

Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5)

4th Grant Call Briefing

10 January 2025

Overview of the Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5)

CoT V5 – Launch of 4th Grant Call

- The 4th grant call for Vertical 5 – City in Nature (under the Cities of Tomorrow R&D Programme) (CoT V5) has been launched as of **3 January 2025**.
- We invite interested researchers to submit suitable full proposals for potential funding support under **3 Call Topics**:
 - 1) Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife
 - 2) Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps
 - 3) Effects of greenery on outdoor thermal comfort perception across land use and form
- Interested parties are strongly encouraged to form research teams that collaborate across public research institutes and the private sector (including industry), and support translation of research outcomes to real-world applications.

Schedule

9:30am	<u>Overview of CoT V5 4th Grant Call</u> <ul style="list-style-type: none">• Overview of the Cities of Tomorrow R&D Programme – Vertical 5 City in Nature (CoT V5)• Grant Call conditions and eligibility criteria• Review process• Instruction for submission of proposals• Q&A on grant call processes• Third Party Risk Management (TPRM) briefing
10:10am	<u>Call Topic 8: “Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife”</u> <ul style="list-style-type: none">• Overview of Call Topic 8 (15 min)• Q&A (5 min)
10:30am	<u>Call Topic 9: "Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps"</u> <ul style="list-style-type: none">• Overview of Call Topic 9 (15 min)• Q&A (5 min)
10:50am	<u>Call Topic 10: "Effects of greenery on outdoor thermal comfort perception across land use and form"</u> <ul style="list-style-type: none">• Overview of Call Topic 10 (15 min)• Q&A (5 min)
11:10am	End of Programme

Grant Call Eligibility & Funding Criteria

Grant Call Eligibility

- All Singapore-based public research institutes (RIs) (e.g., Institutions of Higher Learning (IHLs) and A*STAR RIs), companies, company-affiliated research laboratories or institutions and not-for-profit entities are eligible to participate in the call.
- The Lead PI who leads the Research must be based in Singapore. Collaboration with Singapore-based and foreign organisations and experts, in the capacity of Co-Investigator (Co-I) or as Collaborator, is allowed.
- All funding awarded must be used to carry out the research work in Singapore, unless expressly approved by the grantor.
- Grant applicants are strongly encouraged to collaborate with industry partners to develop innovative solutions that can address the call objectives and demonstrate strong potential for real-world application within and beyond Singapore.
- R&D proposals already funded by other government agencies will not be considered. R&D proposals with similar scope, which are currently under evaluation by other funding initiatives, will not be considered until the results from the other funding initiatives are finalised. Lead PIs, Co-Is, and Collaborators will need to declare other funding sources as well as participation in other funding initiatives during application.

Additional notes for private sector entities

- Funding for private sector entities would be conditional on collaboration with a public research performer for:
 - Research projects with a total project budget more than S\$500,000;
 - Test-bedding/demonstration/scale-up projects with a total project budget more than S\$2.0mil.
- For projects funding non-Singaporean entities (i.e., companies registered in Singapore with less than 30% local shareholding, determined by the ultimate individual ownership), a Singapore Technology Licensing Office (STLO) must be appointed regardless of the involvement of public research performer.

Funding Criteria

Direct Costs*

- Supportable direct costs are incremental cost required to execute the programme; can be classified into the following cost categories:-
 - Expenditure on manpower (EOM);
 - Equipment;
 - Other Operating Expenses (OOE); and
 - Overseas Travel

Indirect Costs (i.e. “overheads”)

- Costs that are incurred for common or joint objectives and therefore cannot be identified readily and specifically with a particular sponsored research project, but;
- Contribute to the ability of the Institutions to support such research projects (e.g., providing research space, research administration and utilities), and not through the actual performance of activities under the sponsored projects.

** Please refer to the Annex D of the Grant Call info sheet for the list of non-fundable direct costs of research.*

*** According to National Supercomputing Centre (NSCC) Singapore policies, research projects will be charged for access to NSCC’s High Performance Computing (HPC) resources. Applicants are required to budget for their compute requirements and associated costs in grant applications, where necessary.*

Funding Criteria

Singapore-based IHLs/public research institutes

- Lead PI or Co-I will qualify for:
 - **[Direct costs] 100%** of the approved qualifying direct costs of a project;
 - **[Indirect costs] 30%** of the total qualifying approved direct costs of a project.

Singapore-based private sector entities (incl. not-for-profit organisations)

- Lead PI or Co-I will qualify for:
 - **[Direct costs] Up to 70%** of the approved qualifying direct costs of a project
 - 30% for all non-Singaporean entities (incl. non-Singaporean not-for-profits);
 - 50% for Singapore Large Local Enterprises (LLEs);
 - 70% for Singapore Small Medium Enterprises (SMEs), start-ups and not-for-profits.

Overseas organisations

- **Not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired using the funding or otherwise unless expressly approved by the grantor.
 - Exception: **Travel expenses** for Visiting Professors/Experts (e.g., overseas-based Co-Is and Collaborators) **to come over to Singapore**, which should be identified and budgeted for upfront in the Other Operating Expenses vote to be incurred by the Host Institution.

Additional notes on Collaborators

- Collaborators are **not** permitted to receive, directly or indirectly, any part of the funding, whether in cash or in the form of assets acquired using the funding or otherwise unless expressly approved by the grantor.

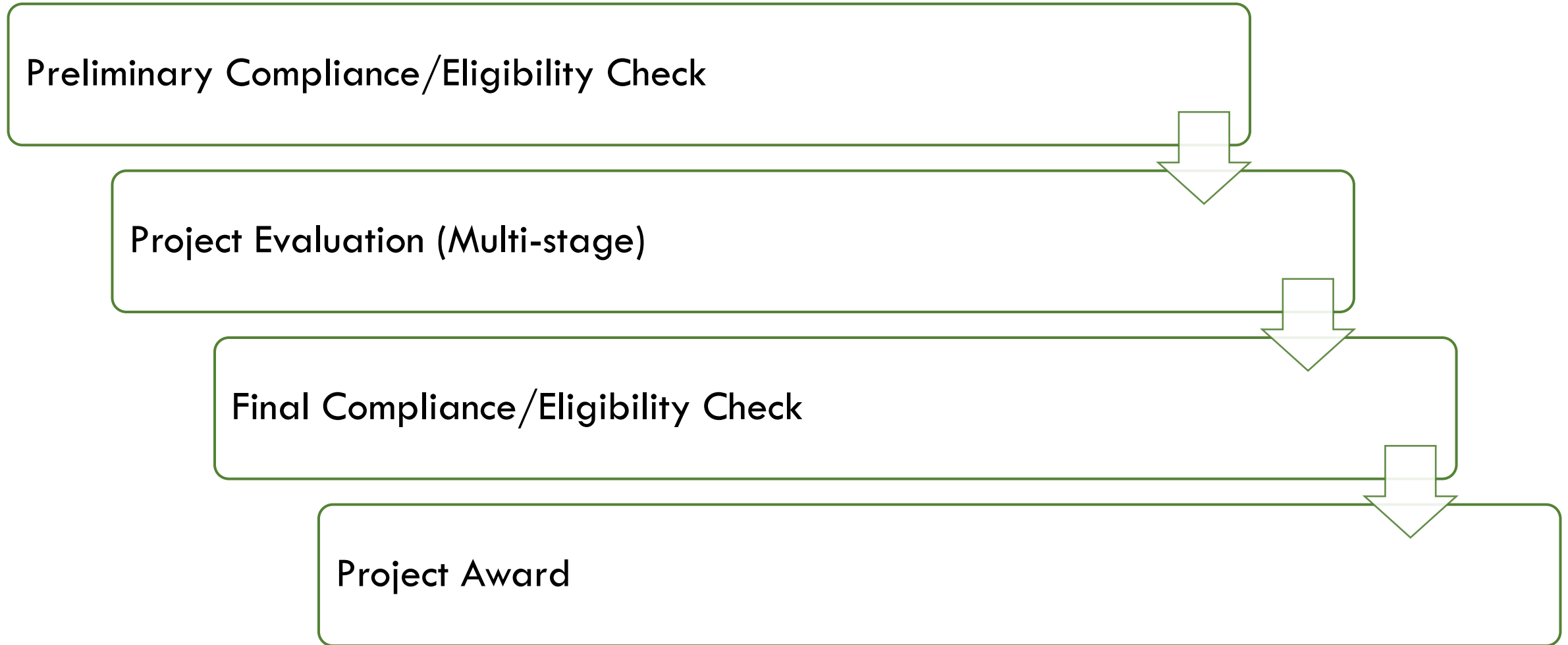
Additional notes on funded assets

- All assets acquired using the funding must be located in Singapore and maintained within the control of the grantees.

Please refer to the Grant Call info sheet for detailed information on the guidelines for the grant call.

Review Process

Review Process – at a glance



Evaluation of Proposals

Evaluation of proposals will include:

1. Technical Peer Review

Proposals will be subject to a round of technical peer review by domain experts* with relevant expertise, to ensure excellent science in proposals.

2. Project Evaluation Panel

Shortlisted applicants will be invited to present their proposals to a Project Evaluation Panel, consisting of relevant agency representatives, the Programme Director, and other external experts (where relevant).

Successful applicants will be informed by the CoT Directorate on the award of the grant. The CoT Directorate's decision on project and funding support will be final.

** Research teams applying for the grant call are invited to recommend potential suitable peer reviewers for the CoT Evaluation Committee's consideration, as part of the proposal submission process. The final decision on the peer reviewers will be decided by the Evaluation Committee.*

Evaluation Criteria

Criteria

Potential Contribution to CoT Objectives

- Relevance of proposed research in contributing to objectives/targets stated for the CoT Call Topic.

Potential for Breakthrough and Innovation

- Quality and significance of proposed research, including value for money, and the potential for breakthrough/innovation to advance knowledge and understanding within its own field or across different fields.

Potential for Application and Deployment in Singapore and Commercialisation/Export

- Potential for application of research outcomes in Singapore by a public agency and potential for solutions to be replicated in Singapore beyond a single site/project.
- Feasibility for commercialisation/ export in areas where Singapore has a competitive advantage.

Execution Strength and Technical Competency of Research Team

- Quality of plans for execution and delivery of the research programme and goals, including the appropriateness of the proposed milestones and deliverables (specific to evaluation of full proposal applications)
- Quality, significance, and relevance of the recent research record of the Lead PI and Co-Is and the strength of the applicant group, including likely synergy in delivering research and potential for international leadership.

Instructions for Submissions of Proposals

Overview of Timeline

FOR APPLICANTS & INTERESTED PARTIES (SGT, UTC +08:00)

Grant Call Opens (for 12 weeks)	3 January 2025, 2.00pm
Physical Briefing for CoT V5 4 th Grant Call	10 January 2025, 9.30am
Grant Call Closes (Proposal Submission Deadline)	28 March 2025, 2.00pm

FOR SHORTLISTED APPLICANTS ONLY

Notification of shortlisted applicants	Q2 2025*
Presentation to Project Evaluation Panel (2 or 3 days)	Q2-Q3 2025*

FOR SUCCESSFUL AWARDEES ONLY

Approval and Letter of Award	Q4 2025 onwards*
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** Timings are indicative; shortlisted/successful applicants will be notified accordingly.*

Grant Call Details

Grant call information and relevant documents at:

- [CoT V5 4th Grant Call website](#)
- [IGMS](#)

Application only through IGMS:

- See section on “Application Guidelines”. All funded proposals should follow the prevailing Research Grant Terms and Conditions and NR Fund Guide.
- The application will only be considered valid if the submission of the full proposal is completed in IGMS, including endorsement by the Director of Research (also in IGMS) by the proposal submission deadline (**28 March 2025, 2.00pm**).
 - A copy of the application should also be sent via email to the CoT Directorate (CoTV5@nparks.gov.sg) after this.
- E-mail or walk-in applications will not be accepted.
- Late submissions will not be considered. Incomplete submissions may also be rejected. Applicants are advised not to submit their application at the last minute in case of technical errors with the IGMS website.
- The following slides outline steps for “Using IGMS” and “Full Proposal Submission”.

Application Guidelines

Please choose one of the options below. It will direct you to the login type based on your choice.



Host Institution Users

- Principal Investigator
- HI Administrator
- Office of Research/ Director of Research
- HI Finance/ HI Human Resource
- Data Administrator/ HI Audit



Individual Users

- Singapore-based Applicants
- Overseas-based Applicants
Eg. NRF Fellowship Applicants



Reviewers

- Singapore-based Reviewers
- Overseas-based Reviewers

Using IGMS:

Key details for first time users

- Under the landing page, select the “**Host Institution Users**” option. This option will lead you to “Login with Singpass (Logging in as Business User)”. Login or register using your Singpass.
- **Authorise ORCID ID** before any grant application.
- Fill up mandatory fields.
- Update user profile.

Application Guidelines

Full Proposal Submission:

- Login to the system using the "Host Institution Users" option and subsequently, via "Login with Singpass (Logging in as Business User)".
- Click on grant call topic of interest under "Open Opportunities" and click "Apply".

For detailed steps, please refer to:

- [Quick guide for Potential Applicants](#); and
- [Help guide for Potential Applicants](#)

(also available on the IGMS "Training Guides" page:

<https://www.researchgrant.gov.sg/Pages/TrainingGuides.aspx>)

Contact Information

- For **general information**, please refer to the Grant Call FAQs document in either:
 - [CoT V5 4th Grant Call website](#)
 - Under “Related Documents” under the grant call topic of interest on [IGMS](#)
- For transparency, no verbal enquiries will be entertained. However, if you require clarification, please email the CoT Directorate at CoTV5@nparks.gov.sg. Answers to all received queries will also be reflected in the Grant Call FAQs document (see above), which will be updated periodically to ensure that all applicants have equal access to additional information.
- For any queries on the **use of IGMS**, please contact the IGMS helpdesk.
Tel No: (65) 6556 8807 or (65) 6556 6971
E-mail: helpdesk@researchgrant.gov.sg

Q&A on Grant Call Processes

MND Family Third Party Risk Management Programme (TPRM)

Restricted \ Non-Sensitive

Most cyber incidents that affected MND Family in recent years were due to Vendor/Partner Incidents

Problem Statement for TPRM Programme

As Govt systems are reasonably protected, we can expect attackers to target our Third Party vendors/systems, which are less well defended. Further, breaches may not be known and reported.

TPRM is designed to enable agencies to establish adequate oversight over Third Parties:

- Risk assessment at the start of all Projects.
- Certification in Cyber Hygiene and Data Protection.
- Continuous Monitoring of Vendor Performance

TPRM Expectations for Vendors/Research Partners

- ▶ Infosecurity Hygiene Certifications
 - ▶ Cyber Essentials (CTE)
 - ▶ Cyber Trust Mark (CTM)
- ▶ Data Hygiene Certifications
 - ▶ Data Protection Essentials (DPE)
 - ▶ Data Protection Trust Mark (DPTM)
- ▶ Demonstrate above hygiene in daily work as advised by certifying companies.

		Cyber Trust Mark				
	Cyber Essentials	Tier 1: Supporter	Tier 2: Practitioner	Tier 3: Promoter	Tier 4: Performer	Tier 5: Advocate
Cyber Governance and Oversight						
1. Governance				●	●	●
2. Policies and procedures				●	●	●
3. Risk management		●	●	●	●	●
4. Cyber strategy						●
5. Compliance		●	●	●	●	●
6. Audit					●	●
Cyber Education						
7. Training and awareness*	●	●	●	●	●	●
Information Asset Protection						
8. Asset management*	●	●	●	●	●	●
9. Data protection and privacy*	●	●	●	●	●	●
10. Backups*	●	●	●	●	●	●
11. Bring Your Own Device (BYOD)					●	●
12. System security*	●	●	●	●	●	●
13. Anti-virus/Anti-malware*	●	●	●	●	●	●
14. Secure Software Development Life Cycle (SDLC)						●
Secure Access and Environment						
15. Access control*	●	●	●	●	●	●
16. Cyber threat management					●	●
17. Third-party risk and oversight						●
18. Vulnerability assessment				●	●	●
19. Physical/environmental security			●	●	●	●
20. Network security			●	●	●	●
Cybersecurity Resilience						
21. Incident response*	●	●	●	●	●	●
22. Business continuity/disaster recovery			●	●	●	●
	8 DOMAINS	10 DOMAINS	13 DOMAINS	16 DOMAINS	19 DOMAINS	22 DOMAINS

DPE

- 1:** Register your DPO with ACRA/PDPC
- 2:** Take inventory of your organisation's personal/biz critical data, hardware and software, accounts
- 3:** Establish your organisation's data protection and security governance policies
- 4:** Develop an incident response and data breach management plan
- 5:** Complete Data Protection and Cybersecurity training set out for employees
- 6:** Implement Data Protection and Cybersecurity measures

DPTM

Principle 1: Governance and Transparency

- A: Establish data protection policies and practices
- B: Establish queries, complaints and dispute resolution handling processes
- C: Establish processes to identify, assess and address data protection
- D: Establish a data breach management plan
- E: Accountability
- F: Internal Communication and Training

Principle 2: Management of Personal Data

- A: Appropriate Purpose
- B: Appropriate Consent
- C: Appropriate Use and Disclosure
- D: Compliant Overseas Transfer

Principle 3: Care of Personal Data

- A: Appropriate Protection
- B: Appropriate Retention and Disposal
- C: Accurate and Complete Records

Principle 4: Individual's Rights

- A: Effect Withdrawal of Consent
- B: Provide Access and Correction Rights

How to Get Certified

- ▶ Cyber Hygiene Certification (from CSA)
 - ▶ <https://www.csa.gov.sg/our-programmes/support-for-enterprises/sg-cyber-safe-programme/cybersecurity-certification-scheme-for-organisation>
- ▶ Data Hygiene Certification (from IMDA)
 - ▶ <https://www.imda.gov.sg/how-we-can-help/data-protection-essentials>
 - ▶ <https://www.imda.gov.sg/how-we-can-help/data-protection-trustmark-certification/>
- ▶ Your company may be eligible for grants/subsidies for the 2 certification. Please contact CSA and IMDA for more details.

Call Topics for CoT V5 4th Grant Call

4th Grant Call: Topic 8
CoT_V5_GC2025_08

R&D Theme 2 - Biodiversity monitoring to improve adaptive management of urban biodiversity

Call Topic: Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Budget: S\$ 2.3 Mil

Duration of Project: 3 years

Lead Agency: NParks

Member Agency: HDB

Call Topic:

Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Background

- Bioacoustics monitoring is an emerging cost-effective means of recording animal vocalisations to allow species identification, and to measure spatial distribution and behaviour in the survey area. Current methods of monitoring biodiversity include manned surveys and the use of motion-triggered camera traps. These methods are manpower-intensive, require specialised expertise, and may not capture species which are difficult to spot, especially in dense forest habitats.
- This project aims to determine the effectiveness of a bioacoustics system¹ to monitor Singapore's biodiversity, in terms of accuracy and cost-efficiency as compared to traditional manned surveys. Building on an earlier pilot study² between NParks and NUS, the project seeks to expand the capabilities of the algorithm and evaluate the effectiveness of the bioacoustics system by comparing the output from manned surveys over a similar time period across different habitat types.

¹ This refers to a combination of off-the-shelf recording system and the developed algorithm that will be used to collect data on faunal vocalisations and differentiate the vocalisations (i.e. classify and identify specific species) through machine learning.

² The pilot study was conducted at a single site (the Learning Forest at Singapore Botanic Gardens, where the associated habitat type is young secondary forest/parkland) between July 2020 and February 2021. The algorithm was able to identify specific bird sounds down to species level in a complicated urban soundscape, classify sounds it could not identify into clusters based on the spectrogram, and triangulate the location of the calls. However, it also misidentified various common species and produced many clusters of unidentified bird sounds.

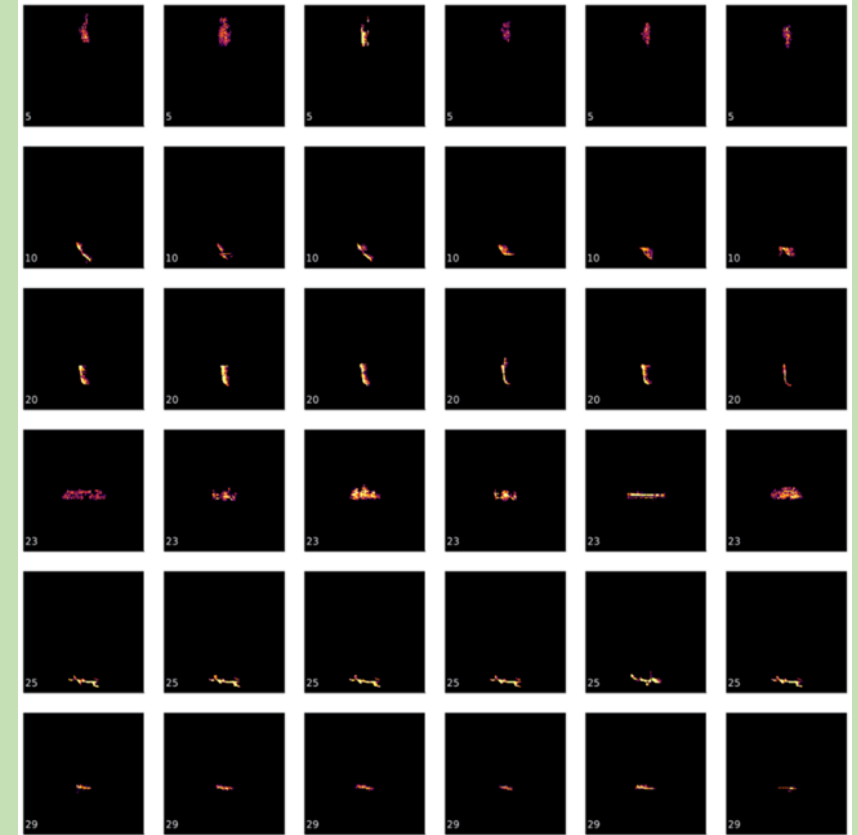
Call Topic:

Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Objectives

- Improve the accuracy of the Bioacoustics algorithm in identifying the vocalisations of bird species in Singapore.
- Use collected data to refine the algorithm and optimise its ability to identify the calls of bird species from different habitats, including the 10 bird species under the Ecological Profiling Exercise and Species Recovery Programme.
- Determine the time and manpower savings that will be achieved from deploying the bioacoustics system as compared to typical manned surveys.
- Expand the algorithm's capabilities to other taxa groups by training it to recognise frog species commonly found in urban areas.

Projects are also encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.



The algorithm classifies the various bird sounds based on the properties of their spectrograms. Each image represents one distinct type of vocalisation.

Call Topic:

Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Technical Deliverables

- Improve the overall classification accuracy of the algorithm from 70% to at least 80%.
- Improve the number of bird species detectable by the algorithm from the current 36 to at least 70, including the 10 bird species³ under the Ecological Profiling Exercise and Species Recovery Programme.
- Evaluate the effectiveness of the bioacoustics system by comparing the output of the system with results from manned surveys over a similar time period, focusing on whether the system leads to a reduction in manned survey effort for (i) urban ecosystems with various anthropogenic noise such as traffic and construction noise, and (ii) more natural areas like mangroves (Pulau Ubin) and primary forest (Bukit Timah Nature Reserve) with more faunal vocalisations from insects and mammals.
- **Train the algorithm to recognise at least 10 frog species commonly found in urban areas.**

³ The 10 species are: *Straw-headed Bulbul*, *Green Imperial Pigeon*, *Blue-rumped Parrot*, *Oriental Pied Hornbill*, *Red-wattled Lapwing*, *Blue-throated Bee-eater*, *Baya Weaver*, *Blue-winged Leafbird*, *Common Hill Myna*, *White-rumped Shama*.

Projects are encouraged to further build upon the above-mentioned deliverables, and/or propose additional deliverables.

Call Topic:

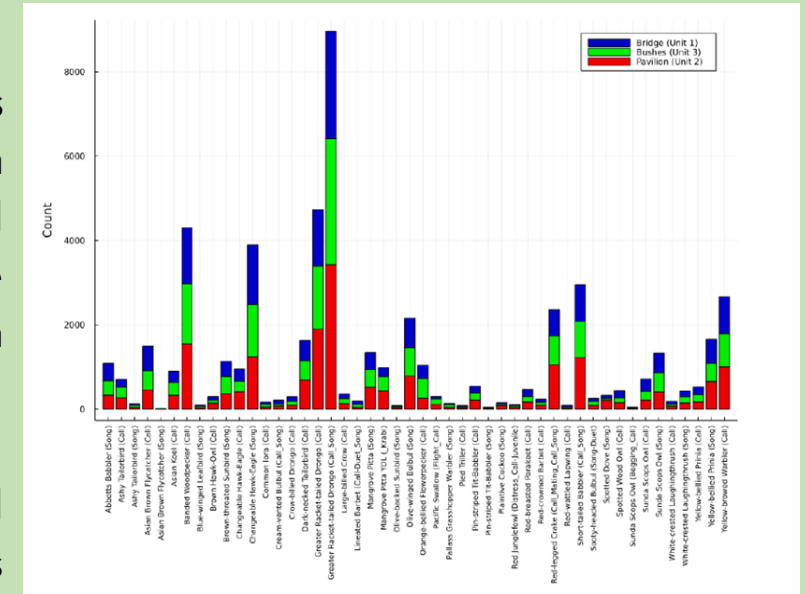
Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Impact Outcomes

In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:

(a) The use of bioacoustics in our biodiversity monitoring initiatives has the potential to provide a wealth of useful data to inform conservation actions over a shorter period compared to manned surveys as the algorithm will be able to run autonomously most of the time, leading to time and manpower savings associated with biodiversity monitoring.

(b) If proven effective, the bioacoustics system will enable NParks and HDB to monitor bird species of conservation significance as well as amphibians more comprehensively and effectively as compared to manned surveys, which will enhance our conservation efforts (e.g., monitoring of target birds under the Ecological Profiling Exercise and Species Recovery Programme). The technology could also be deployed as part of baseline surveys in Environmental Impact Assessments (EIA) for development projects for collecting biodiversity baseline data.



An example of the algorithm's output after analysing recording data collected over one day, with identified bird species on the X-axis and number of associated recordings on the Y-axis.

Call Topic:

Optimising passive acoustics monitoring with machine learning as a tool for monitoring Singapore's wildlife

Role	Agency
Lead	National Parks Board (NParks)
Member	Housing & Development Board (HDB)

4th Grant Call: Topic 9
CoT_V5_GC2025_09

R&D Theme 2 - Biodiversity monitoring to improve adaptive management of urban biodiversity

Call Topic: Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Budget: S\$ 1.37 Mil

Duration of Project: 3 years

Lead Agency: NParks

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Background

- Freshwater biodiversity is declining globally mainly due to habitat degradation and decline in water quality. Natural streams may deteriorate overtime undetected, even in our Nature Reserves. For instance, the extirpation of the Singapore Freshwater Crab (*Johora singaporensis*) from its type locality in Bukit Timah Nature Reserve occurred due to water acidification. Land use changes have also altered hydrological and riparian conditions of waterways, which may cause changes in aquatic fauna community composition and favor the proliferation of invasive species, at the expense of native biodiversity.
- As traditional field survey methods such as field observation or specimen collection are often opportunistic, time-consuming and labour-intensive, there is a need to develop more cost-effective and accurate tools to facilitate the detection and rapid monitoring of species in freshwater streams and swamps. This can help to better inform the biodiversity conservation and management of tropical forest streams and freshwater swamps (e.g. detect presence of rare species and invasive alien species) to preserve freshwater biodiversity.
- Generally, eDNA field work is more accurate and cost effective (i.e., less labour- and time-intensive) than traditional survey methods. However, the majority of eDNA research and development for freshwater environment has largely been conducted in temperate regions, and the lack of genetic sequence data for many tropical taxa poses challenges for the application of eDNA technology for biodiversity sampling and assessment in the tropics.

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Objectives

- 1) To develop water environmental DNA (eDNA) protocols* for rapid assessment:
- a. To comprehensively detect and monitor biodiversity within natural freshwater habitats of Singapore (forest streams, freshwater swamp) targeted species of conservation significance—including rare or behaviourally cryptic and threatened native species (e.g. Singapore freshwater crab *Johora singaporensis*, bladefin catfish *Encheloclarias kelioides*), and potentially invasive non-native species (e.g., redclaw crayfish *Cherax quadricarinatus*, motoro stingray *Potamotrygon motoro*) that may threaten native aquatic fauna, using quantitative PCR (qPCR) and digital droplet PCR (ddPCR) ; and
 - b. To determine and monitor aquatic community structure and dynamics (e.g. richness and relative abundance) within natural freshwater habitats of Singapore (forest streams, freshwater swamp) by identifying representatives of key taxonomic or functional groups (e.g., fishes, decapod crustaceans) using eDNA metabarcoding.

* The focus of the study is on developing sampling protocols and eDNA barcoding library for local tropical forest streams and freshwater swamps. Hardware for eDNA sampling will be based on commercially available products.

Projects are also encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Objectives (cont'd)

- 2) To refine and optimise the eDNA protocols developed under Research Objective #1 by conducting:
- a. additional site-specific field samplings for validation or ground-truthing to address a variety of biodiversity management scenarios/objectives for cost-effective detection and monitoring of:
 - i. Targeted species of conservation significance; and
 - ii. Representative assemblages or suites of species (e.g., functional groups) that are characteristic of rare and sensitive freshwater habitats (e.g., hill streams; freshwater swamp); and
 - iii. Indicator species that could inform site management or decision making in land use and conservation planning.
 - b. tank and/or field experiments to evaluate DNA degradation or signal reduction through manipulation and control of presence-absence of selected representative species (e.g., one invertebrate, one vertebrate).

Projects are also encouraged to further build upon the above-mentioned objectives, and/or propose additional research objectives.

Species of Conservation Interest



Peacock bass *Cichla orinocensis**



Motozo stingray *Potamotrygon motoro**



Bladefin catfish *Enchelocarias kelioides*



Caecilian *Ichthyophis paucisulcus*



Red-claw crayfish *Cherax quadricarinatus**



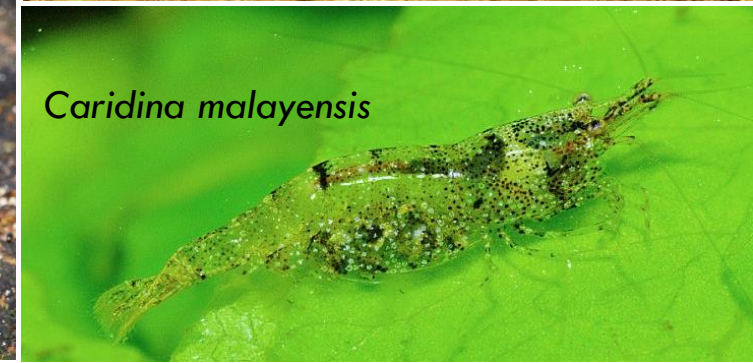
Parathelphusa reticulata



Indo-Chinese spotted barbs (*Barbodes rhombeus*)*



Johora singaporensis



Caridina malayensis

* Potentially invasive non-native species that may threaten native aquatic fauna

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Technical Deliverables

(1) Develop eDNA sampling protocols with sufficiently high accuracy and efficiency¹ for the detection and long-term monitoring of:

a) Rare or behaviourally cryptic and threatened native species (e.g. Singapore freshwater crab *Johora singaporensis*, bladefin catfish *Encheloclarias kelioides*), and invasive non-native species (e.g., redclaw crayfish *Cherax quadricarinatus*, motoro stingray *Potamotrygon motoro*) that may threaten native aquatic fauna, using quantitative PCR (qPCR) and digital droplet PCR (ddPCR) so that pre-emptive strategies can be implemented to protect native species.

b) Aquatic community structure and dynamics (i.e., to develop species diversity index for freshwater habitats to show species richness and relative abundance across Singapore) by identifying key taxonomic or functional groups (e.g., fishes, decapod crustaceans) through the use of eDNA metabarcoding.

(2) Develop an eDNA barcoding library for native species which is validated by site-specific field samplings, for biodiversity conservation and management and to improve the accuracy of the species identities in global DNA sequence repositories like GenBank and BOLDSystems.

¹ This project aims to achieve a species detection rate of 90% within 4 samplings using eDNA.

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Impact Outcomes

In relation to the overall aims and key research themes of CoT V5, this project should look towards contributing to the following impact outcomes:

- Development of cost-effective, rapid and comprehensive biodiversity assessment on detection of conservation significant freshwater species or invasive species that threatens local aquatic fauna in forest streams and freshwater swamps will significantly improve the efficiency and coverage of monitoring work island-wide and greatly reduce the man-power required. With similar available resources, this will enable more sites to be assessed and facilitate the decision making on selection of sites for habitat conservation and restoration.
- Cost-effective, rapid and comprehensive biodiversity assessment on identification of broad taxonomic or functional groups that are representative of rare aquatic habitats, or indicative assemblages of habitats that may be impacted by development projects.
- The developed eDNA protocols and eDNA barcoding library could be incorporated into agencies' existing EIA/EMMP workflows. The solution could potentially be adopted by environmental consultancies who conduct field surveys.

Call Topic:

Development of environmental DNA tools for rapid and comprehensive biodiversity assessment in tropical forest streams and freshwater swamps

Role	Agency
Lead	National Parks Board (NParks)
Member	
Member	

4th Grant Call: Topic 10
CoT_V5_GC2025_10

R&D Theme 4 - Nature-based solutions for inland climate change adaptation

Call Topic: Effects of greenery on outdoor thermal comfort perception across land use and form.

Budget: S\$ 1.4 Mil

Duration of Project: 3 years

Lead Agency: NParks

Call Topic:

Effects of greenery on outdoor thermal comfort perception across land use and form.

Background

Outdoor Thermal Comfort (OTC)

- Refers to the condition of mind that expresses satisfaction with the outdoor thermal environment. It is influenced by various environmental factors such as air temperature, humidity, air velocity, and radiant temperature, but also the behavioral, psychological, physiological state of the outdoor space users.
- Two main types of OTC indices used in Singapore:
 1. Simple indices—computed based on direct measurements of the environment (e.g. Heat index, Wet Bulb Globe Temperature).
 - E.g. Wet Bulb Globe Temperature (WBGT) to communicate heat stress advisory in Singapore.
 2. Rational indices—derived from heat budget models of human body (e.g., Universal Thermal Climate Index, Physiological Equivalent Temperature).
 - E.g. Usage in academic research to infer thermal acceptability range in Singapore.
- These indices are then linked to thermal perception, which can also be influenced by a person's internal state and surrounding environment.

Call Topic:

Effects of greenery on outdoor thermal comfort perception across land use and form.

Research Gaps

OTC Acceptability Ranges differ across Land Use

Table 9. OTC acceptability ranges in different studies (in °C)

This study		Others		
Urban pocket park	Commercial	SBG (Heng & Chow, 2019)	Taiwan (square) (Lin & Matzarakis, 2008)	Singapore (aggregated, Yang et al., 2013)
27.1 to 31.1 (dry) 17.7 to 25.7 (wet)	28.8 to 31.6 (dry) 27.4 to 35.4 (wet) 30.1 to 34.3 (dry) 31.3 to 33.8 (wet)	24.2-31.9	26-30	25.9 – 30.2

It seems that OTC acceptability range was higher in commercial area even though there was less greenery. Respondents are **more tolerant to heat in commercial areas compared to parks** (Philip, 2020).

But the author also concluded that the quality of greenery matters.

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Effects of greenery on outdoor thermal comfort perception across land use and form.

Research Gaps

- Past and on-going studies on thermal comfort perception have limited land use and urban form considerations at the same time. As such, there are no standardized thermal comfort perception baseline across land use and urban forms for different socio-demographic groups. E.g.
 - Heng and Chow (2019) in Singapore Botanic Gardens only.
 - Wong et al. (2013) in outdoor leisure areas only.
 - Philip (2020) in commercial and residential urban park.
 - SMU (2024) in parks and commercial settings only.

Local studies are not specific to distil the type and mechanisms on how greenery can affect thermal comfort perception, and the **exact** contribution of greenery to improving or moderating thermal comfort perception in Singapore remains unclear.

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Problem Statement

There are still uncertainties on how greenery affect thermal comfort perception in Singapore. Specifically, we are interested to know the answers to the following questions:

- What is the thermal acceptability range across land use and socio-demographic groups for simple and rational indices?
- Given the same thermal condition, what type of greenery can make people feel cooler?
- Given the same thermal condition, what landscape layout can make people feel thermally comfortable?
- How can we use greenery to achieve acceptable thermal comfort in view of land use and form, and user's perspective?

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Project objectives

1. **Calibrate** thermal comfort perceptions and acceptability ranges against OTC indices (both simple and rational) across land use, urban form and socio-demographic and lifestyle groups.
2. **Uncover** the mechanisms behind the impact of greenery on thermal comfort perception. Specifically, to answer:
 - how the different types of greenery could moderate thermal comfort perception.
 - how a user's dynamic experience of greenery (i.e. thermal history) could affect thermal comfort perception (e.g. presence of greenery 10 minutes before the survey).
3. **Demonstrate** the improvement of thermal comfort perception with greenery via proof-of-concept landscape design.
4. **Develop** on decision-support guidelines on utilizing greenery at the local and microscale to assist agencies and developers to achieve acceptable thermal comfort.

Impact assessment

The deliverables of the project would collectively provide a common framework for planning agencies (e.g. URA, PUB, JTC, NParks etc) and urban designers to utilize nature-based solutions (i.e. parks and greenery) to improve thermal comfort brought upon by UHI and climate change.

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Technical Deliverables

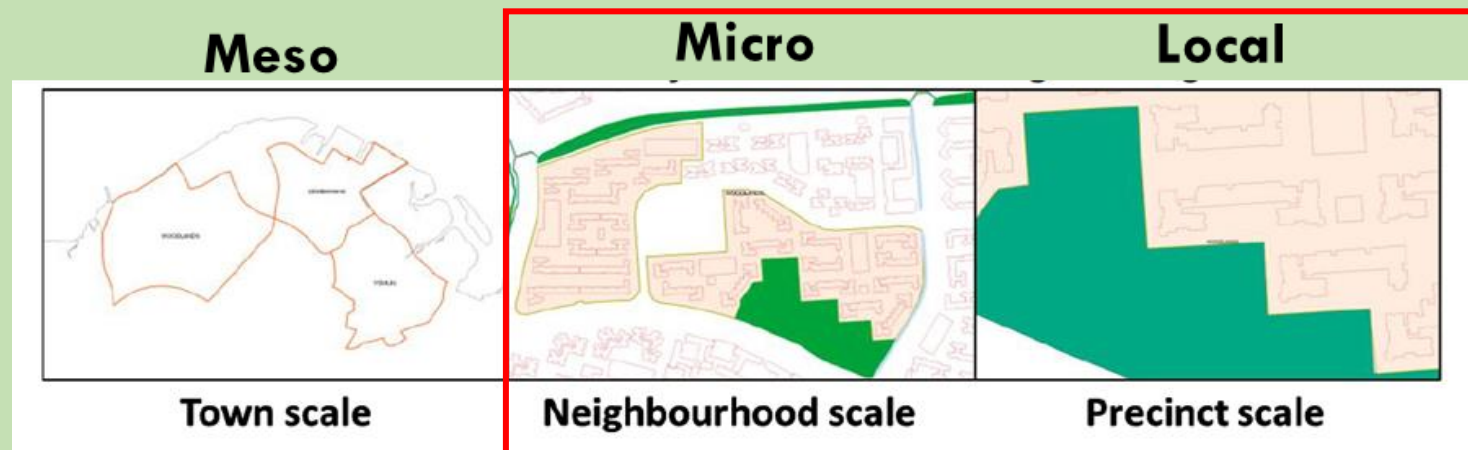
- 1. Calibration of thermal comfort perceptions and acceptability ranges** against OTC indices across land use and socio-demographic groups.
 - Factors to minimally include:
 - OTC indices: WBGT, UTCI, PET.
 - Land use: Parks, Residential, Business/ Commercial, Industry.
 - Urban form: building height and density, sky view factor, types of greenery.
 - Socio-demographic: different age groups
 - Lifestyle pattern: green space user
 - Assessment on the need for recalibration of perception and acceptability ranges, and recommendation on the frequency and sample size needed.
- 2. Model and report** on how greenery would affect or moderate thermal comfort perceptions and acceptability ranges.
 - To leverage on findings from Deliverable 1.
 - To minimally understand their relationships with:
 - Quantification of greenery, such as leaf area index, sky view factor by greenery, average vegetation height.
 - Quantification of urban forms, such as building height.
 - Differences across socio-demographic & lifestyle groups, and influences of their dynamic experience of greenery/ thermal history (e.g. presence of greenery 10 minutes before the survey).

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Technical Deliverables

- 3. Proof-of-concepts (POC)** of using greenery in landscape design at the local scale that could improve thermal comfort perception based on findings from Deliverable 1 and 2. The POC should demonstrate effective greenery designs in at least 2 sites to be determined with agencies. Proposals are to recommend at least 2 possible sites/ settings for agencies' consideration.
- 4. Decision-support guideline** on utilizing nature-based solutions at the local and microscale to assist agencies and developers achieve acceptable thermal comfort for users or residents of the space.
 - Guidelines are to synthesize findings from Deliverable 1, 2 and 3, as well as existing literature/ research of heat stress impact across the population.



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Role	Agency
Lead	National Parks Board (NParks)

Thank You

For further enquiries, please contact: CoTV5@nparks.gov.sg