiped out so quickly.

He reminds us, "Once they are gone they can't be re-established. Maybe you can reintroduce aquatic fauna from elsewhere, but soon will there be an elsewhere?"

In Singapore, after we lost our natural coastlines, our native freshwater fishes have been concentrated in the central catchment area and Bukit Timah Nature Reserve. Being in a protected area helps them to maintain a presence, and causes Heok Hui to be cautiously more optimistic. Still, he warns, "Even if a specie is not vulnerable in the region, we must keep it from going extinct locally—not under our watch!"

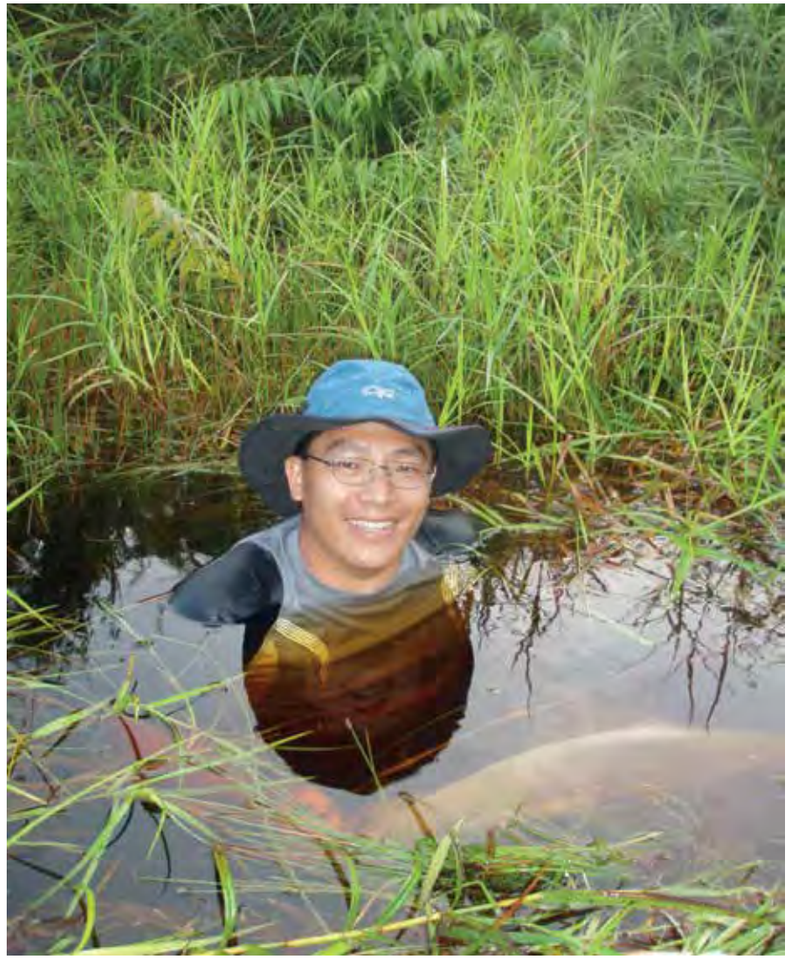
To that end, he is appreciative of WRSCF's lending its weight to conservation efforts.

Sometimes it takes an article written a decade previously to inspire someone on the other side of the planet. Sometimes it takes a humble fund like the WRSCF to bring everyone together to make grand plans work.



ABOVE
The Sundaic freshwater fish Red-Listing team. Photo by Wildlife Reserves Singapore.

LEFT
International and local specialists bring their expertise and experience to the table. Photo by Paige Lee / Wildlife Reserves Singapore.



ABOVE
Tan Heok Hui deep in research, at a black water stream in Central Kalimantan. Courtesy and copyright Tan Heok Hui.

RIGHT
Archerfish. Photo by David Tan / Wildlife Reserves Singapore.

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This diversity of freshwater fishes causes some pause in light of the impressive fact that freshwater makes up a tiny amount, only about 0.01%, of Earth’s water supply. Thus, Horn (1972) calculated that freshwaters hold a far greater ‘density’ of fish species than the oceans—greater by 7500 times!”

JOHN G. LUNDBERG, MAURICE KOTTELAT, GERALD R. SMITH, MELANIE L. J. STIASSNY, ANTHONY C. GILL, *SO MANY FISHES, SO LITTLE TIME: AN OVERVIEW OF RECENT ICHTHYOLOGICAL DISCOVERY IN CONTINENTAL WATERS* (2000)

Spreading the Word

Responsibility

Everyone needs to care enough about nature so there is the collective will to protect it. WRSCF nurtures a deeper appreciation through various education and outreach activities that engage Singaporeans of all stripes.

It is a responsibility we don't take lightly. By raising awareness of the natural world, we give people a sense of purpose in their interactions with wildlife.

WRSCF seeds capacity building—the imparting of skills and mobilising of volunteers to take an active role in wildlife conservation. Citizen science in its various forms allows concerned Singaporeans to take ownership of the environment. It is about fostering pride in our natural heritage and cherishing what we have before it is too late. Ultimately, we hope to see every citizen feel responsible for the survival of our fauna.

Through the projects we fund, we are mentoring the stewards of the future.

Photo by David Tan / Wildlife Reserves Singapore.

> "Study nature, love nature, stay close to nature. It will never fail you."
>
> FRANK LLOYD WRIGHT (1867–1959), AMERICAN ARCHITECT, WRITER AND EDUCATOR

Adult male horseshoe crab.
Photo by Laura Yap.

Soft-Selling the Shell

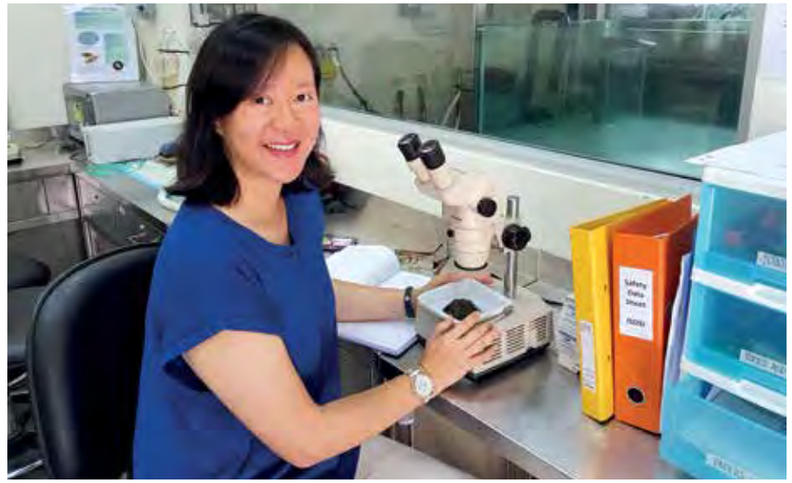
When Singaporeans are introduced to the Mangrove horseshoe crab, they invariably ask, "Can it be eaten?" Dr Laura Yap laughs it off, saying what is more important is that locals know we have the iconic species right in our own backyard, and that both the vulnerable species and its natural habitat, under threat from urbanisation and pollution, are in need of conservation. As a keystone of the mangrove ecosystem, a decline in their population can have a huge impact.

"We want to get the public on board to save this species," she says. To that end, Laura has organised countless booths over the years at the Festival of Biodiversity, Asia Dive Expo and school exhibitions during Biodiversity Week.

On display she puts horseshoe crab moults and carcasses, as well as horseshoe crab eggs under a portable LCD microscope. Educational posters and videos disseminate information about the species' dwindling numbers and distribution globally. Always a hit, though, is the horseshoe crab origami, which even Members of Parliament Desmond Lee and Grace Fu couldn't resist trying their hands at. Laura shares, "When we explain to children that horseshoe crabs are 'living fossils' as old as the dinosaurs, their eyes open in awe and they get very excited. As for the seniors, they reminisce with us about their teenage years when they would walk along beaches and be able to find so many horseshoe crabs. Kampong dwellers might even have harvested the females for their eggs."

Such interactions are why she persists with her outreach year after year. Laura advises, "If we want to instil a sense of love and appreciation for nature and the environment, it has to be done from a young age.

"Each and every one of us can play a part, for example, by volunteering in coastal clean-ups, not littering indiscriminately and helping to spread the word about horseshoe crabs."



RIGHT
Researcher Laura Yap in the lab.

BELOW
Abandoned nets are a snare which often entangle horseshoe crabs.

OPPOSITE
A wild horseshoe crab in a mudflat, its natural habitat.

Photos by Laura Yap.

Mangrove Horsehoe Crab

SPECIES (SINGLE SPECIES)
Carcinoscorpius rotundicauda

FAMILY (MULTI-SPECIES)
Limulidae

HABITAT
Mudflats and mangroves

EST. NUMBERS IN THE WILD
Populations have been severely reduced in the last two decades due to habitat loss. According to Cartwright-Taylor et al. 2011, the Mandai mudflats, together with the north-western shore, are probably the last sites on the main island with a thriving population of *C. rotundicauda.*

THREAT STATUS
Vulnerable according to Singapore Red Data Book

LOCATION(S)
Singapore; Kranji-Mandai mudflats, Sungei Buloh Wetland Reserve, Sarimbun, Pasir Ris mangroves (list not exhaustive)

Capacity Building in Action

On the search for the Raffles' banded langur. Photo by David Chen.

The Raffles' Banded Langur Working Group which Dr Andie Ang chairs very early identified a need to raise the profile of this unique species.

"Public awareness plays a very important part in conservation," says Andie, elaborating, "Unlike macaques and otters, people don't get to see the langurs, so they don't relate to them." In fact, the langurs are one of only three species of non-human primates in Singapore, but most of us are not able to recognise it.

WRSCF-sponsored education and outreach programmes, held together with the Jane Goodall Institute (Singapore) and NParks, have since brought Andie and her colleagues around Singapore, Indonesia, Malaysia and Thailand to promote understanding and appreciation for the langurs.

Outreach efforts by the group have included regular updates and the sharing of scientific information in a digestible format via Facebook, publications including *BBC Earth Magazine*, stickers, participation in the Festival of Biodiversity and even a feature documentary *Wild City* for Channel NewsAsia, narrated by possibly the world's most popular naturalist, Sir David Attenborough. More recently, a first educational brochure on "Primates of Johor" was produced and launched in Malaysia.

At home, public talks have drawn an army of over 230 volunteers, who are recruited every six months. These citizen scientists conduct surveys at Lower Peirce Reservoir Park twice each Saturday and Sunday, over a period of 24 weeks for each round. Several rounds have already been conducted, and are still continuing. Each volunteer conducts six surveys.

Andie remarks, "Most of our volunteers would never have seen a Raffles' banded langur before, but by the end of the surveys more than half would have had the chance to spot one. It is very encouraging—I consider this a success."

Upper Seletar, Singapore.
Photo by David Tan / Wildlife
Reserves Singapore.

Epilogue

From the ground up. Photo by David Tan / Wildlife Reserves Singapore.

DR SHAWN LUM, PRESIDENT
Nature Society (Singapore)

10 years: WRSCF has been around long enough to have achieved a few things—and to rightly celebrate them—but we have much to learn and even more to do in the years ahead. We are still in our adolescence, with all of the possibilities and uncertainties that accompany this heady period. How we position ourselves to make the most of the Conservation Fund will be the difference between effective action and mere window dressing at the edge of real conservation needs.

In 2009 when WRSCF was formed, the international conservation community was preparing for the 10th meeting of the Conference of the Parties of the Convention on Biological Diversity (CBD) in Aichi, Japan. Nearly 200 countries that are party to the CBD gathered to set the 10-year targets for conservation that would supercede the CBD's 2010 targets, drafted in 2000. The international community failed to meet the 2010 CBD targets and will not meet most of the Aichi targets as well. Species and the ecosystems that support them are being degraded at ever-increasing rates. The May 2019 report of the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) painted the bleakest picture yet for the future of species and ecosystems: unless there is transformative change around the world in the way we protect habitats, consume raw materials, manage fisheries, grow crops, and so many other technical and humanitarian issues, we stand to lose over a million species and, ominously, the habitats that make life as we know it possible for wildlife and for people.

No pronouncement, however stirring, will save our natural heritage, unless it is linked to good science and to people-driven, holistic and mean-

ingful change on the ground. Parties to the CBD will meet in Beijing in 2020 to set a post-2020 conservation agenda. By the time the new targets are re-evaluated in 2030, the global community will know if we have acted quickly and decisively enough to avert an irreversible biodiversity calamity, or if we and our children will face a biologically impoverished, less wondrous, and more uncertain future. The next 10 years will be critical for protecting ecosystems and wildlife in Singapore and the rest of the world.

Singapore has already made contributions to the protection of the global environment, largely through the efforts of outstanding individuals such as Ambassador-at-Large Professor Tommy Koh. Prof Koh's input proved crucial to the UN Convention on the Law of the Sea, as well as to the 1992 UN Convention on Environment and Development that gave rise to the Convention on Biodiversity and a slew of other environmental agreements. Singapore also has been a leader in trying to harmonise development with the conservation of nature. Prof Koh, who is also Patron of the WRSCF-funded Raffles' banded langur project, has said that "the Singapore story is important to the world because it shows that a city need not be an enemy of nature and biodiversity. In fact, we can turn the problem of urbanisation into a solution for biodiversity conservation."

What lies ahead for WRSCF, and how can it best contribute to ensure the survival and protection of biodiversity in Singapore, and, through local work, wildlife beyond our shores? Here are a few priorities:

Increase our effort to develop conservation capacity in Singapore and advance the careers of young conservation scientists and advocates. We have supported the work of young ecologists; the future of our natural heritage requires that more talented conservationists are identified, supported, and given an opportunity to show what they can do. Conservation will require more than wildlife and ecological expertise, too—we can support research for a generation of planners, policy makers and others who play an important role in protecting wildlife and habitats.

Encourage the use of innovative approaches to conservation and encourage new conservation partnerships. In addition to supporting much needed monitoring and observation-based work, the challenges of main-

ABOVE
The Common Rose—voted as Singapore's National Butterfly. Photo by Tea Yi Kai.

RIGHT
Oriental Pied Hornbill. Photo by David Tan / Wildlife Reserves Singapore.

Colugo on a tree. Photo by David Tan / Wildlife Reserves Singapore.

taining nature amidst increasing development needs will require people working across varied fields. By funding work that falls outside the scope of existing research funding, WRSCF can support novel efforts to provide real solutions for local conservation needs. Whether this be through the support of community-based initiatives to reduce human-wildlife conflict, to enhance conservation policy expertise, or to link conservation to livelihood creation and social enterprise, WRSCF, through its many stakeholders, can help drive much needed conservation models for the future.

Identify conservation priorities at a local level, that might also have implications for the region and beyond. WRSCF has supported a number of important workshops on threatened wildlife such as pangolins, otters and songbirds. Working with local and regional experts, we need to identify other key groups of organisms and habitats, especially, and to bring together experts and conservation managers to ensure that our life-giving natural heritage is better protected, maintained and appreciated.

Link Singapore conservation to regional efforts. Not long ago, conservation in Singapore was less in the world's consciousness when it came to global biodiversity. However, the continued depletion of species and degradation of wild places around the world has imperiled biodiversity to an extent scarcely imaginable a generation ago. Some local species such as the pangolin and straw-headed bulbul are headed for extinction globally, and what we do to save them here safeguards the species for the entire world. In addition, fisheries, the wildlife trade and the loss of habitats needed by migratory species makes the study of any of these cross-border issues in Singapore of regional importance. WRSCF must continue to identify and support projects that align complementary work in Singapore and neighbouring regions to achieve better and lasting conservation outcomes.

Make protection of nature and wildlife an integral part of the Singapore identity. Increasing conservation awareness is important, but making conservation part of the Singapore way of life would be even better. Through WRSCF support of outreach and education efforts, there can be a more strategic and effective guiding of Singapore towards becoming a society synonymous with nature and the environment. We should not be

Adapting to changes in the environment isn't as easy for most wild creatures as it is for this green-crested lizard. Photo by David Tan / Wildlife Reserves Singapore.

“

It's not whether animals will survive; it's whether man has the will to save them.”

ANTHONY DOUGLAS WILLIAMS, CANADIAN AUTHOR AND ANIMAL RIGHTS ACTIVIST

satisfied with just outreach, but go on to convince everyone that we must—and can—achieve the transformative change needed to turn the global extinction tide around.

Looking back at the past 10 years, we can be proud of what WRSCF has contributed to conservation in Singapore. For the next ten years and beyond, more, and more creative, effort will be needed to safeguard nature locally and regionally. I look forward to seeing WRSCF develop as it anticipates and addresses the conservation needs of the future.

LEFT TO RIGHT
Local invertebrates found in Singapore. Photos by David Tan / Wildlife Reserves Singapore.

Milestones in Singapore's conservation history

1884
Birds are the first of Singapore's native wildlife to receive protection, with the enactment of The Wild Birds Protection Ordinance.

1904
The Wild Animals and Birds Protection Ordinance is enacted to cover other wildlife, but does not defend them enough to prevent their extinction.

1908
The Forest Ordinance is enacted.

1951
The Nature Reserves Act is passed.

1967
Former Prime Minister Lee Kuan Yew details his vision to turn Singapore into a Garden City, a goal which is achieved by the late 1980s.

1971
Wildlife Reserves Singapore, a non-profit organisation, is formed to manage the country's zoos.

Late 1970s
The Nature Society (Singapore), an offshoot of the Malayan Nature Society (MNS), is a vocal campaigner for nature conservation.

1990
The National Parks Board (NParks) is established.

1995
Singapore ratifies the Convention on Biological Diversity with the stated aim of becoming a model green city.

2001
The first Blue Plan is produced to protect marine habitats.

2009
The Wildlife Reserves Singapore Conservation Fund is registered as a charity and institution of public character.

2015
The Sustainable Singapore Blueprint 2015 includes biodiversity conservation as a target.

2019
The Wildlife Reserves Singapore Conservation Fund celebrates 10 Years!

Reticulated python. Photo by David Tan / Wildlife Reserves Singapore.

Together, We Protect Wildlife

Wildlife Reserves Singapore
Conservation Fund