
# RULES AND REGULATIONS
## VERSION 2.0

**November 17, 2022**

The XPRIZE Rainforest is governed by these Rules and Regulations. **These Rules and Regulations supersede all previous versions of the rules and regulations as well as the Competition Guidelines** originally published November 19, 2019, and updated June 12, 2020. All participating Teams must adhere to these Rules for Competition rounds in which they compete in order to progress through the Competition milestones and be qualified for selection as a winner of the Competition. Failure to adhere to these Rules may result in consequences as detailed in the Competitor Agreement.

XPRIZE may revise these Rules and Regulations at any time during the course of the competition to provide additional information or to improve the quality of the competition. Future versions, amendments, technical notes, or other documents may continue to elaborate on the operation of the competition, including exact dates and locations of events, specific technical thresholds for performance testing, and operational information. Unanticipated issues, including restrictions to travel, may also necessitate modifications to these documents. XPRIZE reserves the right to revise these Rules and Regulations as it, in its sole discretion, deems necessary or desirable. All registered teams will be notified of any revisions in a timely manner. Please send any questions or communications about them to rainforest@xprize.org.

**NOTE: Bolded items are defined in Section IX: Glossary.**

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# I. COMPETITION OVERVIEW

The XPRIZE Rainforest is a global, five-year, $10 Million competition challenging innovators to develop novel technologies to rapidly and comprehensively survey tropical rainforest biodiversity and use data to deliver new insights in near real-time that promote the health and conservation of this vital ecosystem.

In alignment with the Convention on Biological Diversity[1], and ethical standards for data and knowledge collection and usage[2], successful technologies developed in the competition will demonstrate capabilities that include improved survey speed, autonomous operations, innovative detection methodologies and accuracy, increased spatial survey ability, and rapid data integration to provide new **insights** in unprecedented detail. Teams will have 24 hours to explore up to 100 hectares of tropical rainforest and produce: (1) a biodiversity assessment; and additionally in the Finals, (2) Insights from data analyses that communicate the value of the standing forest.

# II. ELIGIBILITY

XPRIZE believes that solutions can come from anyone, anywhere. Scientists, engineers, academics, entrepreneurs, and other innovators from all over the world were invited to form a team and register to compete. Team registration was open from the launch of the prize until December 31st, 2021. To participate in XPRIZE Rainforest in the competition teams were required to create an account in the **Prize Operations Platform (POP)**. POP is an online platform through which teams register for the competition, pay the required registration fee, and submit important documents throughout the competition. Teams are expected to maintain their POP profiles throughout the competition, ensuring their profile is up to date with the most recent team information. A Team may recruit and add additional experts and members as well as combine with other competing teams at any time throughout the Competition.

[1] https://www.cbd.int/convention/

2International Society of Ethnobiology (2006). International Society of Ethnobiology Code of Ethics (with 2008 additions). http://ethnobiology.net/code-of-ethics/

Early Registration opened on November 19, 2019 with a registration fee of $500 (USD). The Early Registration deadline was October 15, 2020.

The registration fee for teams who registered by the Regular Registration deadline of March 15, 2021, was $1,000 (USD).

XPRIZE retained sole discretion to register and qualify additional teams between March 15, 2021 and the Discretionary Late Registration deadline (in Q2 2022). Teams that registered during this period were required to meet all applicable registration and submission requirements and pay a late registration fee of $1,500 (USD).

## III. TEAM DEFINITIONS

Teams are categorized per the following:

- **Interested Team**: A Team or individual that is interested in participating in the Competition and has created a profile in the XPRIZE internal POP system.
- **Registered Team**: A Team that has paid the required registration fee, signed the Competitor Agreement and is eligible to submit a Qualifying Submission for Judge review.
- **Qualified Team** (up to 50 Teams): A Team that has been selected by the Judging Panel from the pool of Registered Teams based on the strength of their Qualifying Submission.
- **Semifinalist Team** (up to 25 Teams): A Team that has successfully completed the Semifinalist Selection and is selected by the Judges to proceed in the Competition.
- **Finalist Team** (up to 10 Teams): A Team that has successfully completed Semifinals testing and is chosen by the Judging Panel to attend Finals testing.
- **Disqualified Team**: A team that has been disqualified from the competition.
- **Withdrawn Team**: A team that has ceased to continue with the competition or has voluntarily withdrawn from the competition.

## IV. ROLES AND RESPONSIBILITIES

The responsible party for each of these activities is listed below. This is not a comprehensive list; please contact XPRIZE if you have any questions about any activity.

Table 1: Responsibilities

| Activity | Responsibility |
|---|---|
| Design and development of the Solution | Team |
| Coordination of Testing Locations and operations of Field Testing | XPRIZE |
| Transportation of the Solution to a test location and back | Team |
| Deployment and setup of the Solution before any test and removal of the Solution after the end of testing | Team |
| Cost of lodging, travel etc. for Teams | Team |
| Solution inspection and/or verification before and during testing | XPRIZE + Judging Panel |
| Collection of test data from Teams for consideration by the Judging Panel | XPRIZE |
| Evaluation and scoring of Teams' solutions | Judging Panel |

## ADVISORY BOARD

**A.** **SELECTION OF ADVISORS.** XPRIZE has appointed a panel of topical experts and big-picture thought leaders to serve as the Advisory Board for the competition. The Advisory Board will remain in place throughout the competition to advise XPRIZE regarding the scientific and other elements of the competition.

**B.** **INDEPENDENT ADVISORY BOARD.** The Advisory Board will be independent of XPRIZE and all teams and team members. No Advisor, nor any member of the Advisor's immediate family, shall participate, nor have any financial or other material interest, in XPRIZE, the Sponsor(s), and/or any team or team member. All members of the Advisory Board

shall promptly disclose to XPRIZE any such current, former, or expected future conflict of interest with XPRIZE, the Title Sponsor, or any team or team member.

C. **ROLE OF ADVISORY BOARD.** The duties and responsibilities of the Advisory Board may include, but not be limited to: (i) assisting with the establishment of qualifications for prospective Judges; (ii) recommending members of the Judging Panel; (iii) assisting with development of testing protocols and judging criteria; (iv) and providing input toward the development of Competition Guidelines.

## JUDGING PANEL

A. **SELECTION OF JUDGES.** The Judging Panel (as defined in the Competitor Agreement) is comprised of highly qualified and impartial Judges with relevant subject matter and technical expertise.

B. **INDEPENDENT JUDGING PANEL.** The Judging Panel is independent of XPRIZE, the Title Sponsor, any other prize sponsors, and all teams and team members. No Judge, nor any member of Judge's immediate family, shall participate, nor have any financial or other material interest, in XPRIZE, the sponsor(s), and/or any team or team member. All members of the Judging Panel shall promptly disclose to XPRIZE any such current, former, or expected future conflict of interest with XPRIZE, the sponsor, and/or any team or team member.

C. **ROLE OF JUDGING PANEL.** The duties and responsibilities of the Judging Panel will include, but not be limited to: (i) the awarding of points and selection of teams that will proceed to each subsequent round of the competition; and (ii) evaluating teams' compliance with the Competitor Agreement as they relate to prize operations, and these Rules and Regulations for the purposes of the competition.

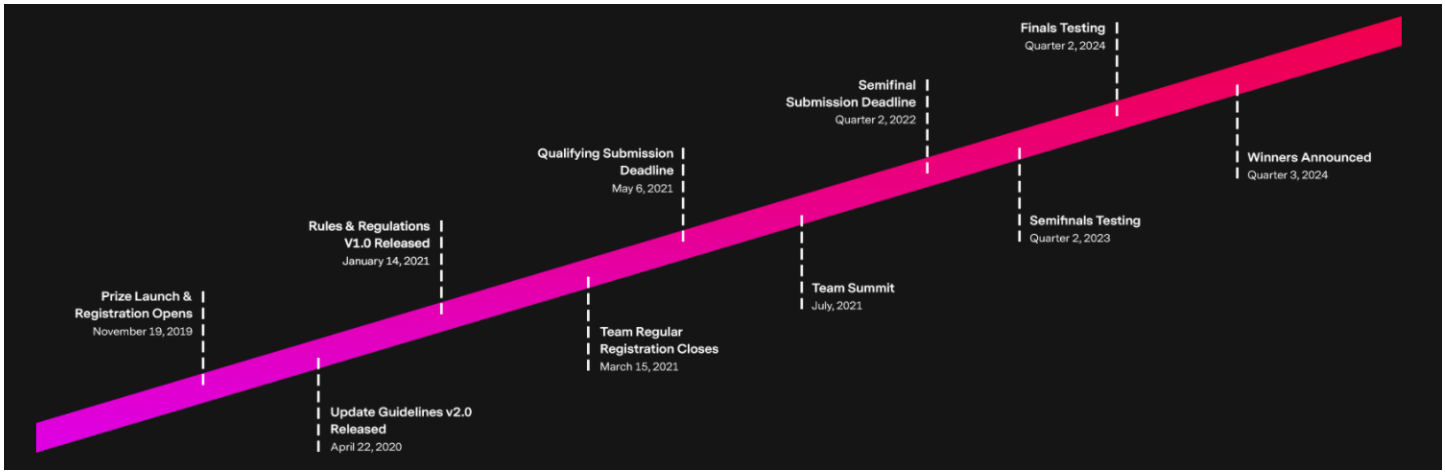
D. **GROUNDS FOR JUDGING PANEL DECISIONS.** Official decisions made by the Judging Panel will be approved by a majority of the Judges that vote on each such decision after careful consideration of the testing protocols, procedures, guidelines, rules, regulations, criteria, results, and scores set forth in the Competitor Agreement, these Competition

Guidelines, Rules and Regulations, and all other applicable exhibits to the Competitor Agreement. If any vote of the Judges results in a tie, then the Judging Panel shall determine, in its sole and absolute discretion, the mechanism to settle the tie. Similarly, if one or more teams are tied at any stage during the competition, the Judging Panel shall have the sole and absolute discretion to settle the tie.

**E. DECISIONS OF JUDGING PANEL ARE FINAL.** The Judging Panel shall have sole and absolute discretion: (i) to allocate duties among the Judges; (ii) to determine the degree of accuracy and error rate that is acceptable to the Judging Panel for all competition calculations, measurements, and results, where not specified in the Rules and Regulations; (iii) to determine the methodology used by the Judging Panel to render its decisions; (iv) to declare the winners of the competition; and (v) to award the **prize purses** and other awards. Decisions of the Judging Panel shall be binding on XPRIZE, teams, and each team member. XPRIZE and teams agree not to dispute any decision or ruling of the Judging Panel, including decisions regarding the degree of accuracy or error rate of any competition calculations, measurements, and results. Teams shall have no right to observe other teams' testing or evaluation, or to be informed of other teams' calculations, measurements, and results, unless such information is made publicly available by XPRIZE.

## V. COMPETITION STRUCTURE TO SEMIFINALS

The competition is structured into four rounds over 5 years. Following testing portions of the competition, additional time and resources will be committed to amplifying the impacts of the XPRIZE Rainforest as displayed in Table 2.




These are the milestones that Teams must accomplish in order to progress in the Competition.

Table 2: Competition Calendar

| | |
|---|---|
| **November 19, 2019** | Prize Launch:<br>Team Registration Opens and Draft Guidelines Available for Public Comment |
| **December 22, 2019** | Competition Guidelines Public Comment Closes |
| **April 22, 2020** | Competition Guidelines Released |
| **October 15, 2020** | Early Registration Deadline |
| **January 14, 2021** | **Rules and Regulations V1.0** Released |
| **March 15, 2021** | Regular Registration and **Competitor Agreement** Deadline<br>Qualifying Round Begins |
| **May 6, 2021** | Qualifying Submission Deadline |
| **June 2021** | Qualified Teams Announced (up to 50 teams) |
| **July 2021** | Virtual Team Summit |
| **Q3 2021– Q2 2022** | Qualified Teams **Solution** Development |
| **Q2 2022** | Discretionary Late Registration Closes and Semifinal Submission Deadline |
| **June 28, 2022** | Semifinalist Teams Announced (15 teams) |
| **Q3 2022 – Q1 2023** | Semifinalist Teams Solution Development |

| | |
|---|---|
| **February 27, 2023** | Semifinal Team Verification |
| **May-June 2023** | Semifinal Testing (Singapore) and Judging |
| **Late July 2023** | Finalist Teams Announced (up to 10 teams) |
| **Q3 2023 – Q2 2024** | Finalist Teams Solution Development |
| **Q2 2024** | Final Team Verification |
| **Q2 2024** | Finals Testing (TBC) and Judging |
| **Q3 2024** | Final Award Ceremony and Winners Announced |
| **Q3 2024 – Q4 2025** | Scaling Impact |

***Note:*** *The above dates are subject to change.*

## QUALIFYING SUBMISSION

Two months after the Regular Registration deadline, each team was required to submit technical documentation detailing their approach and proposed technologies in the form of a **Qualifying Submission**. This prompt was released to Registered Teams in Q1 2021, and included an Executive Summary outlining the team's **Solution**, intended methodologies for data collection and analysis, and other technical details that demonstrate the team's ability to achieve the competition Testing Requirements. The Qualifying Submission was reviewed by the **Judging Panel** to determine which teams will move forward and compete in subsequent rounds of the competition. This submission was also intended to inform XPRIZE and the Judging Panel of potential operational requirements or risks related to testing for this competition.

Teams were also required to include information on how they will use biodiversity data collected during the testing rounds to produce Insights that promote the health and conservation of rainforests. More information about the team requirement to provide Insights throughout this competition can be found in Section VII: Semifinals Testing Criteria and Section XII: Finals Testing Criteria.

The Qualifying Submissions were reviewed by the Judging Panel and 36 teams were selected as **Qualified Teams** to compete in the XPRIZE

Rainforest. The Competitor Agreement was signed and submitted to XPRIZE prior to Judge review of any Qualifying Submissions.

## SEMIFINAL SUBMISSION

Qualified Teams had approximately one year (until Q2 2022) to develop their Solutions and provide an enhanced technical submission (**Semifinal Submission**), which the Judging Panel reviewed to verify each team's ability to participate in testing. The prompt for this Semifinal Submission was provided to all teams advancing in the competition as Qualified Teams. This submission entailed both a written technical document and video demonstration of the team's Solution. The Judging Panel reviewed these submissions and selected 15 **Semifinalist Teams** to advance in the competition. The 15 Semifinalist Teams split a Milestone Prize of $250,000 (USD).

## SEMIFINALS CHECKPOINT VERIFICATION

Prior to participating in **Semifinals Testing**, teams will be required to submit materials to verify they are prepared to proceed in the competition. The **Semifinals Verification** deadline will be February 27, 2023 at 11:59PM PST.

**Note**: Only Teams whose Insurance and Eligibility Requirements have been fulfilled and confirmed by XPRIZE (per the Competitor Agreement) will be permitted to submit verification materials.

Semifinals Checkpoint Verification will consist of the following submissions;

- **Quad chart of the Solution**. Template provided by XPRIZE. Teams are welcome to provide additional quad charts for each sub-system.
- **Video Demonstration**. Video demonstrating the solution at the Technology Readiness Level (TRL)[3] listed within the Quad Chart (see XPRIZE Technology Level Assessment framework). *It is recommended that teams' solution be at minimum of TRL 6 for semifinals testing*

[3] *It is recommended that technology be at minimum of TRL 6 for semifinals testing.*

- **System diagram**. Include a complete system diagram, include subsystems such as transport technology, sensors, telecommunications, control, Data storage, AI/ML, Data Analysis.
- **Data management plan**. To include a flow diagram of the data analysis and verification process. It is vital that all observations are verified and referenced to the RAW data. Observations will be independently verified as part of the assessment by XPRIZE judges and their representatives.
- **Survey methodology plan** for each detection method. Include information on the use of robotics or **UAV**'s at night time and the Scientific justification for the methodology.
- **AI/ML Plan** to include the code for models trained or a link to where this can be found (e.g. github), description of training and evaluation data, expected performance/accuracy, and a plan for verification and retraining. Submitted information will not be shared outside of XPRIZE.
- **Completed RF emissions list**. Template provided by XPRIZE.
- **Complete Equipment Schedule**. A list of solution equipment, to include transport technologies (UAVs, Robotics), payloads, sensors and telecommunications equipment.
- **Risk Assessment (Technology based).** A risk assessment documenting the risks and mitigation plans for using the technology in a rainforest. Include UAV crash in the forest canopy, fuel spills, fires.
- **List of Personnel Attending Semifinals testing in Singapore**. Include copies of the bio page of passports, dietary requirements and any disabled accessibility requirements.

## SEMIFINALS TESTING OVERVIEW

15 Semifinalist Teams are invited to physically demonstrate their Solutions in Singapore for Semifinals Testing. During Semifinals Testing, teams must demonstrate that their technologies can operate autonomously or remotely in a tropical rainforest and detect biodiversity within a **Competition Area** up to 100 hectares in size compiling biodiversity data within a biodiversity report.

Following Semifinals Testing, the Judging Panel will select *up to* ten **Finalist Teams** to split a Milestone Prize of $2,000,000 (USD) and proceed to Finals Testing.

## FINALS TESTING OVERVIEW

During Finals Testing, up to ten Finalist Teams will physically demonstrate that their technologies can operate autonomously or remotely in a tropical rainforest and detect biodiversity within a **Competition Area** up to 100 hectares in size. Teams will be required to produce Insights derived from their biodiversity data and compiled within a comprehensive Biodiversity report. The general location for Finals testing will be announced at the same time as the announcement of the Finalist teams in July 2023.

Following Finals Testing, the Judging Panel will select the winning **Teams** to split a Finals Prize Purse of $7,500,000 (USD).

- First Place: $5,000,000 (Five Million USD)
- Second Place: $2,000,000 (Two Million USD)
- Third Place: $500,000 (Five Hundred Thousand USD)

There will also be a Bonus Prize Purse in the amount of $250,000 (Two Hundred and Fifty Thousand USD) that may be awarded at the Judging Panel's discretion to one or more Finalist Teams whose solutions demonstrate groundbreaking achievements.

## SCALING IMPACT PHASE

Following the announcement of the winning teams, XPRIZE will facilitate a 12 month impact phase of the competition where the Finalist solutions will scale to be utilized by end users, researchers and IPLC's to produce Biodiversity assessments, providing new insights and updated biodiversity data in some of the worlds most important rainforests and protected areas.

# VI. SEMIFINALS TESTING

Semifinals Testing will take place in Singapore between the 22nd May and the 14th June 2023. XPRIZE will establish a minimum of three Competition Testing Areas and three **Practice Areas**.

Teams are responsible for funding and securing the necessary logistical arrangements for travel, accommodation and subsistence. Teams will be

permitted to arrive in Singapore in advance, in order to begin testing and trialing their solutions in designated practice areas from 22nd May 2023. Teams are requested to inform XPRIZE, in advance, of their intention to use any of the practice areas to allow for deconfliction between other teams.

Prior to testing, teams using **UAV** technologies will require their pilots to pass a UAV theory test provided by the Civil Aviation Authority of Singapore (**CAAS**). The theory test must be completed within Singapore and will be booked through XPRIZE Rainforest staff. Tests will be available for teams on the following dates.

**CAAS** UAV Theory Test Days (subject to change)

- 22nd May - 24th May 2023
- 1st June 2023
- 5th June 2023
- 8th June 2023

There will be five test days that will run between the 1st and the 15th June 2023. Teams will be allocated test days closer to the event. Teams will have exclusive use of practice sites 48 hrs prior to their allocated test day. (see Table 3: Semifinals testing calendar)

Semifinals Testing Days (subject to change)

- 28th May 2023
- 1st June 2023
- 4th June 2023
- 8th June 2023
- 11th June 2023

There are two social events and the two conferences within the semifinals testing calendar that semifinalist teams are welcome to attend and showcase their solutions. Space is limited so please contact a member of the XPRIZE Rainforest staff to express your interest in attending any of these events.

Social Events

- Opening Ceremony - Evening of May 25, 2023
- Festival of Biodiversity - All day May 27, 2023
- Ecosperity Week - June 6-8, 2023
- Closing Ceremony - Evening of June 14, 2023

Table 3: Semifinals Testing Calendar (subject to change)

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| 22 MAY | 23 | 24 | 25 | 26 | 27 | 28 |
| OPEN PRACTICE WINDOW | | | | TEAM 1, 2, 3 PRACTICE | | TEST DAY 1 |
| CAAS THEORY TESTS | | | | | | |
| 29 | 30 | 31 | 1 JUNE | 2 | 3 | 4 |
| TEAM 1, 2, 3 ANALYSIS | | | CAAS THEORY | TEAM 7, 8, 9 PRACTICE | | TEST DAY 3 |
| CAAS THEORY | TEAM 4, 5, 6 PRACTICE | | TEST DAY 2 | TEAM 4, 5, 6 ANALYSIS | | |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| CAAS THEORY | TEAM 10, 11, 12 PRACTICE | | TEST DAY 4 | TEAM 10, 11, 12 ANALYSIS | | |
| TEAM 7, 8, 9 ANALYSIS | | | CAAS THEORY | TEAM 13, 14, 15 PRACTICE | | TEST DAY 5 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| TEAM 13, 14, 15 ANALYSIS | | | | | | |

The maximum testing area is 100 hectares. Distribution of team competition areas will be strategically coordinated and sufficiently distanced to avoid interference, within a homogeneous, undisturbed lowland tropical rainforest landscape. Singapore is a city in nature so teams will likely encounter disturbances from aircraft flying over the competition area and nearby road traffic noise. Although the competition test areas are off limits to members of the public, teams will likely encounter members of the public on footpaths that pass by the base station areas. (see Section VII: Testing Criteria for Biodiversity Survey for additional details).

To ensure a fair and level playing field, the exact competition areas within Singapore will not be provided until the individual team briefings at least 24 hrs prior to the team's assigned testing slot. Testing slots will be allocated following the semifinals checkpoint verification. Each team will be responsible for their own travel and subsistence and for any costs associated with the transportation of their technology, which must be possible to transport to the remote testing location once in country (such as with a single

pickup truck). Teams may be required to attend a mandatory rehearsal period, as well as their scheduled testing day.

Teams will deploy their Solutions from a **Base Station** located at a maximum of 200 meters outside of the Competition Area. The base Station consists of an open sided 10ft x 10ft hut on a concrete base. The huts provide shelter from the rain, treefall, and have lightning protection but not power. During testing, Solutions may operate within the forest and up to the maximum altitude at which unmanned aerial systems (**UAS**) are allowed to operate (under regulations locally coordinated by XPRIZE for the purposes of Testing in the Competition Areas).

During testing, teams may deploy multiple systems, vehicles, and other technologies. While the Solutions must function without a physical link to operators, untethered "connectivity" between the Base Station and the systems is welcome. Teams may not have any humans within the designated Competition Area. However, teams may employ humans outside the Competition Area and at the Base Station (limited to six (6) persons max at the base station at any one time) for:

- Assembly and maintenance of Solution in preparation for testing;
- Technology deployment and recovery;
- Remote-controlled operations and/or supervision of completely autonomous operations;
- Recharging, swapping, or refilling power sources;
- Receiving data transmissions and/or downloading data;
- Data analysis, including Species identification and verification;
- Other necessary activities as approved by XPRIZE.

Teams may not leave vehicles or other equipment in the Competition Area without prior written approval from XPRIZE and the Judging Panel. The competition intends to incentivize unmanned and autonomous technologies that will return to Base Camp without direct human assistance. In the event of an accidental loss of a Solution in the Competition Area requiring human-assisted recovery, or inability to recover the Solution within a reasonable timeframe, a team's overall score will be penalized at the Judging Panel's discretion. Unless otherwise stated, teams will be responsible for recovery of any Solution lost in the Competition Area and will only be permitted physical access to the survey area after the 24 hour period.

As summarized in Table 4, the maximum **Time Limit** for each team to collect data and survey the competition area during Semifinals Testing is 24 hours. Teams will have an additional 48 hours of **Data Analysis** time to process their biodiversity data and demonstrate pathways for developing and producing Insights from all available data sources.

Table 4: Testing Limits (Semifinals)

| **Activity** | **Semifinals Testing Limits** |
|---|---|
| Maximum Testing Area | 100 hectares |
| Maximum Data Collection Time Limit | 24 hours |
| Maximum Data Processing Time Limit | 48 hours |
| Production of Insights | * |

* During Semifinals Testing teams must demonstrate within the 48 hours Data Processing Time Limit how they intend to produce insights

Once the Time Limit clock starts, it will not be stopped if the Solution leaves the Competition Area for any reason, including returning to the Base Station to refill, exchange, or recharge a power source. XPRIZE directing staff may make the decision to stop the clock and halt competition activities in the event of extreme weather conditions that threaten the safety of personnel.

The Judges, as well as NParks and XPRIZE staff, will be on site to observe the teams and their technology. To verify accuracy and integrity of collected data and results, teams must transparently and comprehensively disclose and provide detailed information, with full traceability, outlining methodologies, data collection, data analysis, species observations and identifications. To facilitate this process teams will be required to submit a complete copy of the **RAW** (unedited) data and declare all physical samples to XPRIZE staff at the end of the 24hr survey period and prior to commencing any data analysis. The RAW data should be clear and traceable to the outputs of the data analysis phase for each team, which will be audited by XPRIZE as needed.

Following the 24 hour survey period and the copy and handover of the RAW (unedited) data, teams will commence their 48 hours of data analysis and processing. Each team will have access to a Laboratory at the National

University of Singapore (NUS) throughout the 48 hour period to analyze their sampling data. Unrestricted ethernet and WiFi Internet access will be provided at NUS for teams to use during this 48 hour period. Teams will be responsible for processing all data. Autonomous, manual, on-site or remote data processing is permitted within the allotted time. The Judges, as well as NUS and XPRIZE staff, will be on site to observe the data analysis and processing.

Teams are responsible for their own data security throughout the competition process and should endeavor to secure their data both in situ and in transit. Teams may also transmit and process data during the survey testing if they develop that capability and a copy of the RAW data is provided to XPRIZE staff prior to processing.

Teams will submit a biodiversity report by the end of their allotted 48hr Data Analysis period. The report will include information listed within the testing criteria for the Judging Panel's evaluation (see Section VII: Testing Criteria for Biodiversity Report Requirements for content and additional details).

## VII. SEMIFINALS TESTING CRITERIA

The Semifinalist teams will endeavor to survey the most biodiversity within a designated area of up to 100 hectares in size within a tropical rainforest in Singapore. The Teams will complete their survey within a 24 hour period and use their collected data to produce a comprehensive biodiversity report within 48 hours.

Teams best positioned to advance as finalists will maximize performance on both biodiversity surveying and the production of a report that details the solution methodology and discusses how the solution will provide insights in the subsequent round of finals testing.

Teams will be evaluated both qualitatively and quantitatively by the Judging Panel using the criteria listed within the scoring methodology semifinals section. In order to be eligible for any Prize Purse during the competition, teams must meet or exceed all testing criteria established by XPRIZE and the Judging Panel.

## BIODIVERSITY SURVEY

Teams must generate a biodiversity inventory of observed species richness within the designated Competition Area during the Semifinals Testing. Taxonomically, the Competition will focus on the Animalia and Plantae kingdoms, only.

Permitted survey methodologies, data collection, and specimen sampling will be taxon specific. XPRIZE will not itemize an exhaustive nor conclusive list of approved methodologies to encompass all tropical rainforest biodiversity. Teams must adhere to conventional, ethical, reputable, and local and international protocols that are accepted and regularly practiced in the relevant taxonomic field of study, and obey local or regional regulations relevant to any proposed methodologies in the Testing Locations. Teams must consult XPRIZE pertaining to any methodologies that may cause adverse impacts, harm, or destruction to the Competition Area, and/or those that require specimen collection (See Section VIII: Environment & Safety). Failing to submit, communicate, or seek approval for alterations to methodologies ahead of testing, or the violation of protocols or use of unauthorized methods, may result in deduction(s) from the score of the team in question, or disqualification.

Teams may survey any and all vertical strata of the Testing Area up to the UAV height limit for the location. Subterranean sampling up to a specified depth may be allowed with prior approval of methodologies. Teams will be permitted to deploy Solutions within a designated space up to 100 hectares. Teams exceeding these spatial parameters will be deducted points or disqualified. A minimum survey area is not required. The following is a list of rules that must be followed during the survey.

- Sampling must occur within the allotted 24 hours sampling period.
- Sampling must occur only in the designated geo-referenced plot.
- UAV's must stay below 200ft MSL unless authorized by **CAAS**.
- All deployed technologies must be retrieved.
- All observations must be aligned to a geo-referenced sensor or sample collection location within the assigned plot.
- Teams must use GPS or synchronized and calibrated clocks and produce time stamped evidence of all observations.

- Bioacoustic data of birds, amphibians, and mammals can be counted only if the species can be identified through its sound.
- Remnants of dead organisms (i.e., carcass, fossils, shells, seeds, feathers, skin, antlers, dried leaves, DNA) can be counted only if the species or genus can be identified and listed separately as a remnant or eDNA observation and must be declared on retrieval and prior to removal from the test site for any further analysis.
- eDNA sampling must be conducted using best practices to avoid contamination. Any Contaminated eDNA samples will be disposed of and not counted.
- Pets and cultivated plant observations are allowed.

## BIODIVERSITY REPORT REQUIREMENTS

The presentation of the survey results and methodology are to be presented within a comprehensive report to include the following headings. Sections of the report can be produced, at least in part, prior to the semifinals in Singapore. The report is required to be submitted within 48 hrs post survey.

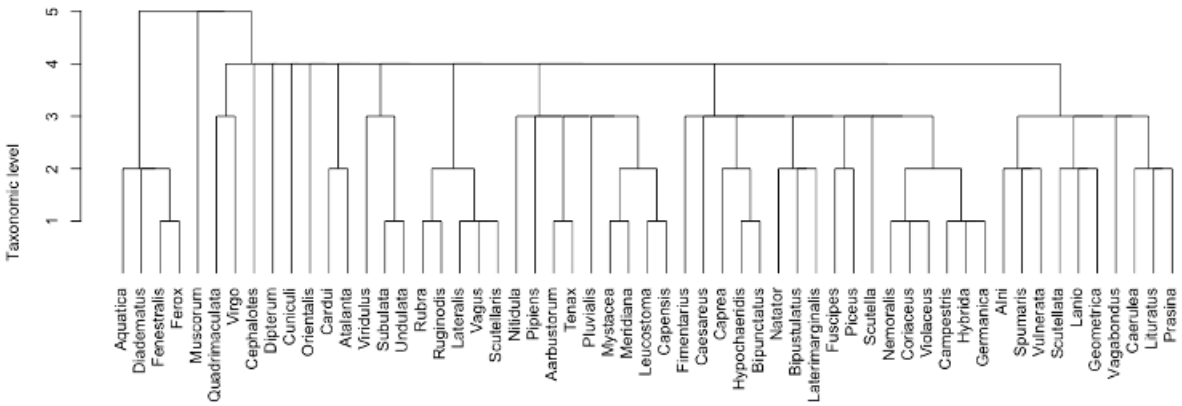
- **Title page –** Template provided by XPRIZE
- **Abstract –** briefly detail the solution, the methodology, major findings and a broad overview of the conclusion.
- **Introduction –** Introduce how the technology solves the XPRIZE Rainforest grand challenge to rapidly and comprehensively survey rainforest biodiversity and use that data to improve our understanding of this complex ecosystem.
- **Approach & Methodology –** provide information on the technological solution and methodologies used to carry out the survey.
- **Results –** to include detailed analysis as listed in the Data Management & Presentation section below.
- **Discussion and Conclusion –** Include future planning, enhancements to further automate the technology, lessons learnt and suggested modifications to the technology and methodology used. Explain how insights (see insights section) might be gleaned from any future surveys/use of the technology. Articulate how the system can be scaled for use by IPLC's.
- **Appendices –** AI/ML information to include the code for models trained, description of training and evaluation data, and the methodology for verification.

## DATA MANAGEMENT & PRESENTATION

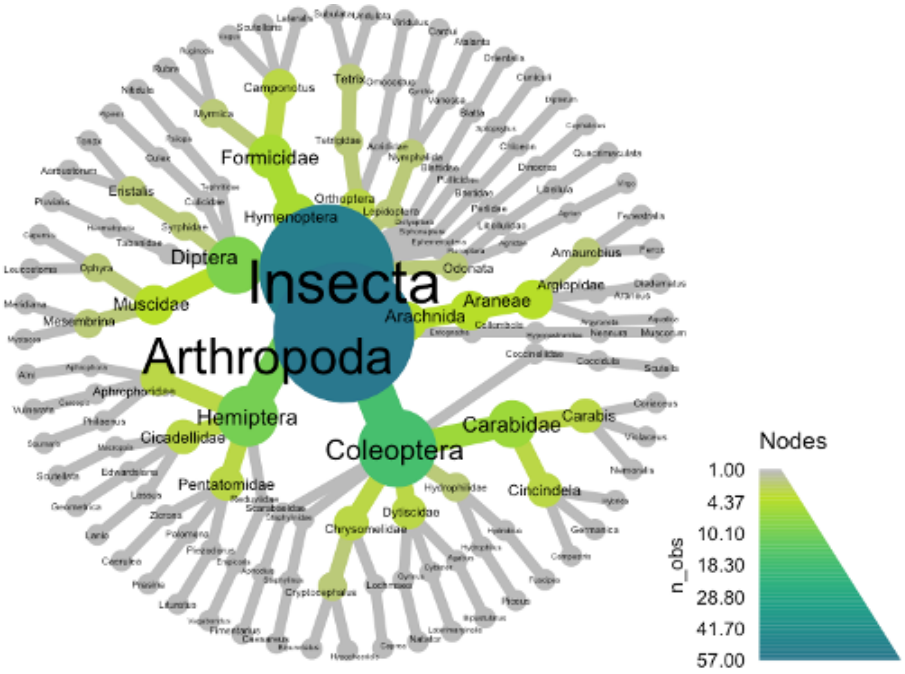
There are four categories of competition data. Teams must provide as much detail as possible and present their data within the results section of the report.

- **RAW Data** – Unedited data captured by sensors and stored prior to any sorting or analyses. Examples of RAW Data include, data captured by a sensor and stored on a media storage device such as SD cards and hard drives. To be provided within 2Hrs of site survey with observation evidence and metadata (to include sensor location (lat/long), date, time, sensor type), teams will be under observation until a copy of this raw data is provided. Teams must also declare and document all physical samples collected as part of this RAW data set.
- **Detailed Analysis** – data that has been analyzed manually or using an AI/ML model, verified and presented in table format and visualization using a simple taxonomic dendrogram and a heat tree diagram (such as Metacoder for R, *see examples below*). Teams are required to provide this detailed analysis as part of the results section of their report within 48hrs.
    1. **Observations Data Set** – table (in .csv format, template to be provided by XPRIZE) providing information on each individual observation. Include sensor location (lat/long), date, time, sensor type, data reference (filename must match RAW data), taxonomy classification from Kingdom through to the lowest identified level, AI/ML detection method, AI/ML % certainty and verification method used.
    2. **Taxonomic Diversity** – Taxonomic dendrogram displaying the taxonomy of each observed species. The Taxonomic levels relating to genus, family, order, class and division.
    3. **Taxonomic Heat Tree Diagram** – Heat tree diagram showing the observed richness and abundance of taxonomy at all levels. Provide a Taxonomic heat tree for each observed division or class.
    4. **Observed Species Richness ($S_{obs}$)** – Total number of individual species observed.
    5. **Observed Species Richness per sensor ($S_{obs}$/sensor)** – number of individual species observed per sensor.

- **GBIF Published** – data uploaded and published on the XPRIZE Rainforest GBIF site. Teams will be expected to publish their data on GBIF within 10 days of the end of the survey. Information, instructions and a training webinar on how to publish to the XPRIZE GBIF portal will be provided to the teams in Q1 of 2023.




Example Taxonomic dendrogram produced in R-studio using the hclust:Hierarchical clustering function, displaying the taxonomy of each observed species. The Taxonomic levels 1-5 relating to genus (1), family (2), order (3), class (4) and division (5).




Example Heat Tree Diagram produced in R-studio using the Metcoder package, displaying the taxonomy, species and taxon abundance, and richness. Each node represents a different level of taxa with the species taxa level single nodes on the outermost branches and taxa levels increasing through genus, family, order, class and division where they all meet at the *Arthropoda* division level. The color code gets darker as the number of species belonging to each taxa level increases.

## INSIGHTS

During Semifinals Testing, Teams are not required to produce insights but must declare what types of Insights are expected to be produced during Finals Testing, and demonstrate how they anticipate producing these Insights using their biodiversity data for the Finals round of the competition. This will be part of the conclusion and discussion section of the biodiversity report. Insights can include, but are not limited to, new ecological dependencies, biodiversity, climate connectivity, anthropological findings, ties to indigenous knowledge, undiscovered threats or even sustainable societal interactions with the forest.

## SCORING METHODOLOGY SEMIFINALS

Teams will be assessed both qualitatively and quantitatively. Qualitative assessments will conducted by the XPRIZE judges and their representatives who will conduct assessments in the following areas;

**Qualitative Assessments During Testing**

- **Technology and Team performance (10%)**. Teams that produce an autonomous system will be scored higher than those who utilize a remotely controlled solution.
- **Technology readiness (10%)**. TRL of 6 is the minimum expected readiness level. Technologies at higher maturity and TRL will be scored higher.
- **Ease of deployment (10%)**. Technologies that are easy to transport (portable by persons) and deploy within a rainforest environment will score higher.
- **Environmental Impacts (10%)**. Teams that have a negative impact on the test area will score less than those that have minimum environmental impacts. Negative impacts include, but not limited to, loss of equipment within the forest, damage to wildlife, plants and waterways, chemical leaks or spills.
- **Ease of use by non-technical end users (10%)**. The ease of which non technical users can be trained to deploy, operate and maintain the solution. Solutions that require extensive and intricate remote piloting will score less than those systems that are easy to remotely pilot or are

autonomous. Autonomous systems will be scored higher based on the ease of planning and programming by non technical users.

**Qualitative Assessments Post Testing**

- **Data Management & Presentation (20%)**. Includes the data analytics methodology, AI plan, AI/ML performance, accuracy and verification.
- **Solutions ability to scale (10%).** Ease of which the solution can be scaled.
- **Biodiversity report (20%).** (See Biodiversity Report Requirements page.19).

**Quantitative Assessment**

Teams will be quantitatively scored on the data that is obtained from the survey **Observed Species Richness ($S_{obs}$)** with the highest number of points awarded for observations to individual species level. The team that has the most validated observations of individual species will gain the highest score, lower value points will also be gained for observations that can't be confirmed at species level but are still unique observations at a tiered taxonomic level. For example, a team that identifies two individuals but can't identify them to species level only to the same genus would earn 14 points, another team that identifies the same individuals down to species level would gain 14 points for the observation to genus level followed by another 8 points for each species to provide a total score of 30 points for the two observations.

Table 5: Example scoring sheet for observed species richness ($S_{obs}$) of vertebrates[4]

| Kingdom 1pt | Division/Phylum 1pt | Class 2pt | Order 2pt | Family 4pt | Genus 4pt | Species 8pt | nObs | $S_{obs}$ Score |
|---|---|---|---|---|---|---|---|---|
| Animalia | Chordata | Mammalia | Primates | Cercopithecidae | *Presbytis* | *femoralis* | 1 | 22 |
| Animalia | Chordata | Mammalia | Rodentia | Sciuridae | *Callosciurus* | *finlaysonii* | 3 | 18 |
| Animalia | Chordata | Mammalia | Rodentia | | | | 13 | 0 |
| Animalia | Chordata | Mammalia | Primates | Cercopithecidae | *Macaca* | *fascicularis* | 62 | 12 |
| Animalia | Chordata | Aves | Coraciiformes | Meropidae | *Merops* | *philippinus* | 2 | 20 |

**Total $S_{obs}$ Score = 72**

[4] A technical bulletin will be released by December 31st, 2022 that will inform teams how Observed Species Richness ($S_{obs}$) will be weighted across different taxonomic groups throughout the Animalia and Plantae kingdoms.

# VIII. ENVIRONMENT AND SAFETY

Safety is a top priority for this competition and to minimize the impact of the competition on the rainforest environment, Solutions must minimize environmental harm and ensure safety of participants and surrounding communities. All teams must comply with the following requirements:

- Teams will comply with all existing environmental, health, and safety regulations in the entire Competition Area including base camp and transit region.
- Any emission of acoustic, electro-magnetic, laser, optical or other energy must be compliant with any existing regulations and best practices for the Competition Area.
- Teams may not use nuclear reactor power sources or in any way allow emission of harmful chemical or biological pollutants.
- Teams may not employ any form of life in their approaches to the challenge.
- Teams must minimize harm to any form of life in their approaches to the challenge. If a team's Solution might impact life, this must be declared and accepted by the Judges in the team's Qualifying and Semifinal technical submissions as well as prior to deployment in the Competition Area.
- Teams must report any harm to life, intentional or accidental, regardless of severity, that occurred during any competition activities, rehearsals, testing, trials or training, to XPRIZE staff immediately.
- Teams must not remove any biological specimens out of the competition area without permission from XPRIZE staff.
- Teams must not remove any biological specimens out of Singapore without the permission of **NParks.**
- Teams are to abide by the laws and regulations of Singapore.
- A research permit is not required but teams are to abide by the rules and regulations within National Parks of Singapore https://www.nparks.gov.sg/gardens-parks-and-nature/dos-and-donts
- Teams are to document their approach to health, safety and environmental compliance.
- Teams must recover equipment that is deployed within the Competition Area. Any disposable portions of the system must be declared and accepted by Judges as causing no harm prior to deployment in the Competition Area.

- Teams must research and obtain any necessary permits for operation in the Competition Area as it pertains to their particular Solution. XPRIZE will collaborate with teams in this activity.

XPRIZE will have the final decision on all above factors and reserve the right to disqualify any Entry, or deny any action, that is determined to be an undue risk. Additional details on Environment and Safety will be provided in future releases of the Rules and Regulations. XPRIZE reserves the right to adjust the Rules and Regulations based on the latest scientific and legal information available at the time to ensure personal and environmental safety. XPRIZE will make all final determinations on safe and acceptable operating conditions, including weather, for Competition operations.

## IX. MODIFICATIONS TO ENTRY

Throughout the competition, except during testing, teams are welcome to continue to develop, iterate, and adapt their solutions; however, any major changes to any Unmanned Aerial Systems or Vehicles (UAV/UAS) after the **Semifinals Verification** on February 27, 2023 will need to be approved by the Singapore Civil Aviation Authority (CAAS). It is recommended that teams limit any changes to UAS/UAVs platforms and limit the modifications to UAV/UAS platforms or payloads that would alter the aerial performance, platform size, weight or power supply after the **Semifinals Verification** submission.

## X. INTELLECTUAL PROPERTY (IP) AND PUBLIC DATA AVAILABILITY DURING COMPETITION

The IP and Entries remain the property of the Teams. Details about IP rights are in the Competitor Agreement.

Survey data to be published on the GBIF hosted XPRIZE site. Teams will be expected to publish their data on GBIF within 10 days of the end of the survey. Information, instructions and a training webinar on how to publish to the XPRIZE GBIF portal will be provided to the teams in Q1 of 2023.

# XI. FINALS TESTING

## FINALS CHECKPOINT VERIFICATION

Prior to participating in **Finals Testing**, teams will be required to submit materials to verify technology readiness[5] and preparation of Solutions to proceed to the final round of the competition. The **Finals Verification** submission deadline is tentatively scheduled for Q1 2024 and details are to be included in subsequent versions of these rules and regulations.

## FINALS TESTING

During Finals Testing, up to ten Finalist Teams will physically demonstrate that their autonomous Solution can operate in a tropical rainforest and can survey biodiversity within 100 hectares of tropical rainforest at a testing location designated by XPRIZE. The general location for testing will be announced in advance of testing so that teams may coordinate necessary logistical arrangements.

The maximum Time Limit for each team to collect data during Finals Testing will be 24 hours. Teams will have an additional 48 hours to process their biodiversity data and produce Insights developed from data collected and analyzed during testing (see Section VII: Testing Criteria).

Finalist Teams will submit their biodiversity survey along with a report that details methods, results, and Insights for the Judging Panel's review (see Section VII: Testing Criteria for additional details).

Following Finals Testing, the Judging Panel will convene to review the submissions, discuss the results, and determine the winners of the Grand Prize and the **Bonus Prize**. The winning team(s) will be announced at an Award Ceremony hosted by XPRIZE in Q3 2024.

Additional testing information will be updated in future releases of the Rules and Regulations, after XPRIZE has completed selection of testing locations.

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[5] *It is recommended that technology be at minimum of TRL 7 for finals testing.*

Table 4: Testing Limits (Finals)

| Activity | Semifinals Testing Limits | Finals Testing Limits |
|---|---|---|
| Maximum Testing Area | 100 hectares | 100 hectares |
| Maximum Data Collection Time Limit | 24 hours | 24 hours |
| Maximum Data Processing Time Limit | 48 hours | 48 hours |
| Production of Insights | * | ** |

* During Semifinals Testing teams must demonstrate within the 48 hours Data Processing Time Limit how they intend to produce insights

** During Finals Testing teams must produce insights within the 48 hours Data Processing Time Limit.

## XII. FINALS TESTING CRITERIA

The **Competition Area**(s) for the Finals Testing will occur in a single location, which will be announced at the same time as the finalist teams. This announcement is expected to take place late July 2023.

Teams will be permitted to arrive at the Competition Areas in advance, in order to test and trial their solutions in a **Practice Area** prior to official testing. Specific timing for permitted arrival will be shared when location details are announced. Teams will be able to enter the communal Practice Area during this time to trial and modify solutions. The Practice Area and Testing Area(s), will be situated in near proximity, however testing will not take place in the Practice Area.

The maximum testing area that teams will be permitted to survey is 100 hectares. Distribution of team competition areas will be strategically coordinated and sufficiently distanced to avoid interference, within a homogeneous, undisturbed lowland tropical rainforest landscape. The extent of overlap between competing teams' Competition Areas, if any, at Finals will be determined upon selection of the Testing Location. Additional criteria will be provided with the announcement of the Finals testing location, and exact Competition Areas will be revealed and assigned following the conclusion of the Practice Period.

## INSIGHTS

Successful teams will use data collected during testing and will combine it with other available data sources to produce new Insights that promote the health and conservation of rainforests. Insights may include, but are not limited to, new ecological relationships or dependencies, biodiversity and climate connectivity, documentation of and solutions for ecosystem threats, anthropological findings, ties to indigenous knowledge, sustainable societal interactions with the rainforest, education, or pathways towards effective conservation action and policy at local, regional and/or international levels. Insights can be large or small scale, for example: from local species specific insights to climate insights of global scope. Teams are encouraged to use artificial intelligence, machine learning, virtual reality, augmented reality, or other means to gain new Insights from and about tropical rainforests.

During Finals Testing, teams must produce actual Insights within 48 hours following their data collection. Teams must demonstrate traceability from the Insights they produce to the biodiversity data they collected during testing. Both the number of Insights and amount of impact will be taken into consideration by the Judging Panel when evaluating team Insights.

## SCORING METHODOLOGY FINALS

The Grand Prize winning teams will survey the most biodiversity within 100 hectares of tropical rainforest in a 24-hour period and use these data to produce the most impactful Insights after 48 hours.

Teams best positioned to win will maximize performance on both biodiversity surveying and producing Insights. The intent of this Scoring Methodology is to incentivize teams to demonstrate a truly multi-functional platform for biodiversity assessment and utilization of those data to discover new Insights that promote the health and conservation of rainforests.

Insights will be judged on their impact, based on the discretion of the Judges and criteria established by the XPRIZE team. Insights will be evaluated on the overall impact they have to rainforest conservation, Indigenous Peoples and local communities, scientific understanding, noteworthiness, and applicability to other rainforest regions. Proficient, and autonomous technological

approaches that are replicable, cost effective, and scalable will be scored favorably.

Teams will be required to provide full transparency and traceability regarding data collection, analysis, and production of insights. Judges must be able to clearly follow the pathways towards species identification and production of insights by teams. Results lacking proof of process will not be considered.

It is within the Judging Panel's purview to consider different or additional criteria that teams present after testing.

Some examples of additional criteria the Judging Panel may consider when evaluating teams include but are not limited to:

- measurements of soil, water, carbon, and/or other materials or abiotic factors from data collected during testing
- Total area covered by a team's biodiversity survey (i.e., with greater area counting for more points).
- Team and solution performance, teams that produce an autonomous system will be scored higher than those who utilize a remotely controlled solution.

All requirements and testing criteria will be finalized and announced to teams well in advance of finals testing.

Further details regarding finals testing criteria, including the collection of Species data, system requirements, and shipping constraints for this competition will be provided in subsequent versions of the Rules and Regulations.

## XIII. GLOSSARY

**Advisory Board:** A select group of prominent advisors who contribute their wisdom, knowledge and guidance to various aspects of the prize.

**Base Station:** A camp that teams will use to manage their operations and launch their Solution into the Competition Area during testing.

**Bonus Prize:** There will be a Bonus Prize Purse in the amount of $250,000 (USD) that may be awarded at the Judging Panel's discretion to one or more Finalist Teams whose Solutions demonstrate groundbreaking achievements.

**CAAS:** Civil Aviation Authority Singapore.

**Competition Area:** The location selected and/or approved by XPRIZE to conduct testing.

**Competition Guidelines:** Document for the public and for teams that describes the requirements and parameters of the competition.

**Competitor Agreement:** A legal and binding document that details the responsibilities of competitors for the prize.

**Data Analysis:** 48 Hrs of time allocated to teams to process and verify their biodiversity data.

**Finals Testing:** The last set of testing events for the prize that will determine the Grand Prize winning teams.

**Finals Verification:** This is a mandatory update to ensure teams are prepared to proceed to Finals Testing. This will most likely consist of written and filmed components.

**Insights:** Teams will use data they collect during testing in combination with other available data sources to produce new Insights that promote the health and conservation of rainforests. Insights may include, but are not limited to, new ecological dependencies, biodiversity, anthropological findings, undiscovered threats, climate connectivity, or sustainable societal interactions with the forest.

**Judging Panel:** The subject matter and technical experts who serve as an impartial and independent evaluation team for all aspects of this prize. Judges score the team submissions and make the final award determinations in both the Semifinals and the Finals Competitions.

**NParks:** Singapore National Parks Authority

**Observed Species Richness ($S_{obs}$)** – Total number of individual species observed.

**Observed Species Richness per sensor ($S_{obs}$/sensor)** – number of individual species observed per sensor.

**Operations Guide:** The Operations Guide will detail the policies and procedures for testing including test scenarios, event operations, logistics, shipping, safety and other details to effectively participate in testing events. There will be separate Operations Guides for Semifinals and Finals Testing.

**Practice Area:** An area at the Testing Location, not to overlap with the Competition Area, where teams will be permitted to trial and troubleshoot their Solutions in the tropical rainforest during a period of time to be determined by XPRIZE immediately prior to Testing.

**Prize Operations Platform (POP):** The standard internal XPRIZE portal for teams to input data for use in this Competition.

**Prize Purse:** This refers to money offered, won, or received as a prize. It also refers to the overall amount of funds allocated to all prizes in this competition.

**Qualifying Submission:** This is a form in POP that must be completed by all Registered Teams. It consists of a series of questions to be answered that outline the expertise, capabilities and plans for the functional Solution that each team will be creating. It will also require an Executive Summary of up to two pages of text, and any supporting images, diagrams, or charts.

**RAW:** RAW unedited data, e.g. Data written to a storage media device such as a Micro SD card by a detection device.

**Rules and Regulations:** Document detailing the testing protocols, specific rules, dates/times, and other details that will govern the competition and will be binding on teams.

**Semifinals Testing:** The set of testing events for the prize that will help determine which teams progress to Finals Testing.

**Semifinal Submission:** The process by which Qualified Teams demonstrate they are sufficiently advanced to progress in the competition as a Semifinalist Team. This submission will consist of written and filmed components which the Judging Panel will review to verify each team's ability to participate in testing. This enrollment may include certain steps and questions to be answered by the teams, such as proof of insurance, attending team member lists, and other details about the logistics of Semifinals Testing.

**Semifinals Verification:** This is a team-provided update to ensure teams are prepared to proceed to Semifinals Testing and consists of written and filmed components which will be reviewed by the Judging Panel.

**Solution:** This refers to a team's specific system (including the operator interface, all sensors, software and mechanical parts) that will be used in the competition.

**Species:** A group of related organisms or populations potentially capable of interbreeding in nature, and producing viable offspring. The Species is the principal taxonomic unit, ranking immediately below a genus.

**Time Limit:** The maximum amount of time teams will be allowed to collect data during Semifinals and Finals Testing.

**UAV:** Unmanned Aerial Vehicle, AKA; Drone, UAS

**UAS:** Unmanned Aerial System, AKA; Drone, UAV