

**Screws Loose**

Project Deliverable C - Design Criteria

**Group 9**

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**1. Introduction**

To support the conservation of endangered bat species in Ontario, we are developing a monitoring system to assess the effectiveness of bat boxes. This deliverable translates the user needs outlined in Deliverable B into specific design criteria. By reviewing and benchmarking existing systems, including technologies used for wildlife monitoring, we will establish target specifications to guide the design of an accurate and reliable sensor-based bat monitoring system. These benchmarks are crucial in ensuring the final system meets necessary goals and contributes to the efforts of conserving bat populations.

**2. Design Criteria**

| **Needs** | **Priority (1,2,3)** | **Functional/**  **Non-Functional/**  **Constraint** | **Related Design Specifications** |
| --- | --- | --- | --- |
| The device will count the number of bats entering/leaving a bat house | 3 | Functional | Data Collection |
| The device will be easy to install by anyone | 3 | Constraint | Maintenance |
| The data needs to be stored on site | 3 | Functional | Data Collection |
| The data needs to be stored offsite | 2 | Non-Functional | Data Collection |
| The device will require minimal maintenance (1/month) | 3 | Constraint | Maintenance |
| The device must have a battery life of at least 1 month | 3 | Constraint | Maintenance |
| The data will be accessible in real time | 1 | Non-Functional | Data Collection |
| The device must monitor the internal conditions of the bat box | 1 | Non-Functional | Data Collection |
| The sensors must not obstruct the bats’ path into the box | 3 | Functional | Data Collection |
| The device needs to be made from environmentally friendly materials | 1 | Non-Functional | Materials |
| The device must be low cost | 2 | Constraint | Cost |

**3. Technical Benchmarking**

The project we were given was to develop a device that can monitor and track bat activity accurately while requiring minimal maintenance and minimal impact on the habitat. The following products can be used to aid us in developing our product.

*1 = poor 2 = acceptable 3 = excellent*

| **Tracking Device** | | [**BatCounter**](https://ecovery.be/en/product/bat-counter/) | [**Counting Bats**](https://bcbats.ca/bat-boxes/) | [**NestboxTech Bird Tracker**](https://nestboxtech.blogspot.com/2019/09/bird-box-activity-counter-v3-build.html) |
| --- | --- | --- | --- | --- |
| **Company** | | **Ecovery** | **Community Bat Projects of BC** | **NestBoxTech** |
| **Cost** | | $3950 | $40 - $50 | $150 |
| **Data Collection** | | Saves data to a local memory in the device in CSV or TXT format - Can send data via email/SMS - Uses 32 infrared beams to detect flight direction => tells how many bats per the square (**may count other animals like birds**). | Employs multiple participants to annually monitor bat box activity.  This is done by stationing participants at exit points to physically count the number of bats leaving the box, by either using a “clicker” or taking a video for counting done offsite. | Uses a pair of IR sensors (inner & outer) => reduced noise and differentiation between in and out events – data gets recorded to a text file that is saved in the Raspberry Pi memory. |
| **Maintenance** | | Battery replacement is every 3 days - uses 8 AA batteries - Other maintenance information not mentioned. | Counting is done annually. The box must be cleaned annually. | Battery replacement (no mention) - box to be drilled - maintenance duration (no mention). |
| **Materials**  **(specifically the box)** | | Aluminium | Cedar Wood  Plywood | Plywood |

| **Design Aspects** | **Priority (1,2,3)** | [**BatCounter**](https://ecovery.be/en/product/bat-counter/) | [**Counting Bats**](https://bcbats.ca/bat-boxes/) | [**NestboxTech Bird Tracker**](https://nestboxtech.blogspot.com/2019/09/bird-box-activity-counter-v3-build.html) |
| --- | --- | --- | --- | --- |
| Track the inhabitants (entering/leaving) | 3 | 3 | 1 | 3 |
| Ease of installation | 3 | 2 | 3 | 2 |
| Data stored onsite | 3 | 3 | 2 | 3 |
| Data stored offsite | 2 | 2 | 1 | 2 |
| Minimal maintenance (1/month) | 3 | 1 | 3 | 1 |
| Battery life of at least 1 month | 3 | 1 | 1 | 1 |
| Real time access to data | 1 | 2 | 1 | 1 |
| Ability to monitor the conditions of inhabitants | 1 | 1 | 1 | 1 |
| Does not obstruct the path for inhabitants | 3 | 3 | 2 | 3 |
| Made from environmentally friendly materials | 1 | 3 | 3 | 3 |
| Low cost | 2 | 1 | 3 | 2 |
| **TOTAL** *(Higher is better)* | - | **51** | **49** | **43** |

**4. Target Specifications**

*Note: Read left to right, the leftmost column of the table represents the item being measured, while the columns to the right describe how it is being measured, including the method and the units of measurement.*

| **Functional Requirements** | | | | |
| --- | --- | --- | --- | --- |
| **Design Specification** | **Value** | | **Units** | **Verification Method** |
| Counter for entering/leaving bats\* | ≥ 0 | | Bats | Testing |
| Onsite storage of data | True | | Boolean | Testing |
| Sensor obstruction | True/False | | Boolean | Testing |

| **Non-Functional Requirements** | | | | |
| --- | --- | --- | --- | --- |
| **Design Specification** | **Value** | | **Units** | **Verification Method** |
| Offsite storage of data | True/False | | Boolean | Testing |
| Real-time data accessibility | True/False | | Boolean | Testing |
| Monitoring of internal temperature | ≥ 0 | | °C | Testing |
| Material sustainability | True | | Boolean | Production |

| **Constraints** | | | | |
| --- | --- | --- | --- | --- |
| **Design Specification** | **Value** | | **Units** | **Verification Method** |
| Ease of installation | True | | Boolean | Testing |
| Routinely maintenance | ≥ 1 | | Months | Testing |
| Lasting battery life | ≥ 1 | | Months | Testing & Analysis |
| Cost | ≤ 100 | | $ | Receipts |

**5. Reflection**

The client meeting helped us refine the project’s focus on tracking bat box usage in Ontario. We identified the primary goal of developing a device that can count bat visits throughout the summer months. Key constraints, such as the need for minimal maintenance, functionality between April and October, and easy installation for non-specialists, guided our design process. The client also highlighted the importance of durability in temperatures above 0°C and the option to modify the bat box to accommodate for the device, giving us flexibility in the design.

Optional features, like real-time data access and internal condition monitoring were discussed as potential additions, but the primary focus remained on developing a functional prototype for the bat activity counter. The meeting provided valuable insights, helping us prioritise key elements while ensuring the project stays aligned with conservation goals.

**6. Conclusion**

This project focuses on designing an efficient and reliable system for monitoring bat activity in bat boxes. The emphasis is on ensuring accurate bat counts while minimising interference with the bats’ natural behaviour. Meeting environmental, cost, and battery life constraints is crucial for the system's sustainability. By incorporating sensors that are easy to install, require minimal maintenance, and store data both on-site and off-site, the system will provide valuable insights into the effectiveness of bat boxes. This, in turn, will play a key role in supporting bat conservation efforts by improving habitat design and contributing to the recovery of endangered species.