Exploring the Eastern Spruce Budworm Population From 2014 to 2023

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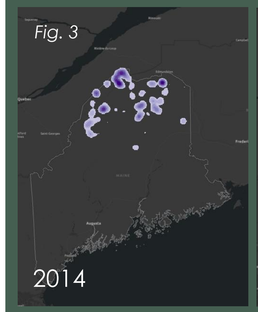

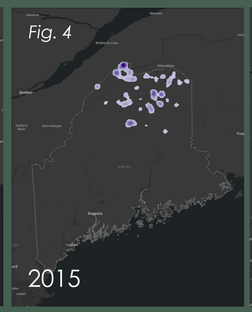

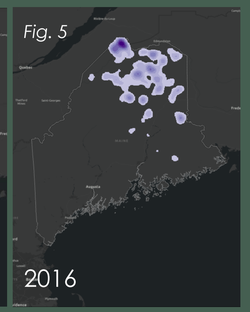

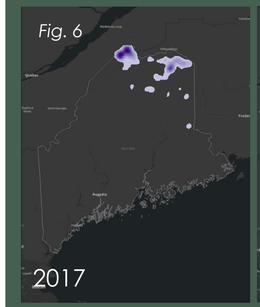

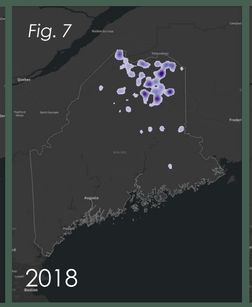

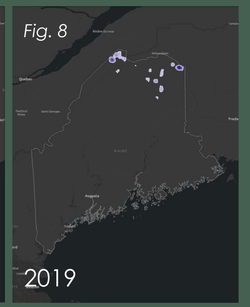

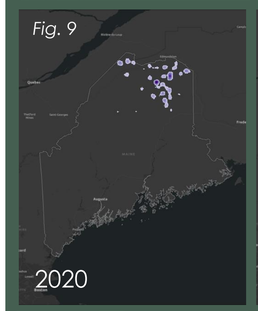

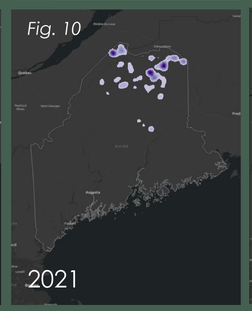

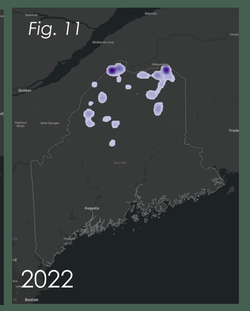

Figures 3 through 12 show the progression of Spruce Budworm hotspots from 2014 to 2023.A search radius was not defined for the tool due to the lack of information regarding moth dispersal.

Background

The Eastern Spruce Budworm is a species of naturally occurring insect that causes major damage to Maine's forests. Despite its name, the Eastern Spruce Budworm is most damaging to balsam fir trees. Spruce is affected to a lesser degree than fir, with more damage being caused to white spruce, and less on red and black spruce.

Fig. 1 shows a comparison between Balsam Fir, White Spruce, and Red Spruce trees

Fig. 2 shows a comparison between black spruce and red spruce

In modern times, Eastern Spruce Budworm outbreaks have occurred in the 1910's, 1940's, and the 1970's, suggesting that an outbreak is due to happen any time now. During the last outbreak in northern Maine, defoliation of balsam fir led to 84% to 97% mortality.

Conclusion

Further analysis could be done using the data that has been collected. This could include more research sites or more traps being placed per site. There should also be a defined time limit for when the traps are placed and pulled to give a more accurate set of data. Other things that could be considered include looking at larval data and their patterns, as well as including a search radius for collecting data. This could be a radius as a whole, or a specified radius where traps need to be placed.

The Eastern Spruce Budworm has been due for an outbreak for over 10 years. Relief efforts as well as preventative measures need to be taken in order to ensure the well being of the forests of northern Maine. Not only are the forests themselves at risk, but also the native fauna and wildlife that can be found in them. If these forests are defoliated, species populations could decline and eventually lead to endangerment or extinction. Serious prevention of the spread and outbreak of the Eastern Spruce Budworm needs to be taken in order to protect the forests and all things that inhabit them.

Methodology

Data was acquired from the University of Maine and the Maine Office of GIS. A shapefile was acquired containing sites where 3 traps were placed, and an average number of moths was counted after a period of time. This table contained data for the years 2014-2020. Three additional excel files were acquired, and a full join was performed to join the three additional tables to the main shapefile. From there, the kernel density tool was used to find hotspots in the data regarding the average moth count. A search radius was not specified because of the lack of information regarding moth dispersal. Figures 3 through 12 on the left side show the hotspots of moths from the year 2014 to the year 2023, which gives an idea of what areas in northern Maine are most vulnerable to defoliation. A state shapefile was also included to better show the state border of Maine. After completing the kernel density maps, the multivariate clustering tool was run on the shapefile containing the averages of all sites for every year from 2014-2023. The tool was run with 5 clusters to get results that would be accurate in displaying moth counts and be easy to read. A box plot was created from the multivariate clusters to display the information on a graph. A townships layer was implemented afterwards and dissolved to then show the trap amount per county. Figure 13 is the completed multivariate cluster map and traps per county with legends displaying what the colors and points on the map mean. Figure 14 is the box plot that was created from the multivariate cluster layer.

Results and Discussion

The kernel density maps as displayed on the right show that moth hotspots tend to be in the northern most areas of Maine where there are balsam fir forests and various species of spruce trees. This could also be due to the migration patterns of the Eastern Spruce Budworm and the fact that they migrate down from areas of New Brunswick in Canada. Relief efforts should be focused on the hotspot areas to reduce further defoliation of Maine's forests.

As shown on the map to the right, most clusters of moths tend to be up in northern Maine. Again, this is expected due to the moth migration patterns. However, there are a few outliers in the clusters. The higher count clusters, between 3 and 5, have started to migrate south into the counties of Penobscot (3rd county from the left and second row from the top), and Piscataquis (2nd county from the left and second row from the top). However, these two counties contain a lesser trap count than Aroostook, which is the dark green county at the very north of Maine. Since the moths appear to be migrating to these two counties from the north, more traps should be placed here in order to ensure the safety and health of the spruce and fir trees.

The kernel density tool could be utilized again with a search radius (if one can be determined) to get more accurate hotspots regarding the moths. Multivariate clusters could also be utilized over maps of kernel density to see how well the clusters and hotspots line up. It may also be useful to look at land ownership in regard to where clusters/hotspots are so that the respective landowners know where to focus preventative measures on.

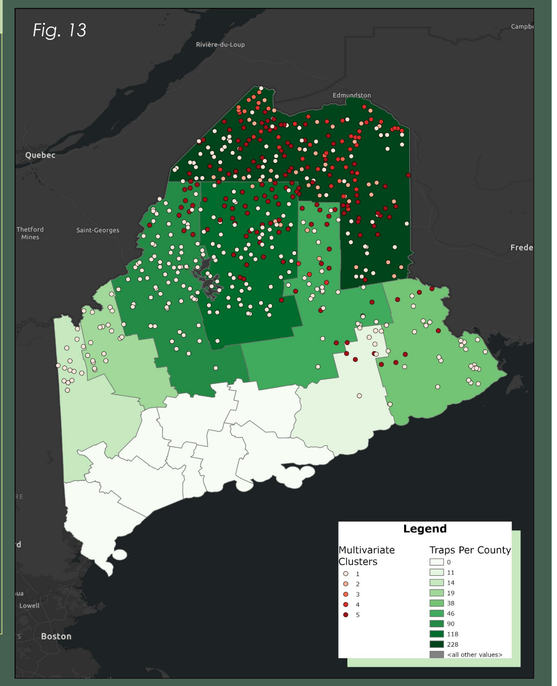

Figure 15 shows the generated clusters based off similar population trends from 2014-2023. Clusters are not in sequential order, rather clusters are formed with features exp ressing similar population trends over the 9 years studied. Cluster 5 has the fewest fea tures, but the highest moth counts and are areas that should be monitored closely.

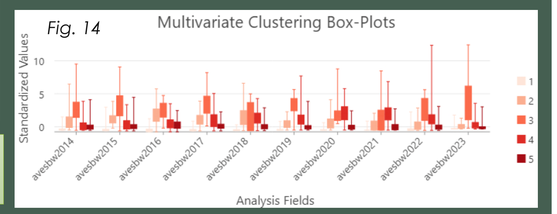

Figure 13 shows a comparison of trap counts per county to clusters of moths. The moth clusters are for every year from 2014-2023. Figure 14 displays the cluster data as a box plot for better understanding.

Acknowledgements

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References

[1]*Balsam Fir (Abies Balsamea), White Spruce (Picea Glauca), and Red Spruce (Picea Rubens) | Maine Natural History Observatory*. www.mainenaturalhistory.org/node/585.
[2]*Maine Office of GIS*. www.maine.gov/megis.
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[4]*Coming Spruce Budworm Outbreak:*, www.sprucebudwormmaine.org/docs/SBW_full_report_web.pdf.