SRS Template

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Overview

Brown Marmorated Stinkbugs (BMSB) are an invasive species in Minnesota and it is in the best interests of everyone, especially the Minnesota Departments of Natural Resources and Agriculture, to track, study, and predict where BMSB populations are located and use that information to inform decision making related to detection and mitigation efforts. The proposed product seeks to analyze and identify current BMSB populations, predict suitable habitats where BMSB are likely to migrate to (if they don't already live there), aggregate these results to help inform stakeholders and decision makers, and make the results readily available and accessible to a broad audience. Through this product, it is our goal that we can minimize the impacts that BMSB will have on Minnesota, and also use this process to inform other interested entities as to how they can go about building a similar system for their respective needs.

Motivation

As of 2021, BMSB has been found in 47 states and 4 Canadian provinces and poses a threat to over 300 plant species in agricultural, horticultural, and natural settings (StopBMSB, n.d.). While the BMSB has caused the most agricultural damage in the Mid-Atlantic States, BMSB poses a potential threat to Minnesota's agriculture, ornamental/landscape plants, and as a household nuisance. Hundreds of tree species in the Mid-Atlantic States have been observed as threatened by BSMB, but it is unclear what species will be preferred in Minnesota (Minnesota Department of Agriculture, n.d.). The potential impact of BMSB in Minnesota is unknown but reports indicate that stink bug numbers increased substantially in 2016 and 2017. Due to this uncertainty, it's important to track recently introduced BMSB to mitigate potential impacts like damage to agricultural crops, degradation of landscape plants, and being a nuisance in homes.

The successful delivery of this product will help the MnDNR prioritize where to monitor and mitigate BMSB. This product will impact the general public but it will mostly impact the Minnesota Department of Natural Resources (MnDNR) and Minnesota Department of Agriculture in their efforts to monitor BMSB. The team at Zaruba & Gisselbeck (ZG) were asked by the MnDNR to create an online system that creates a ranked list of recently introduced BMSB. The MnDNR will not be a design partner with the ZG team.

Definitions

- **API**: An API, or Application Programming Interface, is a “set of definitions and protocols for building and integrating application software” (Red Hat, 2020).
- **REST**: A common API framework that “conforms to the constraints of REST architectural style and allows for interaction with RESTful web services” (Red Hat, 2020). REST stands for Representational State Transfer.

Scope

Functional Requirements

- [Essential] A user can use the product to identify where mitigation efforts would best be directed for the Brown Marmorated Stink Bug in Minnesota.
- [Essential] The end results should be viewable or usable in the following formats:
    - Web map via ArcGIS Online,
    - GeoJSON via REST API
    - (Optionally) as a raster via REST API
- [Nice to have] All product functionalities will be easily usable and accessible to anyone with a basic understanding of Python, and the majority of functionalities will be accessible to anyone with a high school-level education.
- [Optional] A user can use the product to identify where mitigation efforts would best be directed for the Brown Marmorated Stink Bug across the United States and North America.

Non-Functional Requirements

- [Essential] The product must be able to extract, transform, and load data needed for predictive and/or prescriptive analytics into a PostgreSQL database hosted on Google Cloud
- [Essential] The product must be able to run analyses that utilize methods like Random Forest or MaxEnt to predict the presence or risk/hazard to communities and use that data to inform where mitigation efforts should be directed.
- [Essential] The product will push the analysis results to the cloud-hosted database, so that results can be served out via REST API.
- [Nice to have] The product should be able to run in a semi-automated fashion from start to finish, by manually running the scripts which: grabs updated data, runs analytics, and pushes the results to the cloud.
- [Optional] The data pipeline will run in an automated fashion by making use of a scheduler (e.g., Apache Airflow, Dagster, CRON) to update entirely independent of human input.

Out of Scope Requirements

- The REST API will not return any other data other than the top 10 ranked cities to prioritize mitigation efforts.
- The REST API and database will not be highly secured (e.g., no IP restrictions, default security options used).
- The only coordinate systems that will be used for the entirety of the project will be WGS 1984 (EPSG: 4326) and WGS 1984 / Pseudo-Mercator (EPSG: 3857) to maintain simplicity and mitigate against any potential errors that could be brought in accidentally.
- There will be no real-time, on-demand analytics. This is not to say that there won't be real-time, on-demand data access.
- The data will not be updated more than once a month, at best. Annual updates are the preferred solution.

Persona Acceptance Criteria

As a developer I …

- Require access to sufficient data sources so that I can conduct meaningful analyses
- Require access to Google Cloud and ArcGIS Online so that I can communicate the results to end users and operators

As an Operator I …

- Require a basic knowledge of programming so that I call a REST API and access the results dataset
- Require insight on how analyses were performed so that I can explain my data sources and methods to downstream users and stakeholders

As an end user I …

- Require access to easy-to-use and intuitive interfaces so that I can directly interact with the results
- Require meaningful and informative metrics and analysis results so that I can make more informed decisions regarding BMSB mitigation and prevention efforts

Open Questions

- What additional security steps must be taken into account for the database and REST API (e.g., login credentials, firewalls, limiting IP connections)?
- In the ArcGIS Online web map, what data must be available?
- Is an ArcGIS Online web map a necessary medium for viewing the results, or are there other acceptable mediums (i.e., ArcGIS Experience Builder, ArcGIS Dashboards, Streamlit, etc.)?
- The requirements call for a ranked list of cities as the output, but are there any requirements or preferences as to how rankings are calculated?

Dependencies

- ArcGIS Online
- ArcGIS Pro & ArcPy
- Google Cloud PostgreSQL Instance

References

Minnesota Department of Agriculture. (n.d.). *Brown Marmorated Stink Bug*. https://www.mda.state.mn.us/plants-insects/brown-marmorated-stink-bug

Red Hat. (2020). *What is a Rest API?* https://www.redhat.com/en/topics/api/what-is-a-rest-api

StopBMSB. (n.d.). Where is BMSB? https://www.stopbmsb.org/where-is-bmsb/

University of Minnesota Extension. (2022). *Brown Marmorated Stink Bug*. https://extension.umn.edu/yard-and-garden-insects/brown-marmorated-stink-bug

Appendix

Table 1. Time Estimate by Function

Functions	Team Member	Estimated Time
1. ETL	**Both**	**12 hrs**
1.1. Extract Observation Data from 3 Sources	TBD	1.5 hrs
1.2. Transform Data to Common Schema	TBD	1 hr
1.3. Load Transformed Datasets into DB	TBD	2.25 hrs
1.4. Collect Other Environmental or Climatic Data	TBD	3 hrs
1.5. Transform Environment & Climate Datasets (As Needed)	TBD	1.25 hrs
1.6. Load Environment or Climate Datasets into DB	TBD	3 hrs
2. Analysis	**Both**	**3.5 hrs**

2.1. Presence-only Prediction Model	TBD	1.5 hrs
2.2. Aggregate Model Results to Cities	TBD	1 hr
2.3. Finalize & Clean Results	TBD	1 hr
3. Data Management	**Both**	**6 hrs**
3.1. Load Analysis Results into DB	TBD	1 hr
3.2. Serve Out Results as REST Service	TBD	3 hrs
3.3. Serve Out Prediction Raster via REST?	TBD	2 hrs
4. Visualization	**Both**	**3.5 hrs**
4.1. Visualize Results through AGOL Map	TBD	1 hr
4.2. Visualize Results in a Dashboard	TBD	2.5 hrs
TOTAL		**25 hrs**