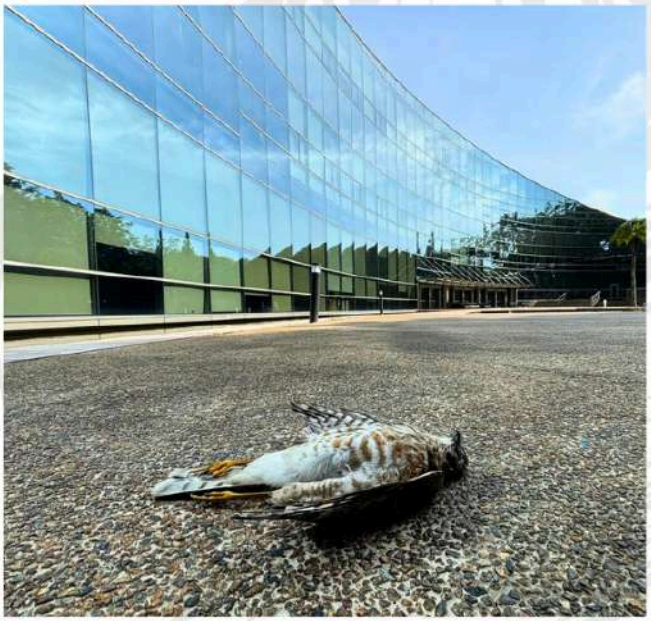

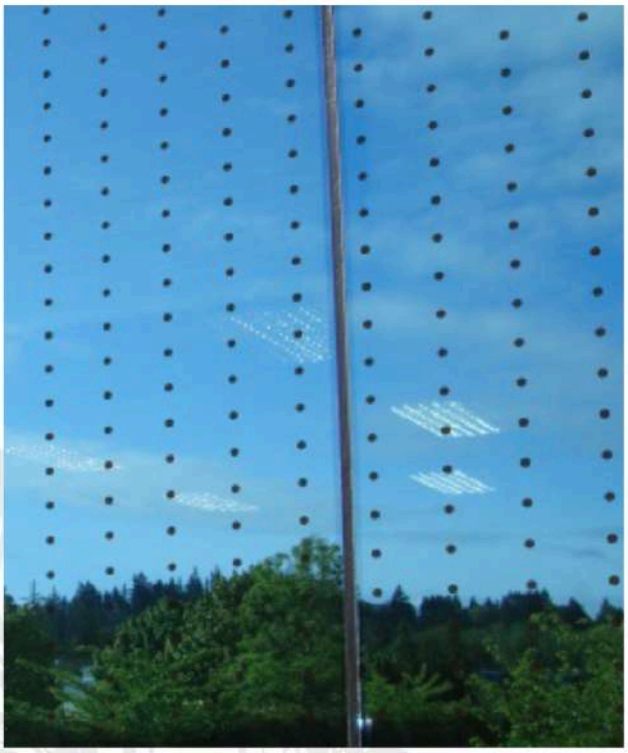

Can NTU be a Campus in Nature?

A proposal to Reduce Bird-Building Collisions at the ADM building

by Project Avigate, an NTU student initiative.

Content

Contributors

This proposal is prepared by concerned students and alumni of NTU.

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We would like to thank all volunteers who have contributed to this project, especially for their time-intensive monitoring efforts, and those who shared their heartfelt concerns and traumas through interviews. Thank you, Dr Anuj Jain and Ar. Kuan Chee Yung, for the professional advice related to architecture, and Dr Tan Yen Yi, for tirelessly maintaining the island-wide dead bird hotline and being a great inspiration. A big shout-out to NTU faculty members who have been giving us scientific and strategic advice along the way, scientists who endorsed the report, and seniors who started advocating for this issue many batches ago. Last but not least, thank you, for letting us know there are people out there who care about the well-being of birds and wildlife.

With love,

PROJECT AVIGATE

Endorsement

During the ADM faculty meeting on 24th April 2024, all faculty members unanimously supported the implementation of solutions in line with the recommendations in this proposal.

External scientific experts who endorsed this report:

Name	**Designation/Affiliation**
Mr David Tan Jian Xiong	Avian Biologist & Local Bird Collision Researcher, PhD Candidate, University of New Mexico
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Executive Summary

1. Building collisions are the largest source of urban bird mortality globally. Located within two major global bird migratory flyways, Singapore's greenery-rich urban areas are prone to bird collisions. Hotspots include the Central Business District and the fringes of the Central and Western Catchment (NTU).
Singapore is an important rest stop for migratory birds travelling long distances to the warmer south, as it forms a part of the East Asian-Australasian Flyway (EAAF) and the Central Asian Flyway (CAF). Local studies found that proximity to forests, as in the case of NTU, strongly predicts the collision of both migratory and non-migratory species.

2. Bird collisions in NTU are concentrated at the ADM building and have lasted at least 19 years. Through daily monitoring and rescue efforts during migratory seasons in the past 3 years, we recorded 122 collisions from 22 different species. These include conservation-significant (threatened) species like the Blue-eared Kingfisher, Cinnamon Bittern and Brown-chested Jungle Flycatcher.
Daily monitoring and rescue efforts over the past three migratory seasons showed that the ADM building has a disproportionately high number of collisions, likely due to its large reflective glass surfaces and funnel-like shape.

3. Local bird experts, environmental scientists, and the ADM community have strongly supported adopting cost-effective solutions like glass decals or paracords.
Avian biologists and empirical studies agree that decals are viable solutions, effectively reducing the collision by more than 90%. Decals cover only 6-8% of the glass surface, effectively retaining the building's lighting or solar load characteristics. Paracords also have minimal effect on the solar load, but might obstruct the windows, depending on installation methods. Finally, online surveys targeting NTU students and in-person interviews with the ADM community found overwhelming support for some solutions to be implemented.

4. Bird-friendly buildings align fully with Singapore's national bird conservation strategies, NParks' 2022 Bird-safe Building Guidelines, and NTU's green building and infrastructure targets in the 2021 Sustainability Manifesto. Alongside other wildlife management measures, it enhances NTU's status as a Campus in Nature.
Implementing bird-safe measures provides an extraordinary opportunity for the university to enhance its ambitions of achieving Green Mark Platinum for all eligible buildings on campus. It addresses the well-being and reputational risks and turns them into opportunities for NTU.

Preface

This project is an ongoing collaborative student effort that began three years ago. On 24th September 2022, a few students witnessed the collision of four migratory Yellow-rumped Flycatchers (*Ficedula zanthopygia*) at the School of Art, Design, and Media (ADM) building. Shocked by the incident, these students initiated the bird collision monitoring effort by rallying volunteers from the Nature Guiding and Human Wildlife Coexistence portfolios of NTU Earthlink. Since then, the team has grown to include 30 undergraduate and graduate students spanning many faculties like ASE, SBS, CCEB, CEE, MAE, SCSE, ADM, SSS, SOH, and NBS.

The team is dedicated to finding a **win-win-win solution that reduces bird casualties, improves community wellbeing, and advances NTU's progress towards a sustainable campus**. Since launching the 2021 Sustainability Framework, NTU has made commendable progress through establishing the Sustainability Office in 2022 and attaining the prestigious Eurocham Sustainability Award in 2023. NTU has also committed to the ambitious goal of achieving a 100% Green Mark Platinum certification for all eligible buildings on campus. The team wholeheartedly supports these aims and hopes to be a valuable partner in NTU's sustainability journey.

Apart from monitoring efforts, the team has also consulted many subject matter experts, including professors and researchers at the NTU Asian School of the Environment, NUS Avian Evolution Lab, and Lee Kong Chian Natural History Museum, NGOs like the Nature Society (Singapore) and the Bird Society of Singapore, as well as the students and professors who use the ADM building every day. The team presents our findings and proposes mitigation plans based on robust science-based evidence and the best available experience from academia and industry.

Introduction

Significance of Singapore in Bird Conservation

Singapore lies within the East Asian-Australasian Flyway (EAAF), which supports the greatest diversity and populations of migratory birds globally, as well as the highest number of threatened migratory species of any flyway (Yong et al., 2015). Birds in this flyway migrate annually over 10,000km to winter in the warmer south and return in the following summer. Located at the tip of the Malay Peninsula, Singapore is a crucial site where many species refuel before crossing the Malacca Straits to arrive at the Sumatran Islands. Furthermore, a recent study by the Singapore National Parks Board used satellite tracking devices to demonstrate that wintering birds in Singapore could also come from the Central Asian Flyway (CAF), adding to the conservation significance of Singapore's habitats as resting and breeding grounds for migratory birds (Li et al., 2020).

Throughout the migration, birds face significant threats such as habitat loss and degradation, hunting or poaching activities, and competition from invasive alien species. This report focuses on **bird-building collisions (BBC)**, defined as the collision of birds with human-made structures, often with windows and other reflective surfaces. Collisions occur when birds cannot distinguish between a reflection and empty open space, while the severity depends on the bird's species, which affects their anatomy and behaviour, like colliding speed. BBC is by far the largest source of urban avian mortality, causing over 1 billion deaths annually in North America alone (Loss et al., 2014; Machtans et al., 2013). Despite the significance of the EAAF, migratory threats like BBC are understudied in our region. A few case studies from East Asia demonstrate that BBC was the primary cause of migratory bird mortality on the Jeju and Hong-do islands of South Korea, and has killed individuals from 63 species between 1980 and 1997 in eastern Hokkaido, Japan (Bing et al, 2012; Kim et al, 2013; Yanagawa & Shibuya, 1998). South Korea's Ministry of Environment further estimated that BBC directly causes the death of 8 million birds each year nationally (The Korea Bizwire, 2019). Furthermore, a recent study on the rehabilitation of collision victims revealed that 60% of patients died in care. This suggests that the real number of collision-caused deaths is much higher than reported from carcasses (immediate deaths) found near buildings (Kornreich et al., 2024).

A systematic review revealed that collision rates most commonly correlate to large areas of contiguous glass, proximity to vegetation, and species-specific migratory routes and behaviours (e.g., super-collider species are significantly more prone to collisions) (Basilio et al., 2020). At the building level, facade type, shape, and orientation could also increase the risks of collisions (Riding et al., 2020). All of these factors are relevant to the city-state of Singapore, which has seen rapid urbanisation and the erection of large glass buildings near pockets of greenery. Indeed, local studies found that forest proximity is a strong

predictor of collision for both migratory and non-migratory species, as birds tend to collide when moving between disconnected parks and forested areas to forage or stop by to rest after long flights (Tan et al., 2017; Tan et al., 2023).

Bird-Building Collisions in NTU

Around one-quarter of documented migratory bird-building collisions in Singapore occur in the West, which is heavily concentrated around the NTU campus or the fringe of the Western Catchment (Low et al., 2017; Tan et al., 2017). For years, students have noticed bird collisions around campus buildings, particularly at the ADM building (**Appendix 1**). The earliest anecdotal records of bird collisions at ADM, as shared by an alumnus, can be traced back to 2006 (19 years ago) when the building was just completed. While ADM is an iconic building well-recognised for its architecture and sustainability achievements, it has unfortunately become a hazard for birds, particularly during the migratory season (**Figure 1**). To better understand the social and ecological aspects of the issue, we interviewed students and staff from ADM and conducted daily surveys during the bird migratory season.

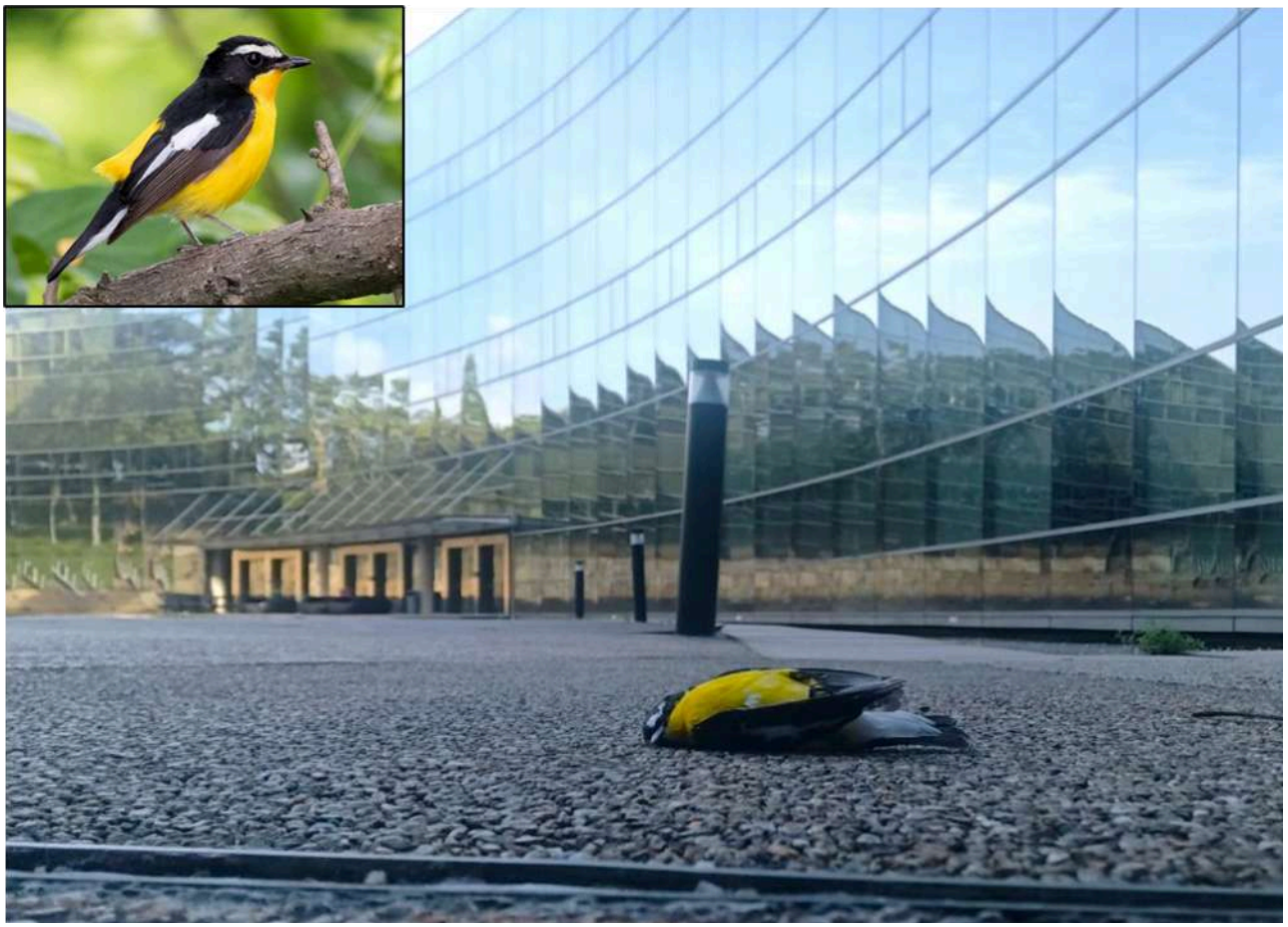


Figure 1. *An adult male Yellow-rumped Flycatcher, along with another 3 individuals, were found dead at ADM on 24th September 2022. Our volunteers have since been monitoring the collisions at ADM. Image credit: (Top left) Kai Pflug.*

Methods

Interview and Online Survey

To better understand how the ADM community perceives the BBC issue, 7 semi-structured interviews were conducted online or in person. The interviewees comprise 4 current ADM students, 1 ADM alumnus, and 2 ADM professors. Apart from interviews, a questionnaire was sent out to the wider NTU community through Telegram group chats. 63 responses were gathered from 9 schools, and respondents included current undergraduates, graduate students, and alumni. The interview transcripts and questionnaire can be found in **Appendix 2**. Unless otherwise stated, all respondents were given a pseudonym to ensure the confidentiality of the interviewees.

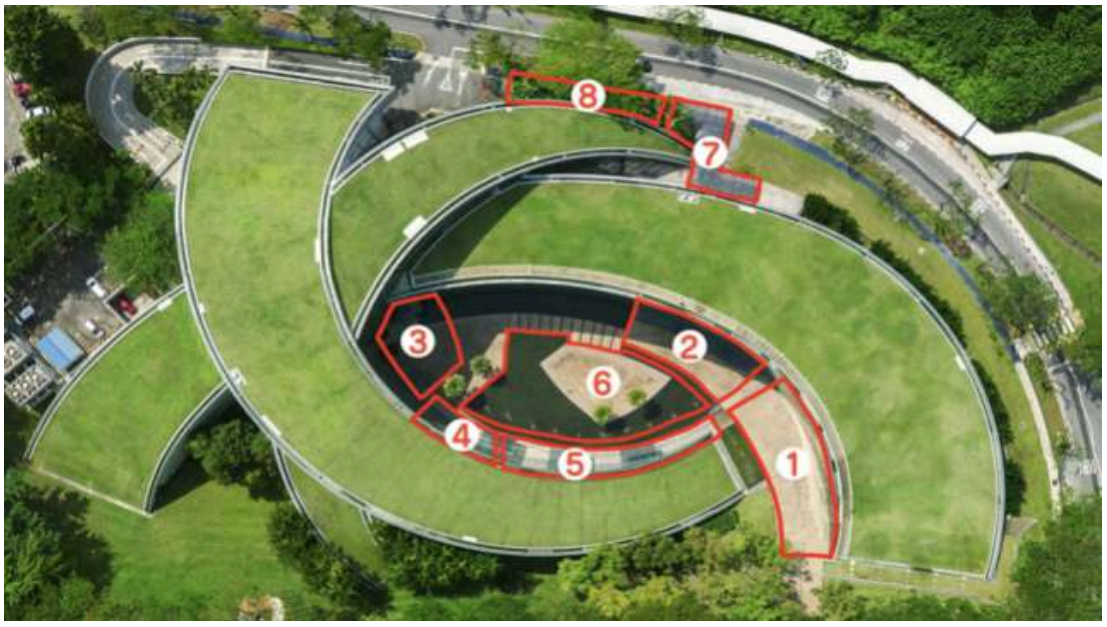


Figure 2. *Survey areas around ADM were divided into 8 patches for record purposes.*

Bird Collision Surveys at ADM

Volunteers monitored bird collisions and attempted rescues at ADM. To date, we have collected data from three migratory seasons (2022/09/24 - 2023/04/15, 2023/08/08 - 2024/04/05, 2024/08/19-2024/12/10). During the survey period, we patrolled the sunken plaza and rooftop from 0730-0830 daily, including weekends, public holidays, and term breaks. We checked for bird collisions and dead birds (**Figure 2**) and identified the bird species for each incident. The collision Area, Date, Time, Gender, Status (Dead/Alive) and Age were recorded in an Excel sheet. As a rule of thumb, birds found at the base of buildings with signs of facial injury or head trauma were classified as building collision victims. Volunteers also checked above window ledges and inside water features for stranded or drowned birds. These data are then analysed to reveal spatial and temporal patterns in bird collisions. We have also identified species that are prone to collisions, as

well as globally and locally conservation-significant (CS species based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species and the Singapore Red Data Book (3rd edition).

Solutions: Literature Review, Expert Consultation, and Market Search

To gain scientific and policy insights as well as formulate the best possible solution, we have conducted a literature review of academic publications, reports, and policy documents. Combined with insights from researchers, architects, and policymakers, we proceeded to search for locally accessible and cost-effective solutions. This ensures that the solution identified is effective and can be efficiently adopted and maintained. Eventually, we concluded that installing window decals is the best solution, and we proceeded to look for suppliers. Of the four suppliers we contacted, both locally and abroad, only one was able to provide the full chain of service from product supply to installation. They have also provided us with an accurate quotation that can be used for NTU's internal budgeting process. Successful case studies are also included.

Risks and Opportunities Analysis

Finally, to better inform decision-makers, we examined different risks and opportunities stemming from possible responses from NTU, such as engaging student bodies and an appropriate media response to the wider concerned public. We explored potential reputational and well-being risks and opportunities, which can translate into tangible losses or benefits for the university. Ultimately, we hope to assist NTU in progressing towards a more sustainable campus in nature, with concrete measures to **safeguard the triple bottom line of community wellbeing, ecosystem health, and the success of the university**.

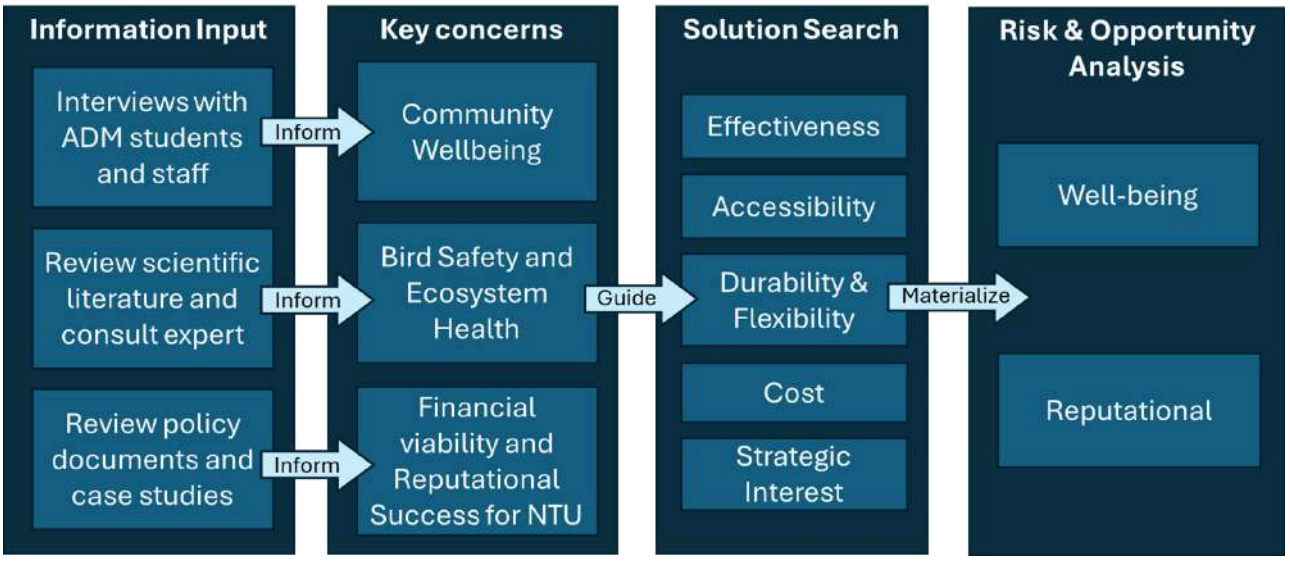


Figure 3. *Summary of methodology and research flow of this report.*

Results: Interview and Online Survey

We found that around half of the NTU student respondents were aware of the bird collision situation at ADM. Considering the sampling bias where interested students are more likely to complete the questionnaire, this proportion is likely overestimated. Interviews with ADM students reveal that awareness even within the ADM community is not high, although upper-year students and long-time staff or professors are generally more aware of the situation.

> *"...this has been happening for quite a while, ever since I was a student." (Professor Desmond Pang, real name, ADM alumnus, batch of 2012)*

> *"It is something that has been talked about through the generations. But nothing has been done. But it's known to, for the people who are always in school." (Jasvic, real name, ADM alumnus, batch of 2018)*

For ADM community members who have witnessed collisions or carcasses of birds, we further prompted them for their feelings and impressions. Some common themes that many respondents shared included feelings of sadness and distress upon seeing the death of birds on their campus.

> *"It made me feel so sad as it was the first time I was present for the death of a beautiful, rare creature, and it was caused by the building we hold dear to our hearts." (Jane, Year 2 Filmmaking student)*

> *"Very upsetting, there are always stunned birds, mynas and rarer birds, outside, and you can hear them hit the window. Sometimes corpses are lying outside... It's very distressing." (Alvin, ADM alumnus, batch of 2023)*

Notably, we were alerted by a respondent who shared that experiencing death was traumatising and she has since avoided the plaza area and water feature (**Figure 4**). We highlight this issue as other students may be similarly affected. There could be further implications for students' well-being beyond avoiding the location.

> *"Because of the incident, I don't really like to go out to look at the pond feature anymore, the pond, the fountain anymore, because I also don't want to see. Somewhat traumatic, like I mean, I'd rather, for me, I'd just rather not go outside and look." (Joan, Year 2 Visual Communications student)*

Figure 4. *A juvenile Yellow-rumped Flycatcher drowned in the water features of ADM.*

Others have expressed disappointment or frustration towards the oversight and inaction of decision-makers despite being aware of the situation. Our survey shows that 81% of students strongly believe that something should be done to prevent further injuries and casualties of birds at ADM (**Figure 5**).

> *"I feel very sad for the birds :(If something can be done to help the birds, the school should do it. I would feel very disappointed if the ADM committee were aware of this problem but did nothing to stop it. Very privileged and insensitive behaviour." (Sarah, Year 2 ADM student)*

> *"Vanity at the price of another life." (Philip, ASE alumnus, batch of 2021)*

> *"[This has] also made me lose a bit of trust in the school administration because this was brought up to them before." (Rachel, Year 1 SOH student)*

Upon deeper reflection, some respondents pointed out the fundamental conflict between bird death, the sustainability reputation of the building and more generally, the university.

> *"I have always seen instances of injured or dead birds in the sunken plaza, and it's really sad - I was wondering how sustainable the ADM building can be if animals*

are going to be harmed... the building is pretty, but the dead birds are not." (Jessica, Year 1 ADM student)

"Sad. ADM is designed to save energy, or in other words, save [the] environment too, but it also leads to [the] death of birds and others." (Marcus, Year 2 CCEB student)

"I feel very sad for all the birds, especially the migrants that have flown so far, that have collided with the building. Such a situation is also at odds with the green certifications and sustainable image the NTU has or is working towards, where green and eco-friendly buildings do not include 'biodiversity-friendly'. I hope that we can work out a solution so that NTU can truly be a green campus." (Ahmad, Year 4 ASE student)

There is also a respondent who does not just feel disheartened by the situation, but also acknowledges his responsibility to enact change within ADM, which he considers a place for creation and a second home to many. This echoes our survey results, where 20 students volunteered to contribute by submitting designs for window decals (**Figure 5**).

"I feel that it is unnecessary and ridiculous that innocent lives should die without getting awareness and notice. Especially where ADM is considered a place of learning to create possibilities. It is also maybe considered a second home for many students. However, to know such a place of importance to us creatives are causing death to others makes me feel responsible to do something." (George, Year 2 ADM student)

When prompted about the feasibility of using window decals as a solution, mixed responses arose. While some students are concerned about the installation as the glass surface area is large, 98.4% of survey respondents support adopting solutions like decals, while a handful wonder if alternative solutions are available. Regardless, the consensus is that some form of solution should be adopted.

"Yes, of course! I think the decals would brighten up ADM, and also help to prevent more bird deaths. We need to learn to coexist with the animals around us in a way that benefits them as well." (Sarah, year 1 ADM student)

"Right, I mean, I think it sounds like a nice idea, um, but, um, if it works, then I think it's feasible… However, with the building rights, I think the school might also have its own guidelines and stuff. Yeah, protocols and stuff that may or may not be feasible" (Professor Desmond Pang, ADM alumnus, batch of 2012)

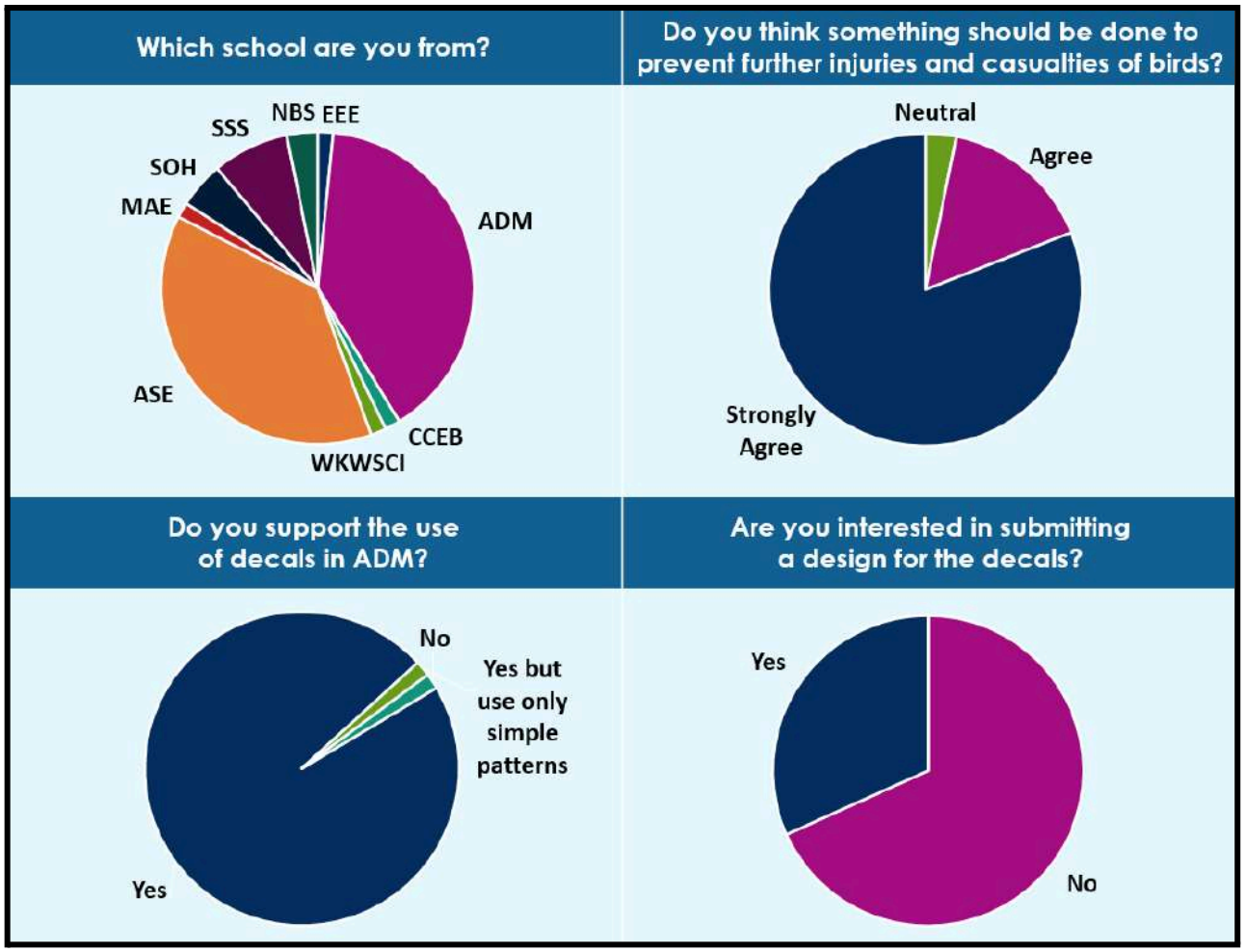


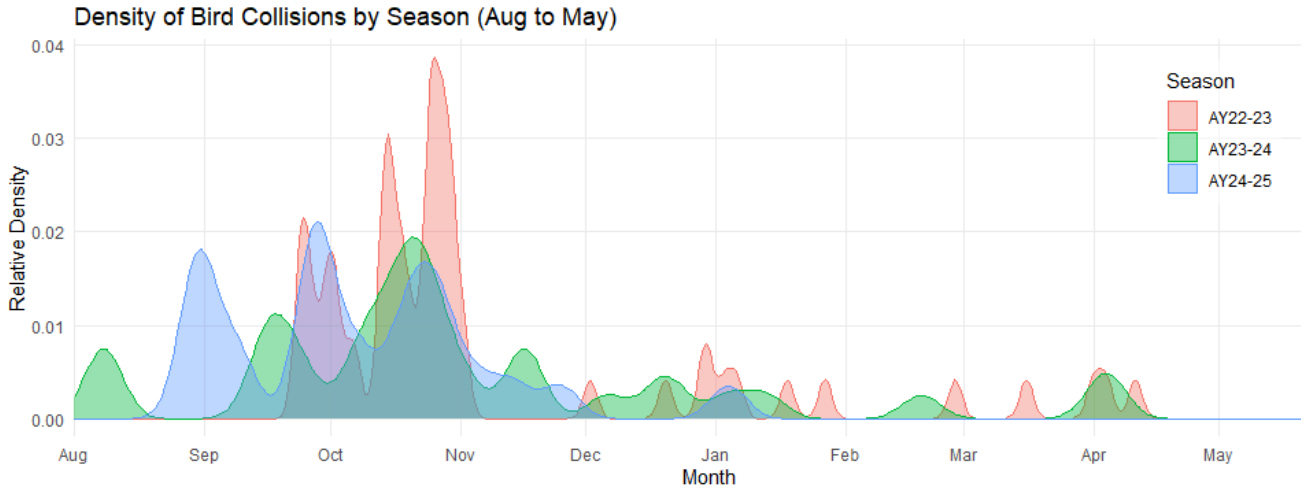
Figure 5. *Selected survey results from 63 respondents. The questions (dark blue rows) and results (pie charts) are presented.* ***Top left.*** *Spread of respondents' main school.* ***Top right.*** *81% of students strongly believe that something should be done to prevent further injuries and casualties of birds at ADM.* ***Bottom left.*** *An overwhelming 98.4% of students support some form of decal as a potential solution to bird collisions at ADM.* ***Bottom right.*** *20 respondents expressed interest in submitting designs for the decals.*

From the interviews and questionnaire, we gathered that bird deaths in ADM do not just bring about bird casualties and ecological harm, but also cause **dissatisfaction and distress** among the ADM community, and risk damaging NTU's reputation on the sustainable front. We would also like to highlight that this survey has yet to capture the impact of the BBC on the **well-being of ADM's janitors**, who have been at the forefront of witnessing death and cleaning up the carcasses for the past 19 years. We could not imagine how the BBC had taken its toll on them when just three years were sufficient to break our volunteers' hearts. We sincerely urge the school to fully consider the negative implications of BBC on both the social and ecological dimensions and take active, progressive restorative actions to tackle the bird collision issue in ADM.

Results: Bird Collision Surveys at ADM

Collision-prone Species

122 bird individuals from 15 families were recorded colliding at the ADM building. The 22/23 migratory season recorded 60 individuals from 11 families, the 23/24 migratory season recorded 36 individuals from 8 families, while the 24/25 migratory season recorded 26 individuals from 7 families. Collision numbers peaked in October and November (autumn passage) for both seasons (**Figure 6, Top**), which agrees with a Singapore-wide study (Low et al., 2017). The highest daily count was 7 collisions. Notably, the Muscicapidae family had the highest collision count in all years, totalling 81 out of 122 records (66%) (**Figure 6, Bottom**). In particular, the Yellow-rumped Flycatcher (*Ficedula zanthopygia*) contributed to 61 collisions in this family (**Figures 7, 8**).



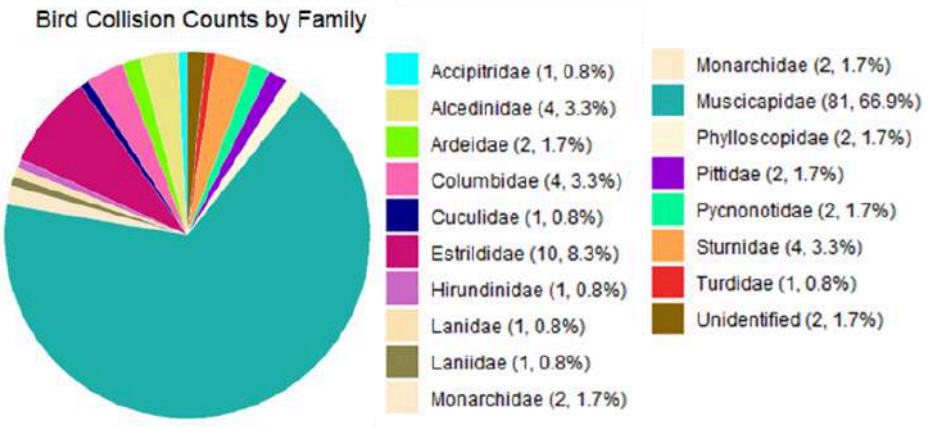


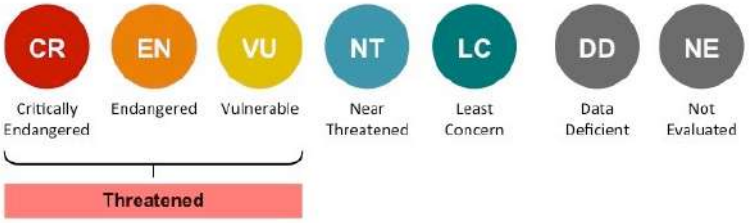
Figure 6. Top. *The collision density of three migratory seasons peaks in October and November.* ***Bottom.*** *Collision count by family. Muscicapidae, the flycatchers, account for two-thirds of the collisions.*

Yellow-rumped Flycatchers have emerged as a “super-collider” migratory species in past studies (Tan et al., 2023). This forest-dwelling species is known to migrate at night and seek out forest shelters during the day to rest or forage. It is thus hypothesised that the species is particularly susceptible to collisions near forest edges, although further analyses of island-wide data are required to confirm this (Tan et al., 2023).

Summary of Colliding Species and Count at ADM between 2022 and 2025

Family	Species	Count	IUCN Status	RDB3 Status
Accipitridae	Japanese Sparrowhawk (*Accipiter gularis*)	1	LC	LC
Alcedinidae	Black-backed Dwarf Kingfisher (*Ceyx erithaca*)	2	LC	NT
	Blue-eared Kingfisher (*Alcedo meninting*)	1	LC	EN
	White-throated Kingfisher (*Halcyon smyrnensis*)	1	LC	LC
Ardeidae	Cinnamon Bittern (*Ixobrychus cinnamomeus*)	2	LC	VU
Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	4	LC	LC
Cuculidae	Hodgson's Hawk Cuckoo (*Hierococcyx nisicolor*)	1	LC	NT
Estrildidae	Javan Munia (*Lonchura leucogastroides*)	7	LC	NE
	Lonchura sp.	3	-	-
Hirundinidae	Pacific Swallow (*Hirundo tahitica*)	1	LC	LC
Laniidae	Tiger Shrike (*Lanius tigrinus*)	2	LC	NT
Monarchidae	Amur Paradise Flycatcher (*Terpsiphone incei*)	1	LC	LC
	Terpsiphone sp.	1	-	-
Muscicapidae	Brown-chested Jungle Flycatcher (*Cyornis brunneatus*)	4	VU	VU
	Siberian Blue Robin (*Larvivora cyane*)	1	LC	NT
	Yellow-rumped Flycatcher (*Ficedula zanthopygia*)	**74**	LC	LC
	Cyanoptila sp.	1	-	-
	Asian Brown Flycatcher (*Muscicapa dauurica)*	1	LC	LC
Phylloscopidae	Eastern Crowned Warbler (*Phylloscopus coronatus*)	1	LC	LC
	Phylloscopus sp.	1	-	-
Pittidae	Blue-winged Pitta (*Pitta moluccensis*)	1	LC	LC
	Western Hooded Pitta (*Pitta sordida*)	1	LC	LC
Pycnonotidae	Yellow-vented Bulbul (*Pycnonotus analis*)	2	LC	LC
	Asian Glossy Starling (*Aplonis panayensis*)	1	LC	LC
Sturnidae	Javan Myna (*Acridotheres javanicus*)	3	VU	NE
Turdidae	Orange-headed thrush (*Geokichla citrina*)	1	LC	NT
Unidentified	Unidentified	2	-	-
		Total **122**		

Figure 7. *Three threatened or conservation-significant species are recorded, while ~60% of all collisions come from the Yellow-rumped Flycatcher.*



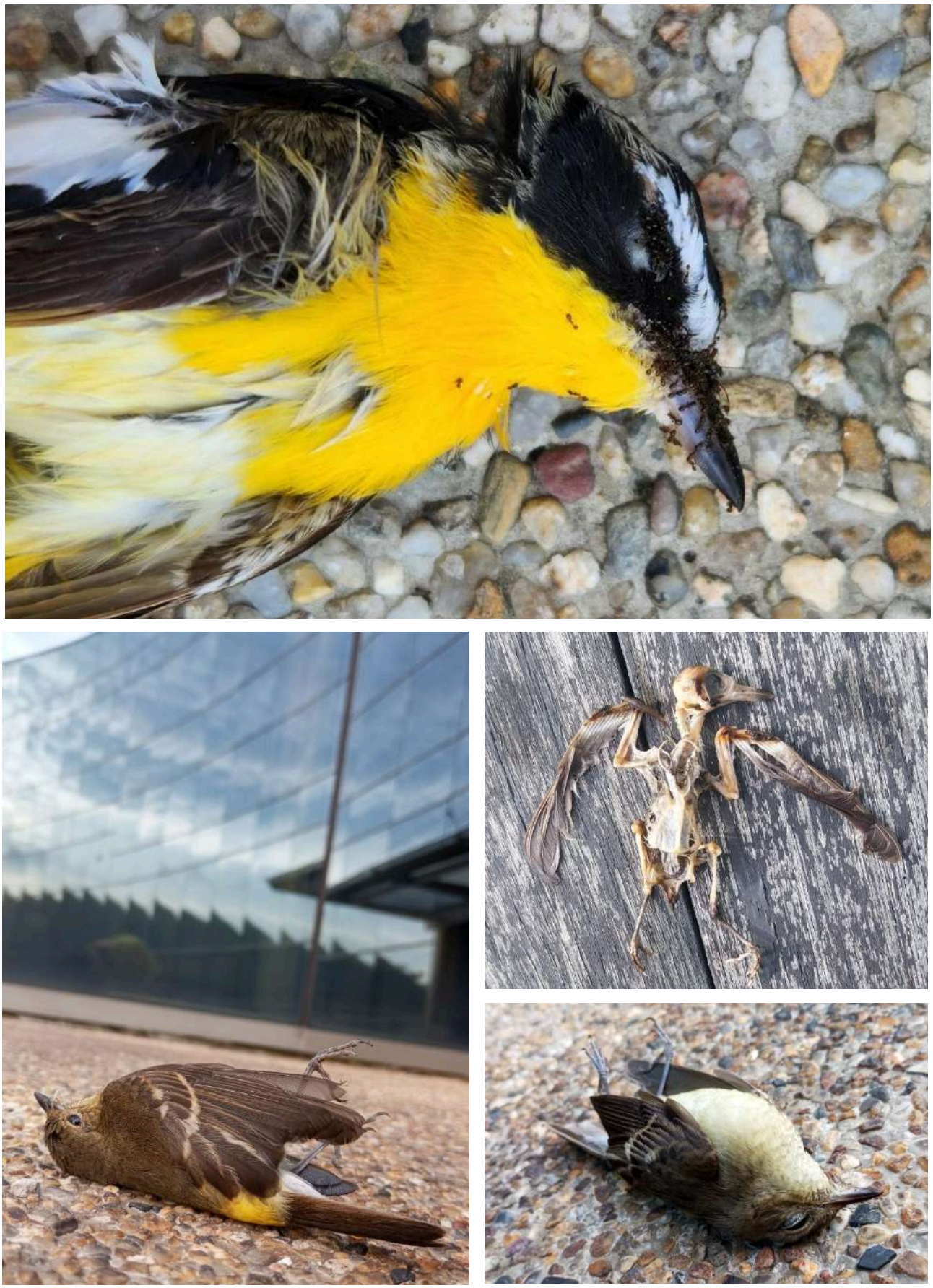


Figure 8. *Yellow-rumped Flycatchers that have collided at ADM.*

Conservation-Significant Species

Notably, seven collision records were of conservation significance, based on the global International Union for Conservation of Nature (IUCN) Red List of Threatened Species and the Singapore Red Data Book Version 3 (RDB3) (**Figure 7**). Four records were of the globally Vulnerable Brown-chested Jungle Flycatcher (*Cyornis brunneatus*) (Birdlife International, 2016) (**Figure 9**). The Brown-chested Jungle Flycatcher inhabits mature and pristine primary forest in its wintering grounds, a habitat that has become increasingly scarce due to clearance for plantations. Along with habitat loss, bird-building collisions may be an emerging threat to this passage migrant in Singapore.

For local species, two species of conservation significance collided at ADM. Two records were of the locally Vulnerable Cinnamon Bittern (*Ixobrychus cinnamomeus*) and the locally Endangered Blue-eared Kingfisher (*Alcedo meninting*) (National Parks Board, 2023) (**Figure 9**). The two species require marsh habitats and forested streams, respectively, and both landscapes have become increasingly scarce in urbanised Singapore (Bird Society of Singapore, N.D.).

Figure 9. *Conservation-significant species that have collided at ADM. Brown-chested Jungle Flycatcher (left) and Cinnamon Bittern (centre) are vulnerable globally and locally, respectively, while Blue-eared Kingfisher (right) is locally endangered.*

Architectural Factors

While certain species are more prone to collisions, the ultimate cause of bird collisions must be attributed to the architectural designs of the building. We highlight several elements of the ADM building that have likely contributed to collisions and mortality.

Firstly, ADM has a large contiguous glass surface, which has been shown to cause more collisions than smaller, discontiguous glasses of the same area (Basilio et al., 2020; Riding et al., 2020). This is likely because with a larger continuous surface, birds are more likely to perceive the reflection as a coherent image of the environment, e.g., blue skies, or tree canopies. Additionally, ADM adopted double-glazed glass, which is designed to

minimise heating while allowing natural light to illuminate the building interior, thereby reducing electricity usage for cooling and lighting (Greenroof.com, n.d.). However, this green feature of the building has also increased glass reflectivity (**Figure 10**). A study found that double-glazed glass could increase the reflectance of ultraviolet (UV), visible, and infrared (IR) light by about 1.37, 1.79, and 1.61 times, respectively (Li et al., 2015). Given further how birds have wider vision than humans in the UV spectrum, the reflection from a double-glazed glass, as perceived by birds, is highly likely more vivid than single-glazed glass.

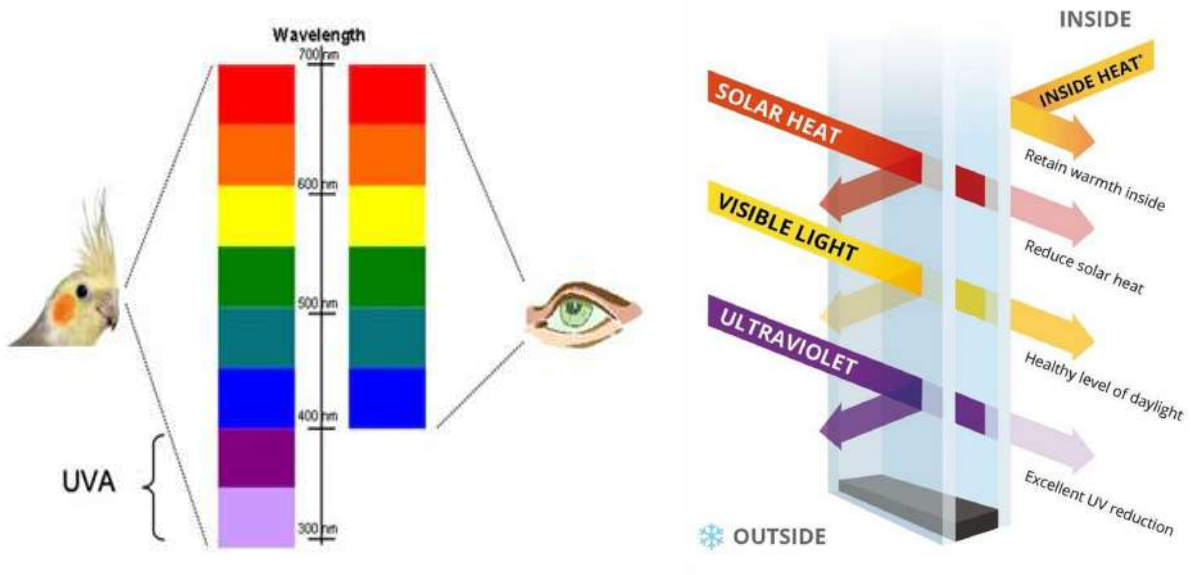


Figure 10. Left. *Birds have a wider visible spectrum than humans. Image credit: M&M (2022).* ***Right.*** *Double-glazed glass is designed to minimise heating, yet also leads to higher reflectivity. Image adapted from RetroGlaze (2024).*

Secondly, almost all recorded collisions happen along the interior of the building, which is indented with a C-shaped curvature. Riding et al. (2020) analysed the effects of facade shape on bird collisions. They found that alcove-shaped glasses like that of the interior of ADM resulted in much higher mortality rates consistent across all seasons, compared to other shapes like convex rounds, porticos, flats, and concave corners.

The C-shaped, horizontal enclosure is lethal as birds generally have larger visual fields laterally than above the head (Martin, 2012; 2017). In other words, birds identify horizontal escape paths more easily than vertical ones. Indeed, we noted that the birds that survived the first collision tend to collide multiple times within the building before dying (**Figure 11**). Cases of escape are rare, and of the few instances when birds escaped the building, they exited from the horizontal opening near the flight of stairs rather than flying above and over the glass facades.

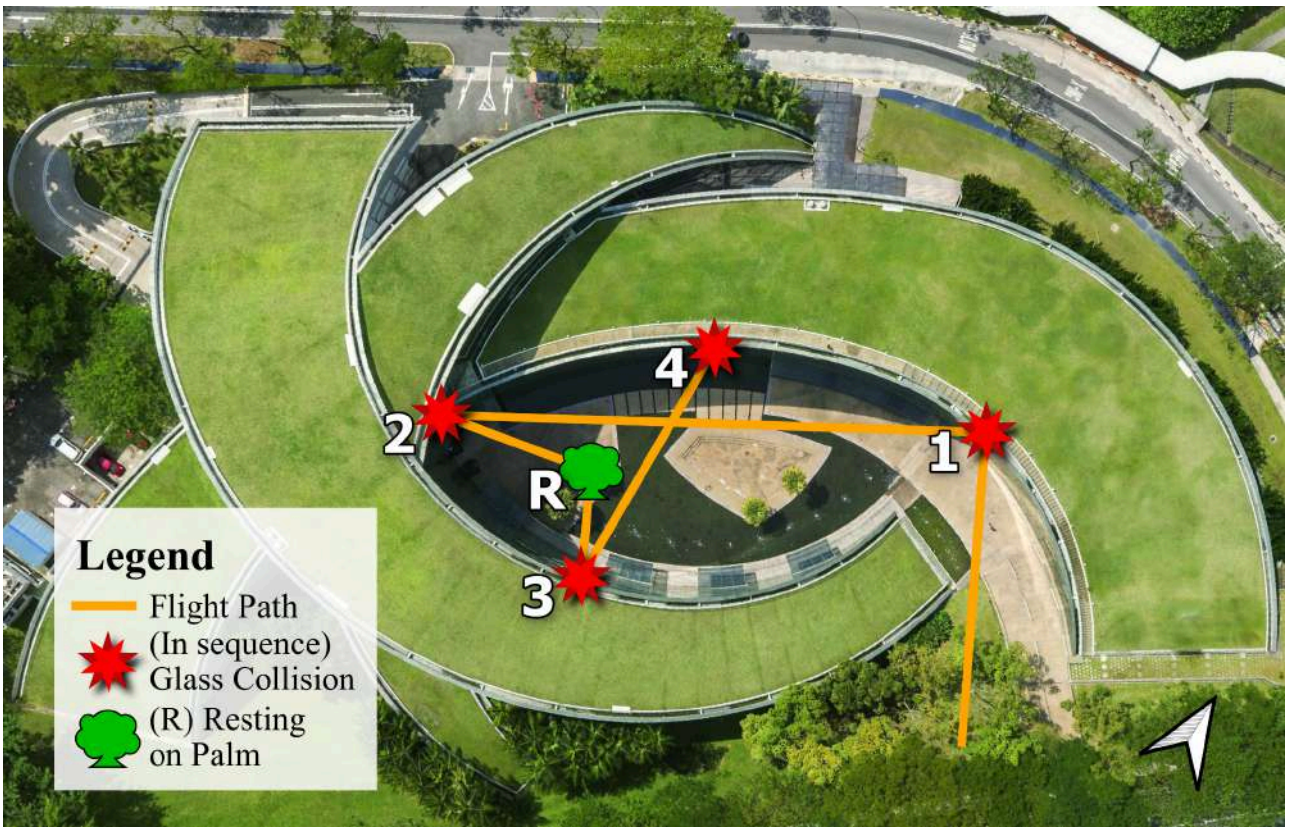


Figure 11. *Illustration of one instance when a bird entered the ADM building near the staircase and collided 4 times in an attempt to escape, before eventually dying. Between the collisions, the bird had landed on the palm temporarily before attempting to fly off again.*

Although multiple factors contribute to how birds are deceived and trapped by glass surfaces, some glass areas are more important when implementing solutions. As seen from the example above, birds usually enter the sunken plaza from the flight of stairs. This entrance area (hotspots 1 and 2, **Figure 2**) accounted for 42% of all collisions (**Figure 12**). Another critical area is at the C-shape's deepest (left) end, where birds get trapped after repeated collisions. 30% of collisions are found here.

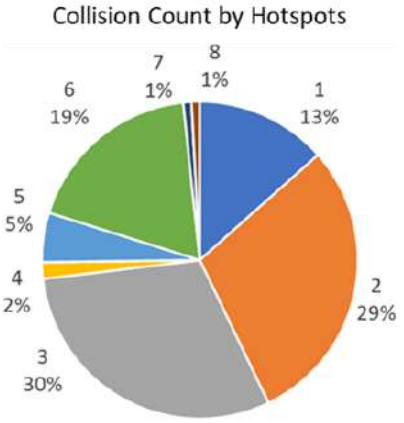


Figure 12. Collision count by hotspots.

Thirdly, parts of the interior surface are immediately next to the water features. Consequently, birds without fatal injuries from collisions might fall into the water and drown (**Figure 13**). While bigger birds might not drown from the relatively shallow water, we have witnessed multiple smaller birds like Yellow-rumped Flycatchers struggling in water before eventually dying.

Figure 13. *Birds fall into the water after collisions. Anti-clockwise: Hodgson's hawk cuckoo, Yellow-rumped flycatcher, Cinnamon Bittern, and Emerald Dove. While bigger birds can keep their head out of the water, smaller birds are more likely to drown.*

Fourthly, we recorded multiple incidents where birds were trapped in the gap between the glass doors at level B1 and the glass awnings (**Figure 14**). Enclosed within a small space resulted in multiple collisions and quickly led to injuries. Simple solutions like installing safety nets could effectively deter birds from entering this gap. We commend NTU's initiative to install safety nets at one of the awnings since the first version of the report, and we are pleased to report that no birds have been trapped at the position since. We recommend NTU to scale this low-cost and effective solution to all 7 awnings. Nevertheless, we should prevent the birds from entering the building in the first place through measures that directly reduce collisions.

Figure 14. *A juvenile Yellow-rumped Flycatcher was trapped in the gap between the glass doors at level B1 and the glass awnings. After getting trapped for hours, it passed away shortly after the NParks staff removed it from the gap, probably due to exhaustion.*

Limitations

Despite the rigour of our sampling within ADM, collision records are underestimated both in ADM and across campus. Birds that collide can be small, making them challenging to detect. Outside the survey period, birds may collide, recover and successfully escape ADM undetected. Additionally, bird carcasses could also be removed by janitors or predatory animals before being recorded. On a campus-wide level, many random reports are of charismatic, colourful species, while "drab" species are typically underreported.

Proposed Solution: Decals

A **popular, low-cost, and well-researched** solution proposed by bird collision experts includes **using decals to cover glasses** prone to collisions. Decals have been widely adopted in countries with high collision rates, such as the US and Canada. Many birds do not perceive glass panels as barriers and obstructions, especially when passing through unfamiliar environments during migration, leaving them vulnerable to collisions with reflective surfaces (Klem, 1989). Decals tackle this issue by distorting the reflection and providing a visual indicator that a window is present, allowing birds to differentiate the glass surface from their natural environment (Klem, 2009). Furthermore, there are specific requirements for the location, size, interval, and materials for the decal to be effective. The requirements as suggested by the **2022 NParks Bird-Safe Building Guidelines** and scientific evidence are listed as follows (National Parks Board, 2022):

1. **Decals should be applied to the external glass surface.**

A team at William & Mary's Institute for Integrative Conservation found that applying decals on the internal surface of the glass was largely ineffective, while application on the external surface led to 47% more avoidance (Swaddle et al., 2023). In general, it is recommended that decals be placed on the outer surface of glass, as strong glass reflections will hide patterns that are placed on the inner surface (Sheppard, 2019).

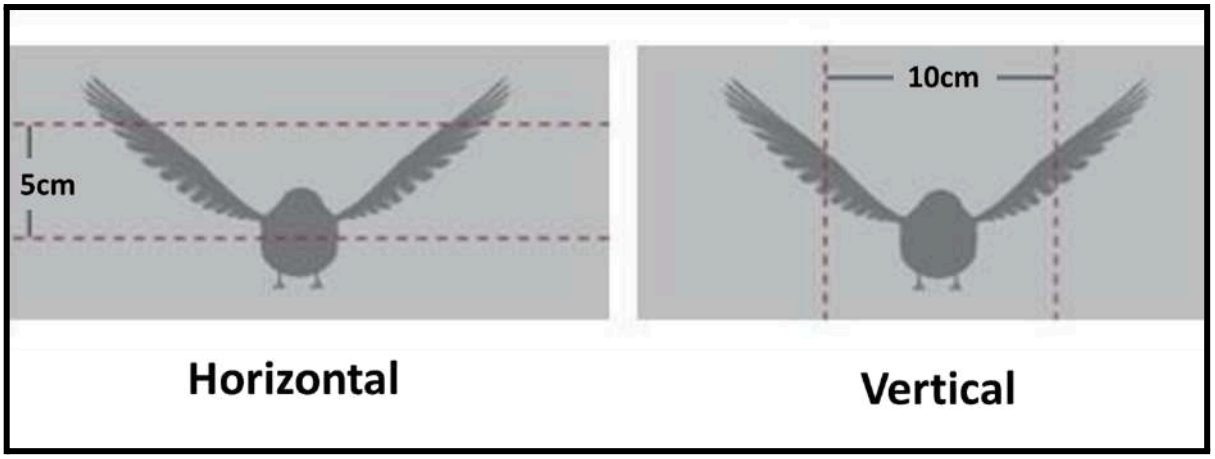


Figure 15. *The 5x10 rule of decal density. This ensures even the smallest birds do not perceive gaps large enough for them to pass through. The rule should be locally adapted to the size of smaller colliders. Figure adapted from the US Green Building Council.*

2. **The 5x10 rule: Decals should not have gaps larger than 5x10cm.**

Research has very consistently shown that spaces between pieces of the decal should measure less than 2 inches (about 5.08cm) high and 4 inches (about 10.16cm) wide, such that small birds do not perceive the gap as empty (**Figure 15**) (Klem 2009; Sheppard and

Phillips 2015). Stripes and dots can be incorporated to help minimise areas of glass uncovered by decals. Any stripes should be at least ¼ inches (about 0.635cm) wide, while dots should be at least 0.2 inches wide (about 0.508cm). It should be noted that the size restriction should be relative to the species most commonly colliding at the location. Given that colliders at ADM are generally small birds, we recommend, as per NParks guidelines, to lower the requirement to 5x5 cm.

3. **The material of decals should be of high contrast as perceived by birds.**

Birds can see UV light in addition to the visible light spectrum. Thus, it is possible to utilise UV-reflective decals that are translucent to human eyes to reduce BBC incidents. While this method results in fewer changes to the building's appearance, many studies have cautioned that UV patterns require strong contrast to be effective, especially in the early morning and late afternoon, when UV in sunlight is at low levels (Klem, 2009). This is coupled with the fact that many colliders at ADM are known to be night-time flyers, which means they usually seek resting spots near dawn. The American Bird Conservancy, for instance, has explicitly mentioned that UV patterns may be ineffective for many species, including flycatchers (Sheppard and Phillips 2015). Thus, opaque decals are considered a more effective solution.

4. **Apply decals on at least 85% of all glass surfaces.**

Unlike the exterior glass curtains, the inward-facing glass surface at ADM has no immediate vegetation next to it that could mask the reflection, thus, it is recommended to cover at least 85% of the entire inward-facing surface. The extent of coverage should not be confused with the total surface area covered by the decals, as the decals only cover approximately 6% to 8% of the glass surface (shared anecdotally by Feather Friendly, a private supplier of decals). Thus, there are **negligible solar load concerns** that could affect lighting or energy use.

Successful Examples

NUS Ridge View Residential College

In 2019, staff at Ridge View Residential College (RVRC) of the National University of Singapore (NUS) noticed two dead birds that had crashed into the second and third floors of their college building. Similar to ADM, the collision sites were glass panels that reflected the sky, which led to the birds' confusion during flight. RVRC staff reacted immediately by sourcing dotted decals to be plastered on the glass surfaces (**Figure 16**). Ever since their application, there have been no bird collisions, even during the peak migratory season. RVRC's success demonstrates the feasibility of decals in mitigating bird-building collisions, which should be considered for the ADM building.

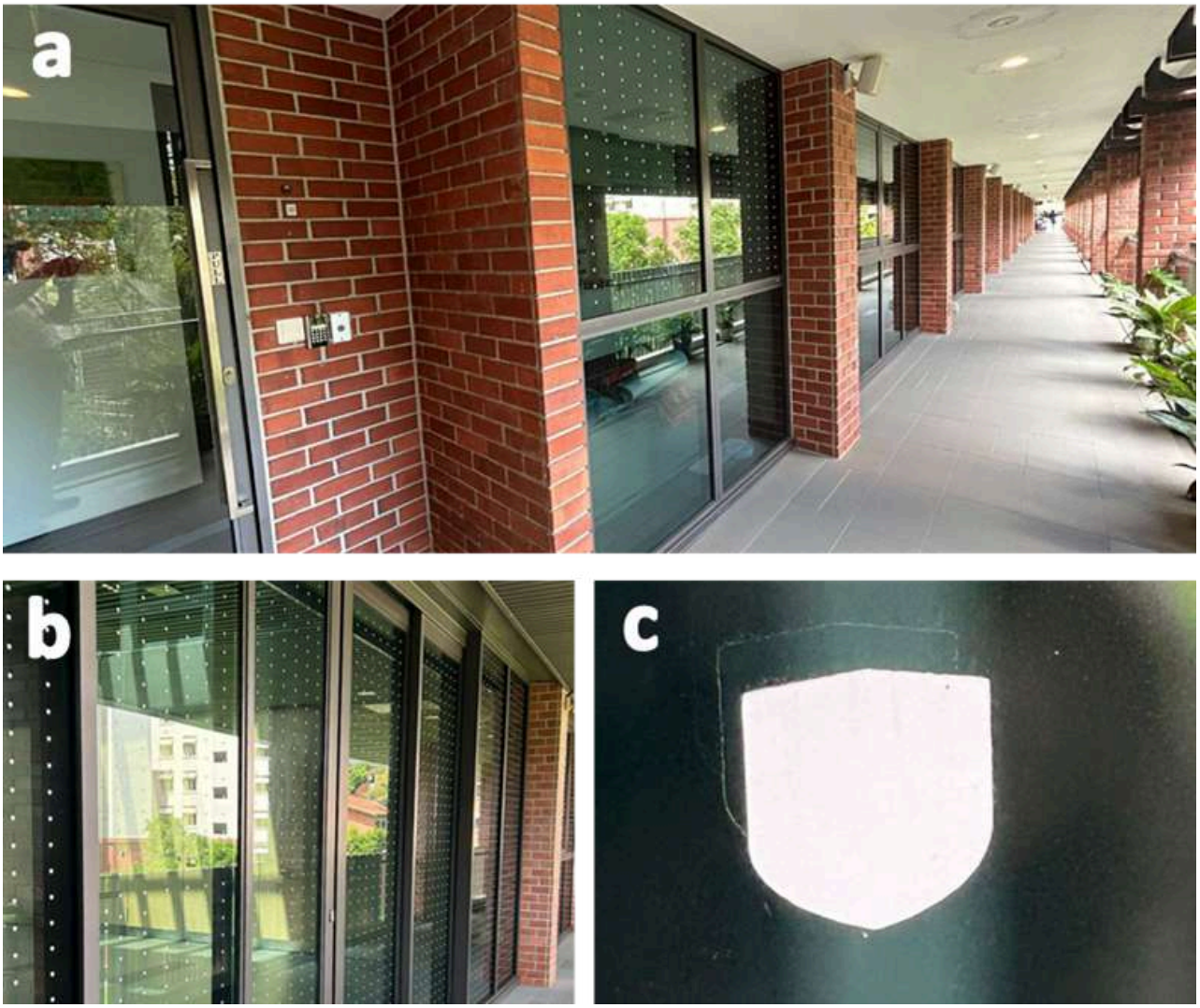


Figure 16. *Decals pasted on the glass surfaces of Ridge View Residential College, NUS.* ***(a)*** *Decals are pasted on the second floor, where offices are located.* ***(b)*** *Decals are pasted on the third floor, where the dining hall is located.* ***(c)*** *A close-up of an individual decal. Photo and information credits: Sivasothi N.*

University of British Columbia

The University of British Columbia (UBC) introduced the Bird Friendly Design Guidelines for Buildings and **mandated compliance for all academic buildings** by 2020 and residential buildings by 2025 (UBC, 2019). Apart from retrofitting bird-safe designs at existing buildings, UBC also requires all new buildings to comply with guidelines.

UBC has extensively incorporated decals into its infrastructure to reduce bird collisions on campus (**Figure 17**). In the guideline, the institution recommends effective glazing designs beyond repetitive patterns, such as patterns that celebrate bird diversity (**Figure 10, b & d**). Different design concepts can be applied to suit the function of the building, e.g., using students' favourite quotes as decal design at a bookstore (**Figure 10, c**). For smaller and more accessible glasses, the community also used oil-based markers to hand-draw designs (**Figure 10, a**). These recommendations have been proven effective on their campus and can be implemented at NTU.

Figure 17. *Decals were pasted on the glass surface of various buildings on the UBC campus.* ***(a)*** *Bird-friendly decal designs using oil-based markers at the Beaty Biodiversity Research Centre.* ***(b)*** *Adhesive film decals at the Centre for Interactive Research on Sustainability.* ***(c)*** *Fritted glass at the UBC bookstore.* ***(d)*** *A pattern of a Swainson's thrush with migration routes mapped from a UBC study. Photo credits: UBC, 2019.*

Complementary Approaches

We also suggest complementary measures that could enhance the effectiveness of decals. One well-established approach is to minimise light spills at night, as migratory birds rely heavily on starlight to orient themselves. Currently, the top of ADM has a row of floodlights that remains lit throughout the night, which could confuse the birds (**Figure 18, a**). Designs that reduce uplighting can be easily retrofitted into existing building designs without altering lighting timing or compromising public safety (**Figure 18, b & c**). Despite the dangers posed by nighttime lights, it's important to note that most collisions still take place during the day, and treating the glass reflection remains the priority.

Figure 18. (a) *Uplights that line the roof of the ADM building could disorient the birds. Photo credits: William Yung.* ***(b)*** *Examples of uplight that should be avoided.* ***(c)*** *Examples of designs that minimise light spills, which do not require removal of the light or compromise public safety. Figure credits: San Francisco Planning Department, 2011.*

Alternative Solutions

In this section, the proposed decals are compared against alternative solutions, which include passive barriers that overlay the reflective window, roof-like structures that block sunlight, and active deterrence through sound and light stimulations. The comparison is done through 5 semi-quantified metrics, each rated from 0 to 4, with 4 being the most favourable. The highest total score out of 20 is considered the best. The 5 metrics are:

- **Effectiveness** refers to how well-established each solution is in reducing bird collision rates and mortality.
- **Accessibility** refers to whether the solution is commercially available in the local market.
- **Durability and flexibility** refer to how future-proof each solution is in the face of potential weathering and change in circumstances.
- **Cost-saving** refers to the monetary investment required to install and maintain the solutions.
- **Strategic Interest** entails any potential implications of the solutions on the ADM community's usage of the building. For instance, one key concern that has been brought up in meetings is the aesthetics of the solution. Another concern is the energy usage of the building, which could affect its Green Mark Platinum certification. There are also concerns about blocking off fire access points and the impact on the glass cleaning routine.

Decals are the most advocated and established solutions globally, especially for large buildings. In the Americas, where birds are colliding in the billions, decals have been proven to be the most scalable and accessible retrofit.

The American Bird Conservancy is the world leader in addressing bird collisions. They innovated the tunnel test methodology to examine the effectiveness of bird-safe solutions, which has become the industry and scientific standard. They have also pioneered building certification credits and policy frameworks to help align industries and businesses with bird-friendly designs. In their bird-safe products database, decals dominate the most effective solutions with the lowest threat factor (ABC, 2025). In the 2022 NParks Bird-Safe Building Guidelines, the only other suggestions apart from decals are screens, nettings, and vegetation, which are examined below.

Passive Barriers: Paracords, Nettings, Screens, Grilles, Shutters, Plants

These solutions aim to provide physical barriers that overlay the reflected glass. Similar to decals, these solutions effectively block off or break up the reflection. They also prevent birds from crashing into the window by providing a buffer or alternative perching spots. Nevertheless, many of these solutions are much easier to implement in the construction

phase rather than being retrofitted. Furthermore, a key concern for these solutions is that they block sunlight from entering the building. Recall that the ADM building is designed to maximise daylighting, which lowers electricity use and contributes to Green Mark certification. Thus, an ideal solution should not significantly affect the natural illuminance. Physical barriers that cover the glass may also impact the visual aesthetic of the building extensively.

Among the passive barriers, planting trees that are tall enough to line the glass surface would require hacking of the floor for sufficient soil depth or additional pots, given the solid floor of the sunken plaza. Planting trees as collision buffers is also a poorly researched method. It may attract more birds and increase collision rates, given that collision rates increase with proximity to green spaces. Grilles, shutters, nettings, and screens are structural extensions that are challenging to install without significant redesigning and reworking of the building's architecture. We do not have the technical expertise to advise on the feasibility.

Paracords

Vertically lined parachute cords (paracords), however, are much easier to retrofit and block minimal sunlight (**Figure 19**). Any cords of any colours, designs, and materials can be hung along the facade, provided they are sufficiently durable and dense at 10 cm intervals. **Dark-coloured polyester cords are ideal** as they are thin (~3-4mm) and weather-resistant. To our knowledge, there are no local suppliers for bird-safe paracord products, although they can be ordered and shipped from abroad (supplier: Acopian BirdSaver). Installation can be done by us or by hiring operators.

It is also **possible to DIY the product** if we do not order from abroad. This can be done by drilling regularly spaced (10cm apart) holes in aluminium bars, pulling the cords through, and tying knots to secure. The "curtain" can then be secured to the top and bottom ends of the glass panels. There are many methods to secure the cords, such as hooks or adhesive clips, but aluminium bars are preferred for large buildings as it is more robust and durable (**Figure 19**). These bars can be screwed, glued, or wedged onto the glass frames. This method has the benefit of being more flexible as the cords are not stuck to the glass. Also, since aerial lift machinery cannot enter the sunken plaza, installation of the top bar can be done by accessing via the rooftop.

Fair warning should be given that DIY would come with more uncertainty on the quality of installation methods, and likely requires trials and regular maintenance later on. Although material costs are **significantly lower**, internal manpower is needed to install and maintain the cords, compared to adopting commercial services. There are also limited

cases of DIY cord installation for large buildings like ADM, although it is increasingly gaining traction as a low-cost, more flexible alternative to decals (**Figure 19**).

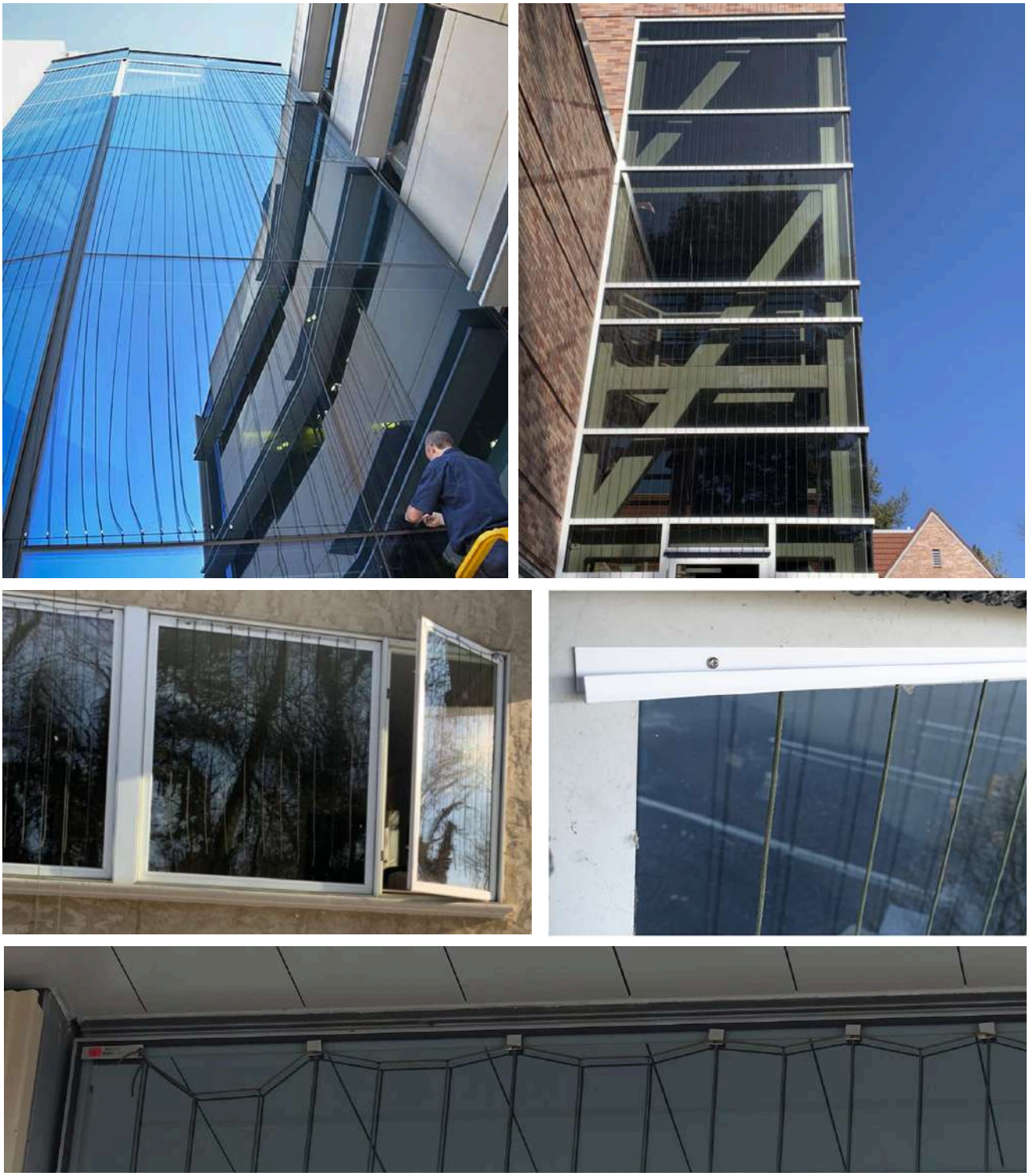


Figure 19. Top. *Examples of paracords on large glass facades. It has received excellent reviews on its aesthetics.* ***Middle.*** *Cords can be attached directly to the window frame to prevent blocking it. Aluminium bars can be screwed, glued, or wedged onto the frame.* ***Bottom.*** *Aluminium bars can be omitted entirely. The curtain is held up only by horizontal cords, which are then secured on hooks or clips.*

Blocking sunlight: Awnings, Roofs, Overhangs, Changing the Glasses

Similar to grilles and shutters, roofs and awnings are structural extensions which will drastically alter the appearance of the building. Furthermore, there are many situations in which roofs do not eliminate reflections from all angles (Sheppard & Phillips, 2015). For this solution to work best, the roof must be so extensive that its shadows cover the entire glass facade. In the case of ADM, this essentially means turning the sunken plaza into a full sheltered space. Some buildings have also opted to swap out the reflective glass panels altogether. Once again, we do not have the expertise to advise on its feasibility.

Active Deterrence: Sirens and Lasers

Airports around the world have adopted more advanced technology to actively deter birds, but it is doubtful that these solutions are suitable for small-scale deployment. Common strategies include using sound and light stimulations. For sound, it could be either loud sirens or recorded audio clips of large raptors. Nevertheless, these methods are both disruptive to the NTU community and wildlife. For example, resident birds of prey have taken up residence in the vicinity of ADM, and the playing of such calls may result in them abandoning their nests or changing their normal behaviours. Ultrasonic sounds, which are less disruptive to humans, are not effective on birds and will impact bat populations in the vicinity. Auditory deterrents will also likely be reliable only for a short period, as birds may learn to distinguish the “fake alarms”. For light, handheld laser beams are commonly used as a low-cost solution. Most importantly, for active deterrence to work, the most crucial element is active monitoring, followed by manually triggering the stimulation. This is manpower-intensive. Airports have advanced bird monitoring and detection systems, which are not possible in the case of NTU.

Summary of Alternative Solutions

The discussions above are semi-quantified into scores, which are summarised in the table below (**Figure 20**). In our opinion, decals remain the best available solution. Cords come very close as a next-best alternative that is significantly cheaper, although it still requires separate installation operators, and might physically obstruct the windows. Attaching the cords on the window frame directly could avert this, but requires more sophisticated installation and customisation. The glass cleaning routine could be affected as the windows are not physically obstructed. Nonetheless, spraying detergent followed by high-pressure water can likely still proceed even with the presence of the cords, although additional precautions are needed. If these are not of significant concern, then cords could be worth trying.

Solutions	Effective	Accessible	Durable & Flexible	Cost	Strategic	Total
Decals	**4**	**4**	**2**	**3**	**4**	**17**
Cords	**4**	**2**	**3**	**4**	**4**	**17**
Roofs	**2**	**1**	**2**	**1**	**0**	**9**
Sirens & Lasers	**2**	**0**	**1**	**1**	**1**	**5**

Figure 20. *Summary of ratings for each solution, where each metric is rated from 0 to 4, and the highest possible total score is 20. Cords are identified as an equally favourable option as decals.*

Risks and Opportunities Analysis

This section presents a forward-looking analysis of the potential risks and opportunities associated with NTU's action to reduce bird collisions on campus. It combines scenario analysis, risk assessment, and cost-benefit thinking to guide informed decision-making. The two aspects examined are well-being and reputation.

Well-being Risks and Opportunities

As captured through the interviews, bird collisions have been jeopardising the mental well-being of the ADM and the wider NTU community (see section on Results: Interview and Online Surveys). Many students and professors who are aware of the situation have repeatedly expressed their frustration and dissatisfaction. The janitors who have been quietly sweeping the carcasses away still receive little to no attention from the management. Yet perhaps the most impacted students are the volunteers who have dedicated their early mornings and late nights to rescue injured wildlife (which goes way beyond birds), monitor the threats they are facing, and actively improve their well-being. Many of them joined the team with burning passion and unparalleled dedication, yet eventually walked away with disappointment, disbelief, and despair over the situation. We sincerely hope that NTU will properly acknowledge the grievances of the community.

Apart from mental well-being risks, bird collision also presents risks to the physical well-being of the community. Bird collisions at ADM result in more carcasses being left around, which could lead to the transmission of zoonotic diseases. This could be through primary contact, i.e., direct contact with the birds, or secondary contact, when the carcass decomposes and attracts other pests or harbours harmful microorganisms. The group of people who are most at risk, once again, are the student volunteers and janitors who are at the forefront of making physical contact with the collision victims. Although the volunteers are already advised to practice good hygiene, such as performing thorough sanitisation after contact, the risks could have been avoided in the first place with proper solutions in place.

Furthermore, a healthy ecosystem has tangible positive impacts on both the mental and physical well-being of the community. In other words, by conserving a healthy environment, NTU has the opportunity to tap into the wealth of benefits that our unique and precious natural environment provides. These advantages brought by an intact, well-balanced ecosystem are called ecosystem services (ES), and they can take many different forms. For instance, **regulating ecosystem services** includes cooling the environment with tree shade, storing carbon, or retaining rainwater, thus preventing floods and ensuring a healthy freshwater supply. A study led by ASE Professor Perrine

Hamel and her Resilient and Inclusive Cities Lab modelled the regulating ecosystem services on the NTU campus (**Figure 21**) (Hamel, 2024).

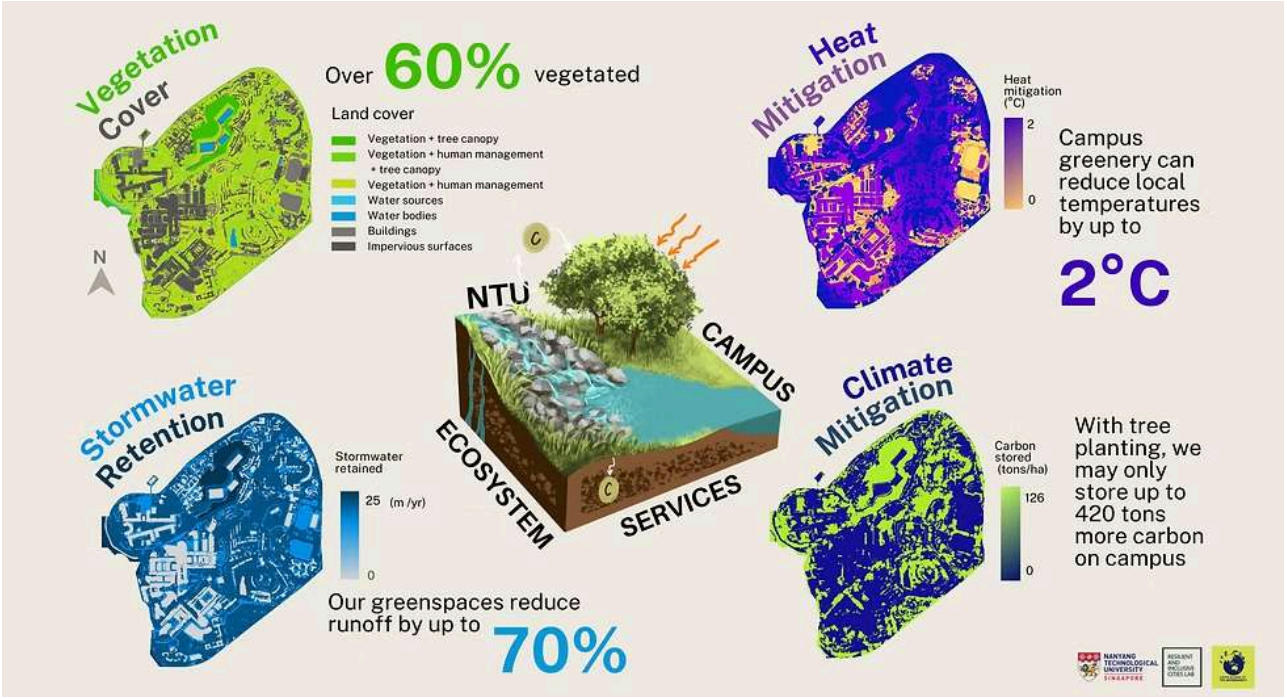


Figure 21. Top. *Regulating ecosystem services on the NTU campus.*

Another category of ES is the **cultural ecosystem services**, which include spiritual enrichment, reflection, recreation, and aesthetic appreciation. While seemingly difficult to quantify, these benefits are tangibly improving the well-being of our campus users. For instance, the psychological enjoyment comes from strolling through a garden in the early morning or evening while enjoying the songscape of birds and the presence of green plants. In our first engagement, a nature walk with NTU offices in April 2024, we invited staff from ODFM, SO, and CC (Corporate Communications), as well as faculty members from ADM, ASE, SSS, and LKC (**Figure 22**). Student nature guides showcased the rich wildlife that users can easily spot on the blue track along the fringe of the Western Catchment forest.

Figure 22. *A nature walk for staff and faculty members from various offices and schools.*

Furthermore, nature on campus has been a vital source of inspiration for student learning and creativity. For instance, the Nature Guiding Portfolio of the Earthlink CCA has been actively documenting wildlife on campus and sharing it with the NTU community (**Figure 23**) (Hamel, 2024). They remain one of the most active portfolios even across all CCAs. Nature on campus offers not just a recreational function, but a precious chance to observe and study some of the otherwise rare species in Singapore, thanks to NTU's proximity to the forest.

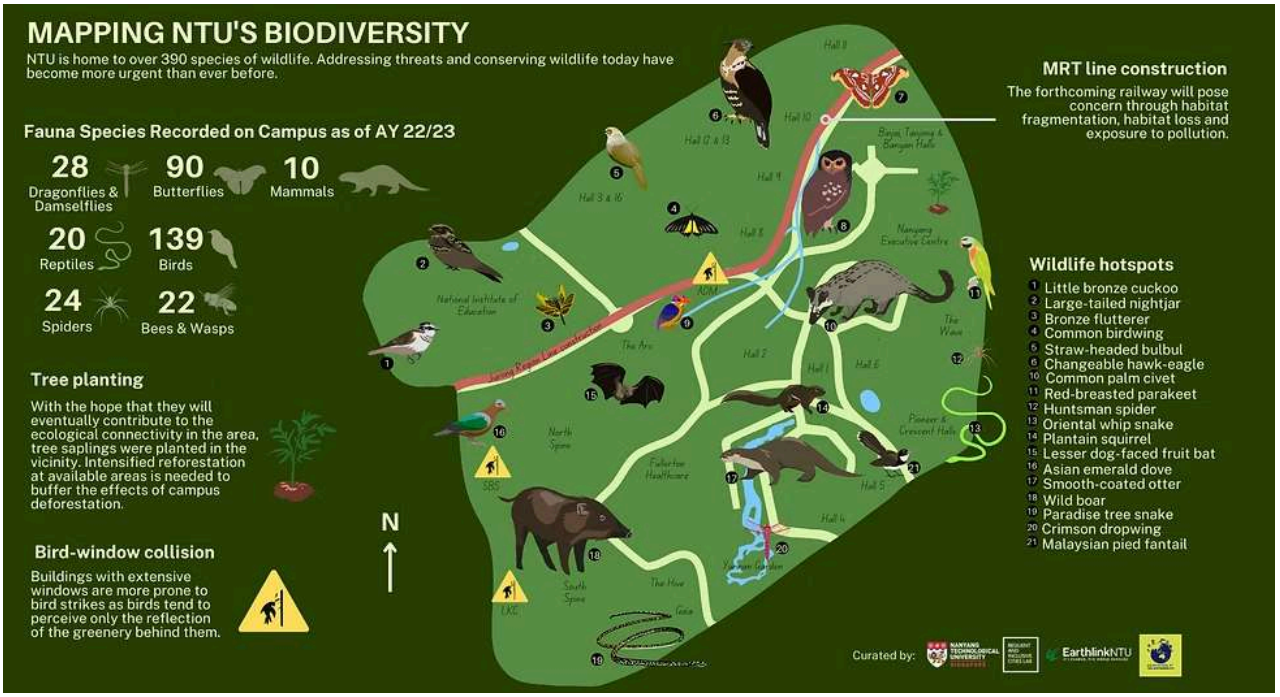


Figure 23. *A map of NTU's biodiversity was created collaboratively by the Nature Guiding Portfolio of Earthlink and the Resilient and Inclusive Cities Lab.*

In 2023, a group of young bird researchers/enthusiasts from NTU achieved something truly remarkable: They published a 138-page-long guidebook to the birdlife of NTU, which includes 135 local and migratory species documented on campus (**Figure 24**). In 2024, a group of WKW students took on the herculean task of a wildlife documentary for their FYP titled Sad Birds Still Fly, which explored "the beauty and challenges of local and migratory birds in Singapore, impacted by urbanisation" (**Figure 24**) (Tapay et al., 2024). One of the key issues highlighted is bird collisions in NTU and around Singapore. Their work has been accepted to the Singapore Youth Film Festival 2024, and won 4 nominations and 1 award.

We believe it is more than fair to say that NTU has been blessed by its natural environment. Nature has become part of NTU's identity as a green campus and is crucial for a flourishing NTU community. NTU can turn the well-being risks into opportunities by

actively engaging the community in formulating solutions to bird collisions and conserving our natural environment.

Figure 24. Left. *Cover page of A Guide To The Birds of NTU.* ***Right.*** *The teaser to the student-filmed documentary, Sad Birds Still Fly.*

Reputational Risks and Opportunities

NTU's long-standing reputation as a sustainability leader could also be severely damaged if bird collisions on campus remain unattended to and potentially reach the public media. The ADM building has received the Green Mark Platinum Award since 2011. One of the building's major achievements was its energy savings of almost 120,000 kWh per year (enough to power 27 4-room HDB flats a year). However, as explained previously, this is achieved through using large glass facades that are highly reflective. In other words, the current prestige of ADM, and to some extent that of NTU, builds upon the harm that it imposes on the birds and students.

Along with reputational risks comes an opportunity for NTU to revise its approach to sustainability. One of the main commitments in NTU's sustainability framework is to make all NTU buildings Green Mark Platinum certified by 2035 (NTU, 2021). However, a more holistic approach to sustainability would require NTU to move beyond the carbon or waste-focused mindset and include more biophilic goals. For instance, the most widely used green building certification scheme globally, the Leadership in Energy and Environmental Design (LEED) certification, has piloted a bird collision deterrence credit since 2011. Due to its popularity, this credit has been a permanent addition to the LEED library since 2022. While local schemes like the BCA Green Mark do not have such criteria (due to low awareness of bird collisions locally), it is ironic for NTU to promote its "green buildings" when they have killed hundreds of birds over the past two decades.

One way to incorporate biodiversity-friendly actions is to align the management of the ADM building and the wider campus with NParks' Landscape Excellence Assessment Framework (LEAF). LEAF certification focuses not only on resource efficiency and emission reduction, but also on the contribution to wildlife and local biodiversity. LEAF certification is not new to NTU, as the Yunnan Garden has been a LEAF Gold-certified park since 2022. Upon preliminary estimates, installing bird-safe measures alongside continuous monitoring and community engagement could improve ADM buildings' LEAF Assessment rating by at least 10 points, on top of its already outstanding water management. Opportunistic records during bird collision surveys also showed that ADM attracts a disproportionately high density of uncommon insects. Coupled with more active incorporation of native plants, potentially in collaboration with the NTreeU portfolio of Earthlink, the building could potentially acquire a high-level LEAF certification.

Furthermore, bird collisions at ADM offer a unique opportunity for NTU to stand out as the first university in Singapore to implement bird-safe measures on a large glass building. The challenge to find cost-effective solutions is not unique to universities in Singapore. We have learned through word of mouth that students from Hong Kong University (HKU) and the Chinese University of Hong Kong (CUHK) are also struggling to obtain institutional support for bird-safe measures on campus (**Figure 25**). NTU's positive example for other universities in the region will thus be especially impactful, as awareness of bird collisions in the East-Asian-Australasian Flyways is on an upward trajectory.

表格四　2022年9月至2023年8月，在五個地點分別通過定期鳥撞調查及全球鳥撞地圖公眾報告所收集的鳥撞數字。

Table 4　Total number of individuals and imprints at the five regular survey locations, collected from our regular bird collision surveys and the GCBM from September 2022 to August 2023.

地點 Location	定期鳥撞調查數據 Regular Bird Window Collision Surveys		全球鳥撞地圖數據 Global Bird Collision Mapper	總數 Total
	個體數量 No. of individual(s)	鳥撞拓印數量 No. of bird imprint(s)	個體數量 No. of individual(s)	
美孚 Mei Fu	3	25	5	33
青衣 Tsing Yi	10	4	1	15
尖沙咀 Tsim Sha Tsui	6	4	3	13
中文大學 CUHK	5	28	37	70
香港大學 HKU	7	4	4	15

Figure 25. *CUHK and HKU each experienced 70 and 15 collisions within one migratory season. Figure adapted from the 2022–2023 Report on Hong Kong Bird-window Collisions prepared by the Hong Kong Bird Watching Society (Wong et al., 2024).*

Moving Forward

Our team is dedicated to continuing the monitoring effort in the upcoming migratory seasons. This will allow us to evaluate the effectiveness of the solutions and continue to document this scientifically significant case. Furthermore, bird collisions on campus have occurred beyond the ADM building (Appendix 1). NTU thus has the potential to set a precedent within Singapore for the first large-scale compliance with the 2022 NParks Bird-Safe Building Guidelines and bird-proof the entire campus, as many other universities abroad have done.

Last but not least, we reiterate our vision of finding a win-win-win solution for the community, the birds, and NTU itself. NTU's support of this project will be a significant step towards a biodiversity-friendly campus and greatly benefit its reputation. The social-ecological benefits of solving bird-building collisions are immense. Above all, we believe that the lives of our feathered friends are priceless, and they deserve every effort to be saved from unnatural deaths on campus. We hope that the vision behind the Third Paradise art installation on ADM will become a reality one day:

"The artificial world has provided mankind with comforts, but also led to the deterioration of our natural environment," said Mr Michelangelo Pistoletto, the artist behind The Third Paradise. "The central circle in the symbol, the Third Paradise, represents a world in which there is an ideal balance between human activities and nature, something which is indispensable to ensure the survival of mankind."

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Appendix 1: Historical Records of Bird Collisions in NTU

Apart from the comprehensive survey conducted over the past two years, various collision sightings were recorded from group chats and social media. After retrieving these records from these platforms, we mapped out 46 collisions between 2016 and 2025 that can be georeferenced. From the data, we observed 6 noticeable clusters for bird collisions: Gaia, Nanyang Auditorium, SBS, N2.1, North Hill, and ADM (**Figures 26, 27**). This points to the need to bird-proof our campus beyond the ADM building.

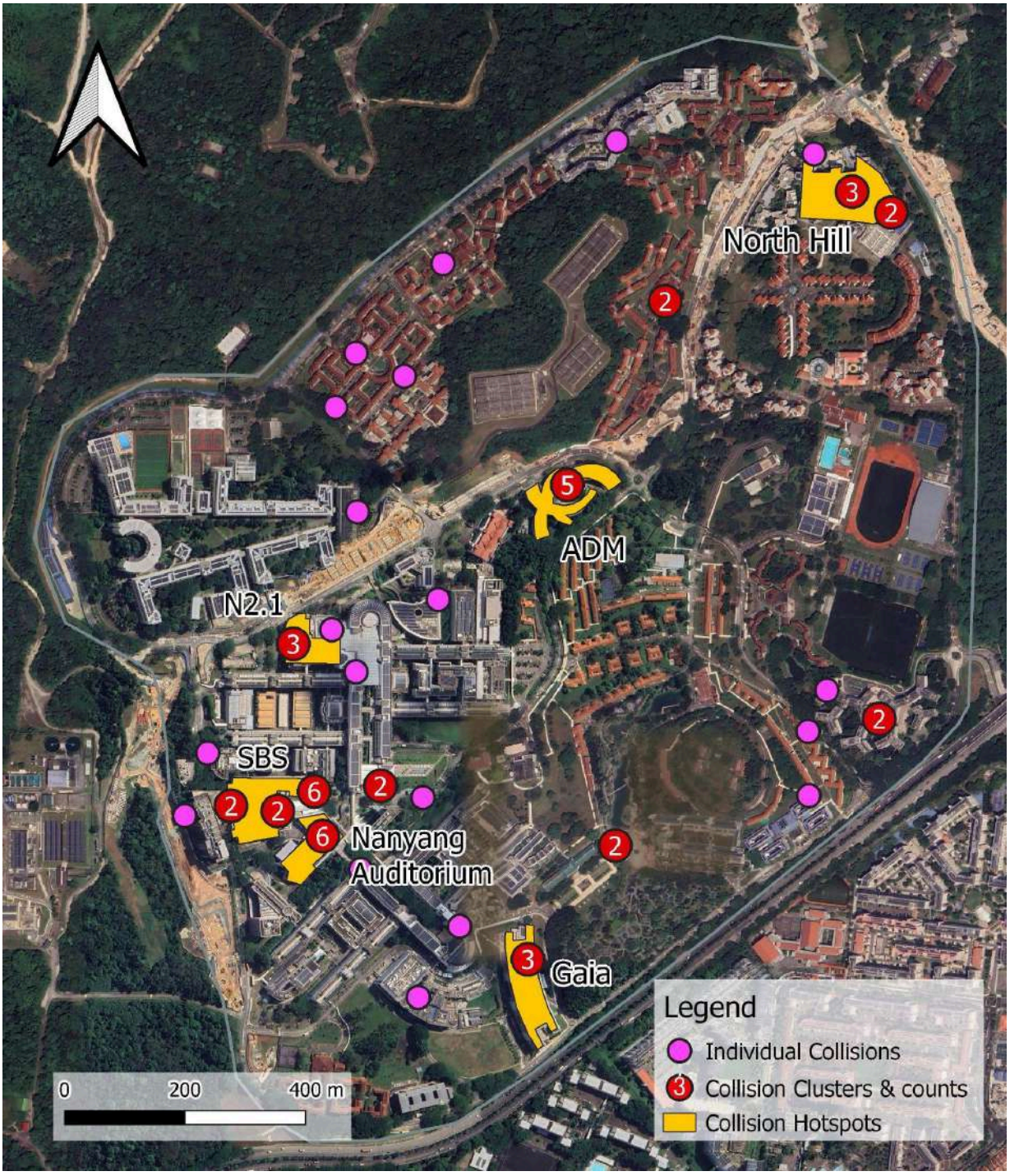

Figure 26. *Historical collision points on campus, with clustering at a few locations.*

Historical Collisions from Random Reports between 2016 and 2025

Location	Year	Family	Species	Count
School of Biological Sciences (SBS)	2025	Estrildidae	White-headed Munia (*Lonchura maja*)	2
	2024	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
	2023	Estrildidae	White-headed Munia (*Lonchura maja*)	1
	2023	Muscicapidae	Yellow-Rumped Flycatcher (*Ficedula zanthopygia*)	1
	2023	Phylloscopidae	Arctic Warbler (*Phylloscopus borealis*)	1
	2022	Columbidae	Pied Imperial Pigeon (*Ducula bicolor*)	1
	2022	Muscicapidae	Yellow-Rumped Flycatcher (*Ficedula zanthopygia*)	2
	2021	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
School of ADM	2025	Alcedinidae	White-throated Kingfisher (*Halcyon smyrnensis*)	1
	2022	Ardeidae	*Ixobrychus* sp.	1
	2021	Muscicapidae	Yellow-Rumped Flycatcher (*Ficedula zanthopygia*)	1
	2021	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
	2021	Muscicapidae	Mugimaki Flycatcher (*Ficedula mugimaki*)	1
	2021	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
	2016	Muscicapidae	Yellow-Rumped Flycatcher (*Ficedula zanthopygia*)	1
	2016	Monarchidae	*Terpsiphone* sp.	1
Nanyang Auditorium	2024	Columbidae	Pink-necked Green Pigeon (*Treron vernans)*	1
	2022	Turdidae	Eyebrowed Thrush (*Turdus obscurus*)	1
	2022	Sturnidae	Asian Glossy Starling (*Aplonis panayensis*)	4
	2022	Sturnidae	Daurian Starling (*Agropsar sturninus*)	2
Gaia	2023	Columbidae	Pink-necked Green Pigeon (*Treron vernans)*	2
	2023	Sturnidae	Asian Glossy Starling (*Aplonis panayensis*)	1
N2.1 (North Spine Plaza)	2023	Nectariinidae	Ornate Sunbird (*Cinnyris ornatus*)	1
	2023	Megalaimidae	Coppersmith Barbet (*Psilopogon haemacephalus*)	1
	2022	Psittaculidae	Long-Tailed Parakeet (*Psittacula longicauda*)	1
North Hill Halls	2024	Sturnidae	Asian Glossy Starling (*Aplonis panayensis*)	1
	2024	Pittidae	Blue-winged Pitta (*Pitta moluccensis*)	1
	2023	Pycnonotidae	Sunda Yellow-vented Bulbul (*Pycnonotus analis*)	1
	2022	Strigidae	Oriental Scops Owl (*Otus sunia*)	1
Crespion Halls	2023	Pittidae	Blue-winged Pitta (*Pitta moluccensis*)	1
	2022	Oriolidae	Black-naped Oriole (*Oriolus chinensis*)	1
	2022	Columbidae	Zebra Dove (*Geopelia striata*)	1
Hall 12	2024	Pycnonotidae	Yellow-vented Bulbul (*Pycnonotus goiavier*)	1
	2023	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
	2023	Ardeidae	Black Bittern (*Ixobrychus flavicollis*)	1
TCT Theatre	2025	Pycnonotidae	Yellow-vented Bulbul (*Pycnonotus goiavier*)	1
	2024	Cuculidae	Indian Cuckoo (*Cuculus micropterus*)	1
	2023	Sturnidae	Asian Glossy Starling (*Aplonis panayensis*)	1
Hall 14	2024	Alcedinidae	Black-backed Dwarf Kingfisher (*Ceyx erithaca*)	1
Hall 1	2023	Pittidae	Blue-winged Pitta (*Pitta moluccensis*)	1
Hall 5	2022	Pittidae	Blue-winged Pitta (*Pitta moluccensis*)	1
Hall 8 & 9	2025	Rallidae	White-breasted Waterhen (*Amaurornis phoenicurus*)	1
	2022	Pycnonotidae	Red-Whiskered Bulbul (*Pycnonotus jocosus*)	1
LWM Library	2019	Zosteropidae	Swinhoe's White-Eye (*Zosterops simplex*)	1
LT1A	2019	Alcedinidae	Black-backed Dwarf Kingfisher (*Ceyx erithaca*)	1
N3.2	2023	Rallidae	Unidentified Rail	1
Nanyang Crescent	2022	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
Nanyang Lake	2022	Sturnidae	Asian Glossy Starling (*Aplonis panayensis*)	2

NIE	2021	Turnicidae	Barred Buttonquail (*Turnix suscitator*)	1
North Spine	2023	Alcedinidae	Black-backed Dwarf Kingfisher (*Ceyx erithaca*)	1
CCEB	2022	Columbidae	Asian Emerald Dove (*Chalcophaps indica*)	1
SPMS	2023	Phylloscopidae	Eastern Crowned Warbler (*Phylloscopus coronatus*)	1
South Spine	2024	Muscicapidae	Asian Brown Flycatcher (*Muscicapa latirostris*)	1
	2019	Rallidae	Baillon's Crake (*Zapornia pusilla)*	1
			Total	**59**

Figure 27. *Family and Species list of each bird (that can be georeferenced) that collided between 2016 and 2025.*

Appendix 2: Transcripts of Interviews with ADM Community

The interviews were conducted over text or in person. To protect the privacy of the current students, we have given each student interviewee a pseudonym.

Interviewee 1: Jane (Year 2 Filmmaking Student)

Q: When was the first time you saw a dead bird in Adm? Could you recount what happened?

A: The first time was when I saw the dead hawk at the sunken plaza. I was quite shocked to hear that there was a hawk there because my friend asked me "Do you wanna see the hawk downstairs?" Thinking it was alive I went down slowly to see what was going on but I realised it had passed away from flying into the reflective windows of ADM.

Q: How many times have you seen it after your first sight?

A: None, I have only seen it once.

Q: How did you feel when you saw these dead birds in ADM?

A: It made me feel so sad as it was the first time I was present for the death of a beautiful rare creature and it was caused by the building we hold dear to our hearts.

Q: Do you wish that the school could do something about it?

A: Of course, life (and especially wildlife) in Singapore is so precious, because we don't have a lot of it left. We should do whatever we can to try to help these animals to live full lives in their habitats.

Interviewee 2: Angel (Year 2 Visual Communication Student)

Q: When was the first time you saw a dead bird in Adm? Could you recount what happened?

A: [A friend] showed me a migratory bird that collided with the ADM building.

Q: How many times have you seen it after your first sight?

A: I saw another one the next month, the Japanese sparrowhawk.

Q: How did you feel when you saw these dead birds in ADM?

A: The birds are trying to live. It would not be good for the school to have dead birds littering the area.

Q: Do you wish that the school can do something about it?

A: I think it [decal] is a fantastic initiative! It not only adds an artistic touch but also serves a crucial purpose in protecting birds. Encouraging students' involvement in such a project is a wonderful idea- it fosters a sense of community, promotes environmental awareness, and showcases their creative abilities for a meaningful cause. I imagine it could positively impact the aesthetics of the ADM building and the well-being of the birds.

Interviewee 3: Joan (Year 2 Visual Communication Student)

Q: Okay, so, I heard that you've seen bird collisions around… When was the first time you saw… and could you recount what happened before that and after, like, what's your experience?

A: Actually, I was near the water fountain one day, walking with my friends, and then, I was just, like, looking down on the water, and then suddenly I noticed, like, this dead carcass of a, like, like a small bird. [It] looked like a small bird, maybe like a baby bird. But like, I couldn't really recognize it at first because I didn't know whether it was really a carcass or not. Because it looked like it's been there for a long time. I think I was really shocked…. because I was really looking at the fountain thinking that it would be nice. I don't know, um, like, because it looks very pristine to some extent but Once I really looked, and looked properly, and saw the dead bird, I was pretty shocked.

Q: Like, you feel overwhelmed because of the experience, like, you didn't expect, like, that pond to have that carcass inside?

A: Yeah, yeah, yeah, yeah. And it was kind of strange how it wasn't cleaned either, like, the bird was just left there.

Q: After this incident, right, Like, can you probably [recall] how many times you have already, seen similar things that happen? Or, have you, noticed, rumours going around?

A: To be honest, I don't really. Because of the incident, I don't really like to go out to look at the Pond feature anymore. The pond, the fountain anymore, because I also don't want to see. Somewhat traumatic, like I mean, I'd rather, for me, I'd just rather not go outside and look. And also, I have no reason to go out. That's why, maybe, I don't really notice as much. But, other than that, um…I think, because I don't go out, I don't see the birds. Like them, after colliding with the building, right? Yeah, yeah. But, it also makes sense to me that, The birds would think that this is an empty sky. So I think it's a very, it's quite a pity because we're actually invading their space also.

Q: Do you think the school should do something about it?

A: I don't know, since the frequency of it happening is very high. Obviously, something needs to be done in order to preserve the natural creatures living around NTU. Because you can't completely separate both worlds (natural and human) right? Yeah, both worlds because they will integrate in some way. So that's why I feel like there should be some features that the school can implement right? Maybe not, I think, it's hard to say to completely eradicate this issue, but maybe decrease it. I think that is a more plausible possible thing.

Q: We have proposed a solution to make decals to decorate the ADM building, as not only a way to deter bird collision but also allow ADM students to partake in a community creative endeavour to present adm in a new look, as well as see their creative skills contributed to enabling positive environmental changes. Would you be supportive of that?

A: I think that is the most reasonable solution because I know that the school [wants] so much to maintain some kind of aesthetic because the school is a special feature. However, I also think encouraging the students to take part and then maybe make and enhance the building even more instead of maintaining the mindset that the solutions just make the architecture look ugly or whatever. I'm sure there's some sort of way that we can think of to work around for, like, coming up with a design that can fit with everything. That also doesn't, cause hurt and all the birds dying, you know?

Q: Thank you so much for taking this interview!

Interviewee 4: Sarah (Year 1 ADM Student)

Q: When was the first time you saw a dead bird in Adm? Could you recount what happened?

A: It never really occurred to me that bird accidents were a problem in ADM. The first time I saw a bird carcass was when my friend showed me a picture she had taken of it in front of ADM. That got me really surprised as I knew that birds flew into windows often, but I didn't expect the ADM windows to cause it too.

Q: How many times have you seen it after your first sight?

A: So far I've only seen it once.

Q: How did you feel when you saw these dead birds in ADM?

A: I feel quite sad that these poor birds lose their lives just because they can't see the windows and fly straight into them. I don't think that lives should be wasted like that :(

Q: Do you wish that the school could do something about it?

A: Definitely they should do something! NTU is surrounded by forests so it's our responsibility to take care of the wildlife that share the grounds. Ultimately we are the ones taking their space.

Q: We have proposed a solution to make decals to decorate the ADM building, as not only a way to deter bird collision but also allow ADM students to partake in a community creative endeavour to present adm in a new look, as well as see their creative skills contributed to enabling positive environmental changes. Would you be supportive of that?

A: Yes of course! I think the decals would brighten up ADM, and also help to prevent more bird deaths. We need to learn to coexist with the animals around us in a way that benefits them as well.

Interviewee 5: Jasvic Lye (real name, ADM alumnus, batch of 2018)

Jasvic is the content curator for Death by Man, an ongoing exhibition at the Lee Kong Chian Natural History Museum that brings to light the issues that Singapore's wildlife faces, such as bird-building collisions, roadkills, and human-wildlife conflict. She has done a similar exhibition about human-cased wildlife death for her FYP as an ADM student.

Q: Hi, when you [were in] ADM right, I suppose you know some of the bird collisions, so when was the first time you saw it and how do you feel when you know about this situation?

A: I cannot remember when was the first window strike that I saw, but I remember hearing about it. Definitely before FYP, but I can't remember when exactly. But then I think one of the very first ones was at my friend was talking about the jungle fowl flying into the… I didn't got to see the carcass but they photographed the cleaner pulling out or fishing it out of the water picture line. They were just sending it around. I don't know who had it.

Q: But this like the first time that you actually kind of noticed something going on.

A: I mean, I heard stories here and there like, oh, about birds hitting the glass, but then never really see it for real. That was one of the first ones that I saw, not in person…

Q: But like, you got to know through like image or something?

A: Ya, like the actual, actual case ah. But that is before FYP.

Q: Oh, okay. So it's like, before FYP is, like year 2, year 3?

A: Hahaha, maybe around there.

Q: So, it has been quite a while already?

A: Okay. Like there have been talks around, but I think it is quite known among the ADMers.

Q: Really? But for my cohort of ADMers, it's not really known, but ADM Professors know about this issue. So far, we have talked to one of the directors in ADM, and she said this has been talked about ever since the building was built.

A: Yeah, yeah, it is something that has been talked about through the generations. But nothing has been done. But it's known to, for the people who are always in school. Oh. You know, like, [student] do project in school. We studied in school, especially [near] the water feature, that area where all the birds drowned. When, you know, um, when we hang out there or when we need to spray paint something, we go out there, right? Then, so we will definitely see the dead birds. Whereas those, that always go home or go back hall, of course they don't know.

Q: Is this one of the motivating factors for you to start this project (Death by Man)? Or like what are the motivating factors to start this?

A: Actually, it wasn't so much of ADM. I was just like, looking at it as a whole lah. It just happened that, ADM had this situation. I'm graduating from a school that has this issue.

Q: I'd like just to, like, ask you about, the process of actually doing your FYP at that time, how do you feel when you're taking photos of those carcasses, and probably your thoughts behind, about death by man, especially during your FYP years. Can you talk about it more in detail?

A: I feel more emotionally drained when I'm doing mammals especially I think it's natural because of all the facial features, and that's very closely related to us. Yeah. It's like you see the hands, the thumbprints, and everything. They are closer to us so there is a closer connection. Birds not so much but at the same time, anyone with a heart sees any beautiful thing that just died, you feel it is very pitiful.

Q: You feel empathetic to it somehow?

A: Yeah, and knowing the injury is, and that it went through a …

Q: A very traumatic experience?

A: Yeah, some [were] not instant death even, some is like, slow torture… That is the part where you already start to feel upset. And also you, when I learn a bit more, all these things can be prevented with very simple solutions. And then I'm thinking it's either low cost or easy to implement.

Q: Is like you don't understand why hasn't anything been done despite it being low cost and…

A: Like, there's actually a lot of solutions out there. But then for some reason, it's like, we are more concerned about aesthetics, right? There are so many other things that we consider.

Q: However, they are not in conjunction with whatever the animal is doing, right?

A: So, that's the part that I really don't get it. Initially, I didn't really think much about it. I thought like, I also don't understand, how is it even possible to stop all these birds from flying in the window? Then, I asked all the nature groups and they said, "No lah, very simple lah, just do these things. And these things you can do it at home. So, why is it not done?

Q: During your ADM show, when you were there, and you were showcasing your work, what was the reaction, or what was, like, the response to your work, to people, to industry professionals, to, like, your peers as well, to your work?

A: Only at ADM? Or now at Lee Kong Chien?

Q: No, no, like in every step of the way, like every exhibition.

A: People do cry at my work at every exhibition. Cry, I don't mean like they bawled out but like…I have to pull out a tissue bag. Then, after reading the stories, so they say the images are already upsetting me. Because, … Especially the birds, because they die with their eyes open. So they say it looks so nice, so alive. Then later you find out it's dead. Then it's like your heart sank already. Then you read the story even more. So it's like…

Q: Layers of depression?

A: Yeah, haha. So you just feel worse about yourself. Because of these things.

Q: Is it something that happened even at your FYP show?

A: FYP show, I can't tell if anyone was crying, because it's a 10 days show then.

Q: You're not always there, basically. But during like, for example, the industry night, when you show the professionals, do you see any emotional struggle, that is eating them up or…

A: FYP show, that one a bit hard to say, because. We were at the National Library, the library side, and then the other side was the design centre. So, we were crossing roads constantly to meet each other. So, we (media and design students) were split actually. So some of us were there, some of us were there. So during the industry night right, we were crossing over to each other's side. So we couldn't actually, like, stay there and see the whole reaction of how the professionals are responding to the work. But, it is true that during the 10 days just the public going around - that's where you see the real emotions. But that show was very…Because I only started that work, so it's only like 20 ish.

Q: 20-ish images then…I think you collected quite a lot, like throughout your entire career?

A: Back then you see 20 ish, there is not much impact. People just want to point and hop around. But then, now at Lee Kong Chien, there are 105 photos. It's surrounding you. Yeah. So, that is actually my original intention.

Q: So the one in Lee Kong Chien right now is the original concept of how you want people to receive your work?

A: Yeah. I want people to stand in the centre and all the eyes, it's like all eyes on you. It's like the focal thing that's happening to the audience.

Q: Oh, so you wanted the audience to be the focal point of the work?

A: So, like all these animals are judging you. So, you're standing in front of…

Q: Judgement of all these dead?

A: Yeah, so it's like because of you we have died. So the experience by right - but I could not control the crowd - by right, there is supposed to be only one person there to experience the whole stage.

Q: Oh… so this was the original intention of the work basically?

A: Yeah, yeah.

Q: OK, interesting. Have you been back to ADM for these past few years?

A: Yeah, I went back, I think once or a couple of times, but then it's either to have lunch with my friend or for my matters.

Q: Okay, okay. When you go back there, do you see attitudes changing or some?

A: Because I mostly go back for lunch, right? But when I went back that day, for lunch, My friend did pass me a Javan Munia. Yeah, it died back at ADM, So she passed me that.

Q: There was a nest of Javan munia at ADM in the basement before.

A: Oh, I didn't know. She also sent me a lot of, uh, eggs. Because I, on the side, as a hobby, I collect dead insects.

Q: Is it [for] taxidermy?

A: No, no. I just like dead insects. As in, I don't kill the insects. If it's dead on the floor, I like to keep it lah. So sometimes, my friends see, they were like, Eh, you want this or not? She always comes across, and say, "I don't know why, this month there's a lot, but do you want it?" I say, "OK." For the Javan Munia, I think it was in the obituary so they were affected.

Q: Have you tried to approach the management of ADM?

A: I don't think I approach specifically for this issue. I did because now I'm the campaign manager for Our Wild Neighbours right, it's actually like, I think earlier last year, I approached Professor Oh Soon-Hwa. But it was not for this bird-collision thing. Okay. It's more like, I want to involve ADM students to either do a project on co-existence or anything on native wildlife because we can link them up with the actual local nature groups.

Q: Oh, so it's like Art & Ecology?

A: But not for that course, but more of like, in any way that they could provide. Like, I'm willing to help with that.

Q: Yeah, so how was the feedback or anything about that?

A: She was saying that a lot of Charity groups have already, not necessarily wildlife, like any other charity group, have approached them to say, like, they want to work with ADM students, da da da, like free labour. So she did mention to the FYP students that there is this opportunity, if they want to work on environmental issues, they can contact me. But, we did not get any. However, I expected it, because let's be honest. ADMers love to talk about themselves.

Q: Oh, I see. Would you want to, maybe next time you actually go back there, see the solutions?

A: Yeah, actually, like, what I suggested to the team that went for the exhibition. I was saying that instead of just proposing, because I'm not sure of the extent of the report, but like, instead of just proposing, we should use window decals to block off the reflection or what, comes up with the design first. And then show the management. For example, we have already come up with three versions of the design. This, this and this. Then show them. So that they have a visual. They can visualize how the building will look like with the design. Because now they are concerned about aesthetics. Like, oh, it's the front page of NTU. But if you already come up with it and say this is how it's going to look, or how it can potentially look.

Q: Is it like a mock-up or something of how it will look?

A: Then they're like, actually, yeah, not bad, quite nice. Then it gets you rolling, because if I state that they put out window decals, maybe their mental image is an ugly one.

Q: I was thinking if we want to design the decal, we can involve ADMers, right? I think it would be nice to have collaboration. We can have like an ADM competition on designs for the decal, and then tell them that there are some specific requirements when they submit their designs.

A: Yeah. Okay, because the birds have a different, wider spectrum of colour [vision]. So like, some of them, I heard like some of the garden birds, they have like UV [vision]. So I found it very interesting. Yeah. So that one can consider too when doing the design. But I'm very sure that they also want certain parts that are, like, clear view and not everything covered.

Interviewee 6: Desmond Pang (real name, Lecturer for Visual Communication Students, ADM alumnus from the batch of 2012)

Q: When was the first time you saw a dead bird in ADM? Have you ever heard of it? And then, could you recall what happened when you heard or maybe saw a dead bird in ADM?

A: The first time was probably when I was an undergrad in ADM. That was more than maybe 10 years ago. I haven't really seen it in action. But, especially sometimes on the second floor, where near the staircase to the third floor, that's when sometimes you might see some birds flying towards the building. I don't think I've ever seen one really hit in front of me, but usually what I see is the dead bodies.

Q: In the pond features?

A: Yeah, near the, near the first floor. Yeah, so from what I heard, this has been happening for quite a while, ever since I was a student.

Q: But have you seen it, do you still see this situation, especially now that you're working as a professor?

A: Nowadays, lesser, but also because I hardly go down to the first floor or basement to hang out with the students. But I guess our cleaners also do a good job in the sense that they, I guess most of the time, clean up.

Q: How do you feel about it?

A: I guess a bit sad for the birds, but at the same time, I don't really have any solution to that considering this is a building and there's, it's such a big building, it's entirely made of glass.

And yeah, a bit helpless and also hard to really find a solution to this unless they do something to the entire facade of the building.

Q: We have proposed a solution to make decals to decorate the ADM building, as not only a way to deter bird collision but also allow ADM students to partake in a community creative endeavour to present adm in a new look, as well as see their creative skills contributed to enabling positive environmental changes. Would you be supportive of that?

A: Right, I mean, I think it sounds like a nice idea, um, but, um, if it works then I think it's, it's a feasible, uh, and possible solution that we could. Or your club can try to propose. However, with buildings right, I think the school might also have its own guidelines and stuff. Yeah, protocols and stuff that may or may not be feasible. I guess if it's very minimal damage to the building glass panels, then maybe it's okay. Or, I wonder, does it work if you paste the stickers, the decals, from inside of our building? Would that be easy?

Q: We were thinking of both options because right now we are trying to understand how the decals work. We do know that the glass is one of the distinct features of this building, but we just want to alter the glass reflection a bit so that birds will not be attracted to the building.

A: Have y'all like talked to others? I don't know, like, other faculties from other schools who might work in environmental studies.

Q: Yeah, so it's actually quite a big collaboration between quite a few parties, yeah.

Interview 7: Professor Veronica Ranner (Real name, Assistant Professor for Product Design)

This interview was not recorded and thus no transcription is available. However, Prof Veronica expressed that she witnesses collisions very often as her classroom is next to

the glass panel, and would like progress to be made to address this issue. She also noted that beyond birds, she has observed many frogs and insects getting trapped in the building or drowning in the water feature. She mentioned that the sunken plaza has not achieved its intended purpose and is rarely visited by the building users, especially due to the strong heat in the afternoon. All in all, she suggested the possibility of redesigning the sunken plaza to be more user-oriented and biodiversity-friendly.

Appendix 3: Questions used in Online Questionnaire

1. Which school are you from?
2. Which year/graduated batch are you from?
3. Are you part of NTU Earthlink or other environmental groups?
4. On a scale of 1 to 5, how aware were you of bird-building collisions in NTU?
5. Upon learning about the issue of Bird-Building Collisions, what are your thoughts/feelings? Feel free to share any anecdotes too.
6. On a scale of 1 to 5, do you think something should be done to prevent further injuries and casualties of birds?
7. Below are two common approaches to decals: (1) Regularly spaced circular decals, and (2) customized design (the bird). Regardless of the choice, it is generally accepted that there should be no gaps larger than 5cmx10cm such that birds will not think they can fit through. Would you support the use of such decals in the ADM building to mitigate collisions?

8. Would you be interested in submitting a design for the decals if there is an open call?