Spatial Analysis of Emerald Ash Borer (EAB) Spread in New Jersey

Nazia N. Arbab

Center for Resilient Landscapes, Department of Ecology, Evolution, and Natural Resources

Background

• Emerald Ash Borer (Agrilus planipennis Fairmaireis), is an exotic invasive beetle that affects all species of true ash trees (Fraxinus species) in New Jersey.

• EAB was first detected in New Jersey during summer 2014.

• Nationwide, EAB is incurring billions of dollars cost in tree removals, replacement, and insecticide treatments.

• EAB is not yet fully established in New Jersey.

• Projected future distribution of EAB informs management response.

EAB in New Jersey
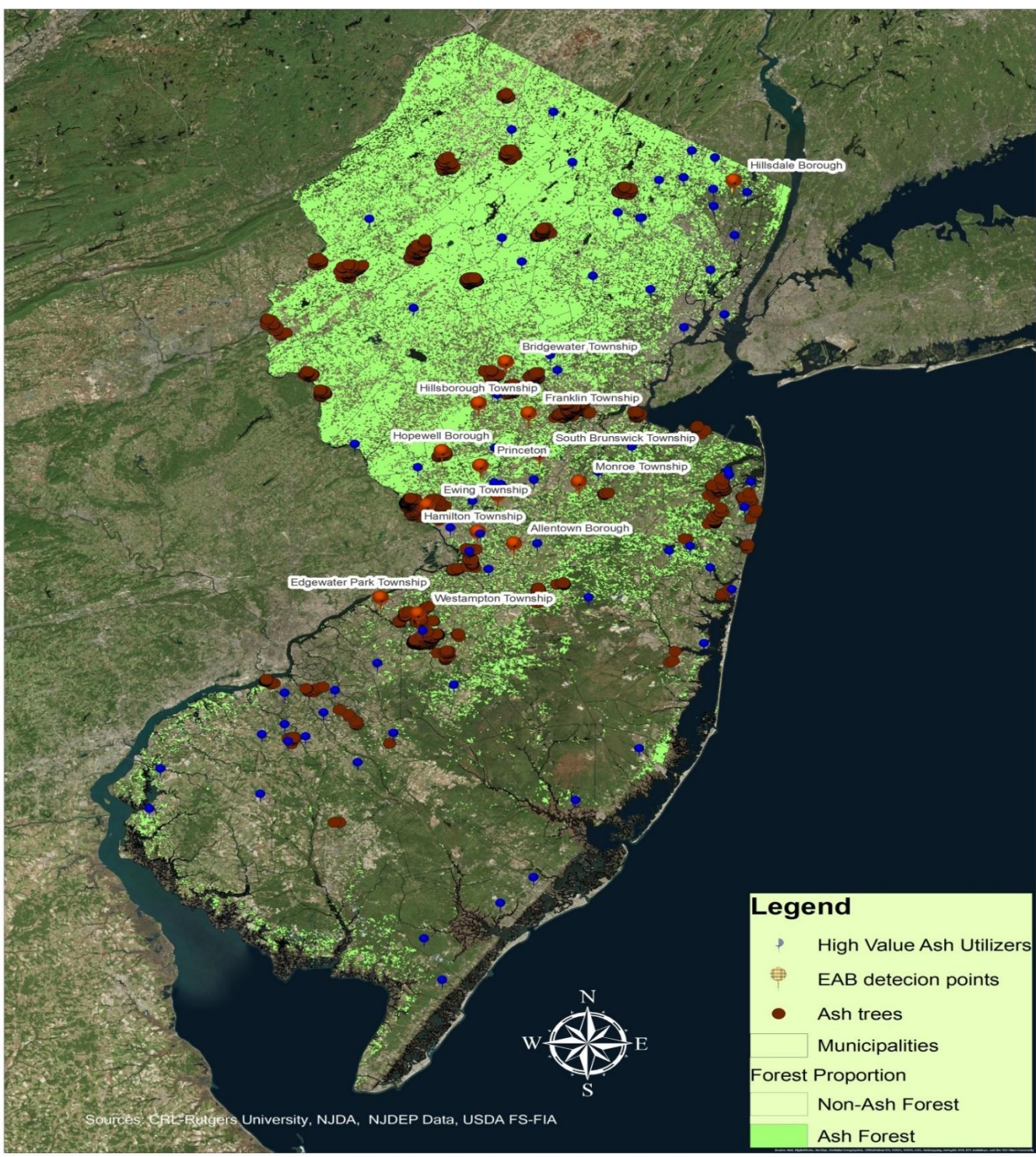
Conceptual Framework
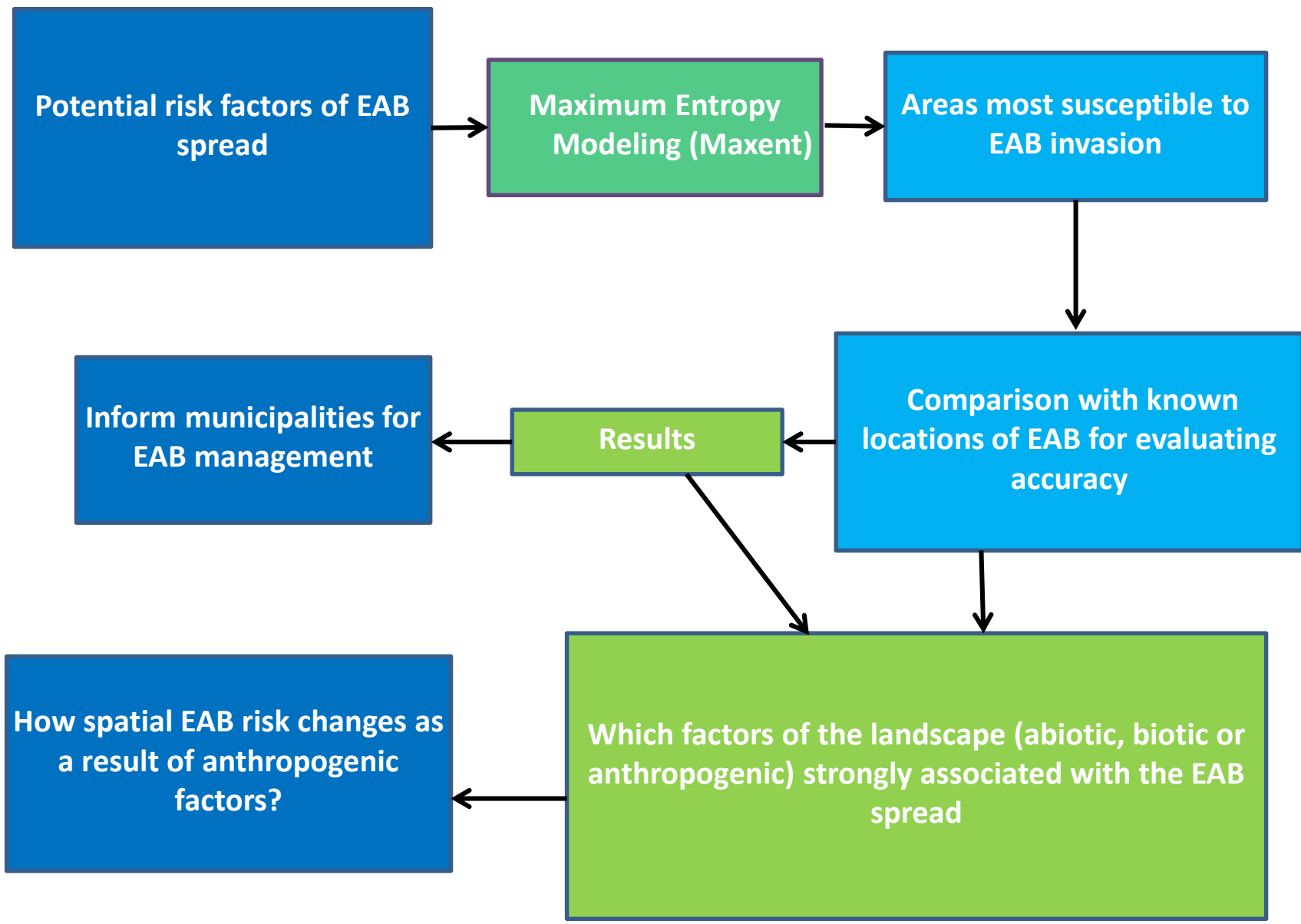
Maximum Entropy Modeling (Maxent)

• Maxent uses identified EAB locations and environmental/anthropogenic factors as prior information.

• Identification of EAB data in New Jersey is incomplete. Maxent provides general approach for making predictions/inferences from presence only (incomplete information) modeling.

• Maxent is suitable for predicting EAB distribution in New Jersey.

Exponential (exp) Maxent distribution (Dudík et al., 2004) for EAB risk is defined as:

$$q_\lambda(x) = \exp(\lambda_1 f1(x) + \lambda_2 f2(x) + \lambda_3 f3(x) + \lambda_4 f4(x) + \lambda_5 f5(x)) / Z$$

Where

$\lambda_1, \lambda_2, \lambda_3, \lambda_4,$ and λ_5 are coefficients for urban areas, elevation, ash basal area, major highways and waterbodies respectively. Coefficients are calculated by the program for each feature (f1, f2, f3, f4, and f5). Z is a scaling factor so distribution sums to 1.

Maxent probability is defined on a pixelated map of the study area. The sample points consist pixels with EAB detection points and the features are environmental/anthropogenic factors.

Preliminary Results
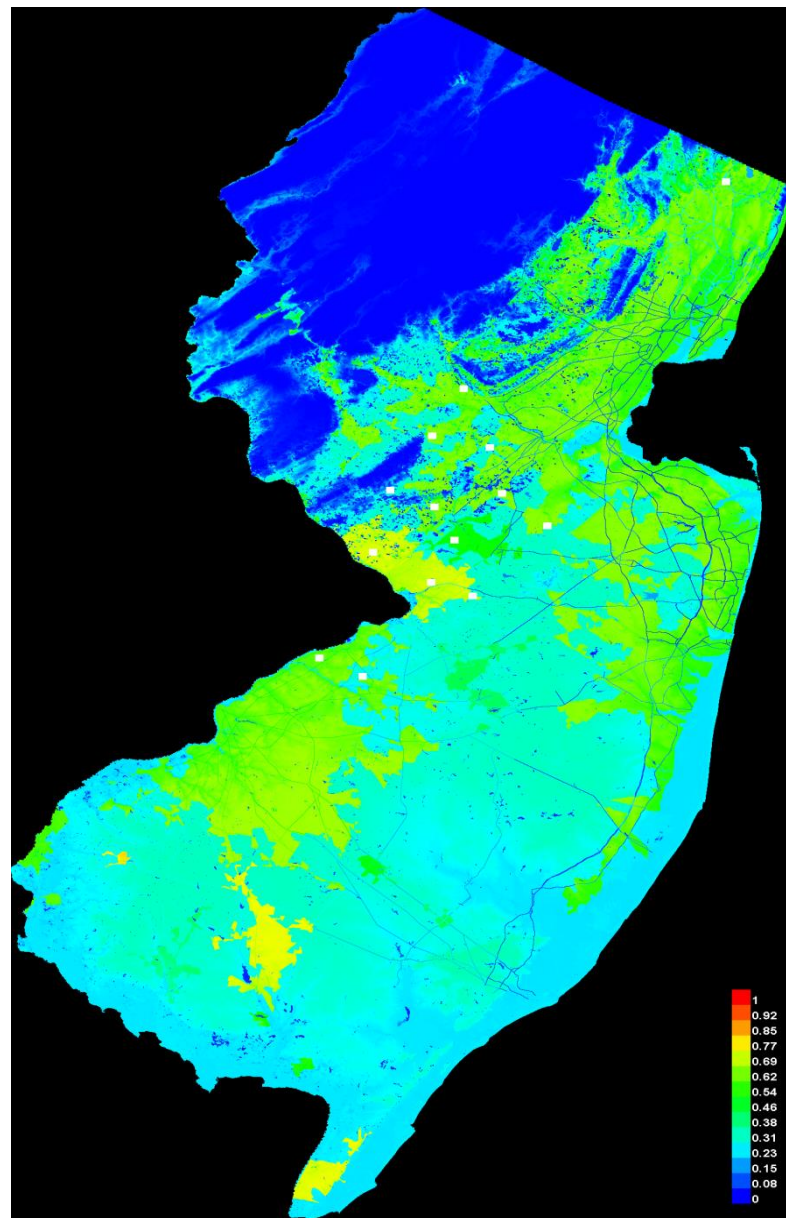
Probability of EAB presence

Estimates of relative contributions of the environmental variables

Variable	Percent contribution	Permutation importance
Urban areas	56.5	20
Elevation	34.5	61.1
Ash basal area	4.4	18.5
Major highways	3.4	14.8
Water bodies	1.1	4.1

In the map, warmer colors show higher predicted probability of suitable conditions and cooler colors show lower predicted probability of suitable conditions for EAB spread.

Preliminary results show higher EAB risk mostly in urban areas, which are closer to major highways compare to non-urban areas.

Future Steps/Work in Progress

Inclusion of campgrounds, wood industries, nurseries, precipitation and temperature data.

Following Elith et al., 2006 study, three statistics will be used with improved data to assess the agreement between the presence-absence records and the EAB risk predictions. These statistics are: (1) Area under the Receiver Operating Characteristic curve (AUC), (2) Correlation (COR), and (3) Kappa statistics.

References

Dudík, M., Phillips, S. J., & Schapire, R. E. (2004). Performance guarantees for regularized maximum entropy density estimation. Proceedings of the Seventeenth Annual Conference on Learning Theory (pp. 472--486). Springer-Verlag.

Elith, J. et al. 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography 29: 129-151.
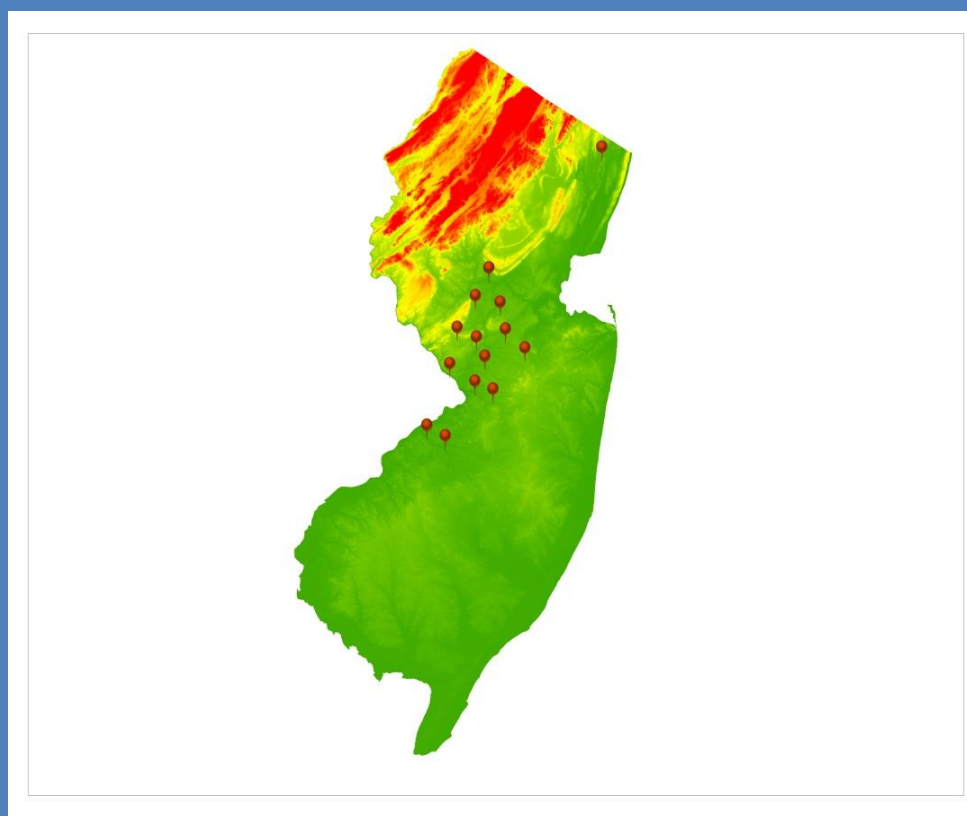
Mapping Risk Factors
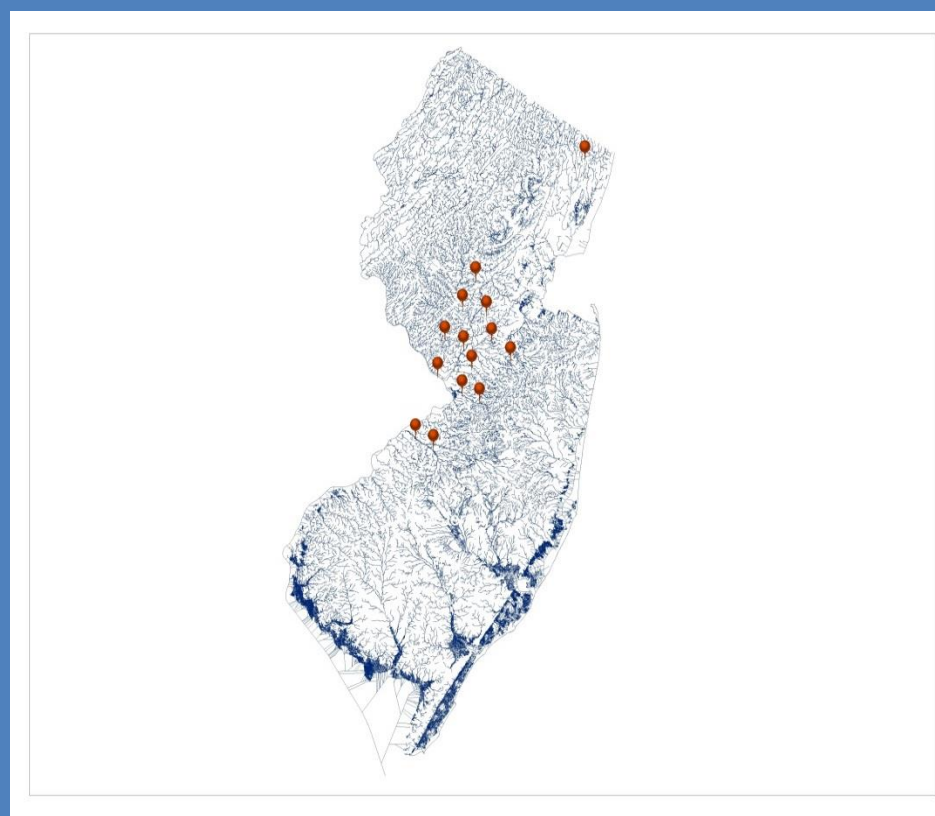
Anthropogenic Factors
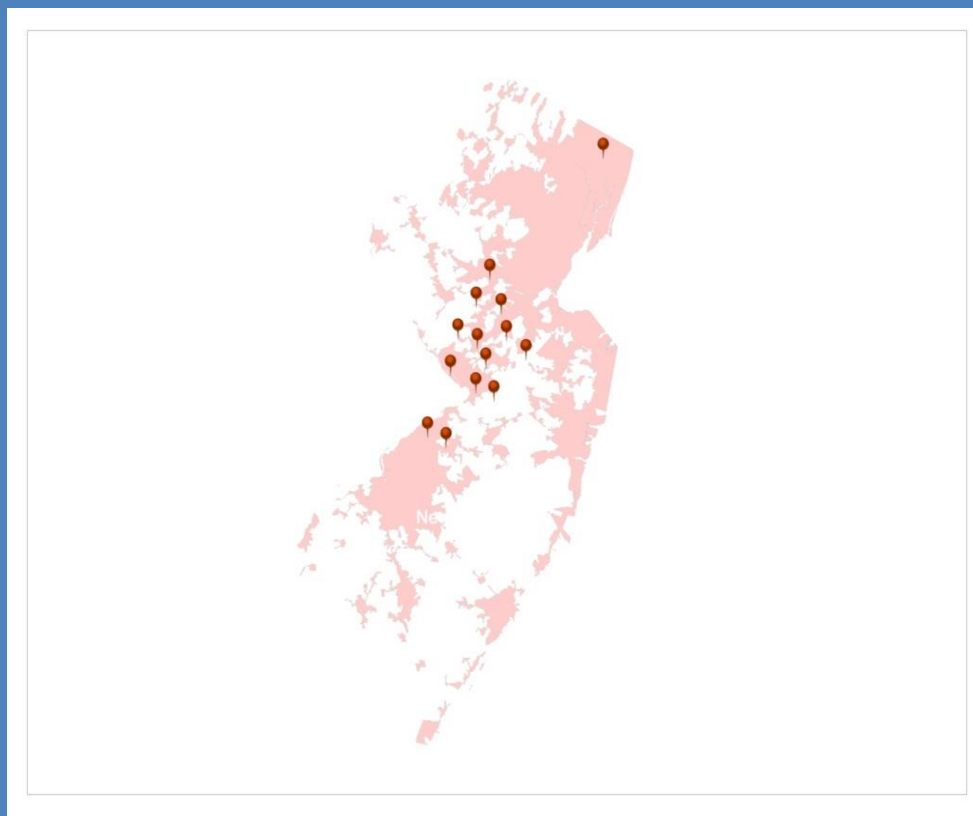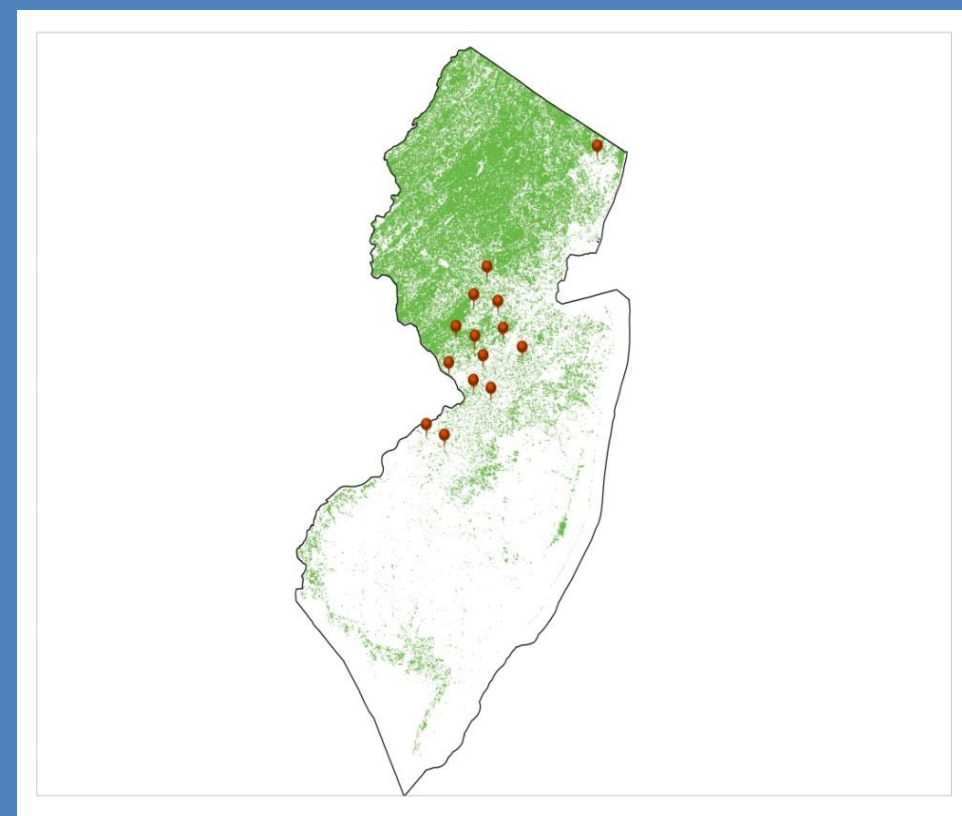

Urban areas
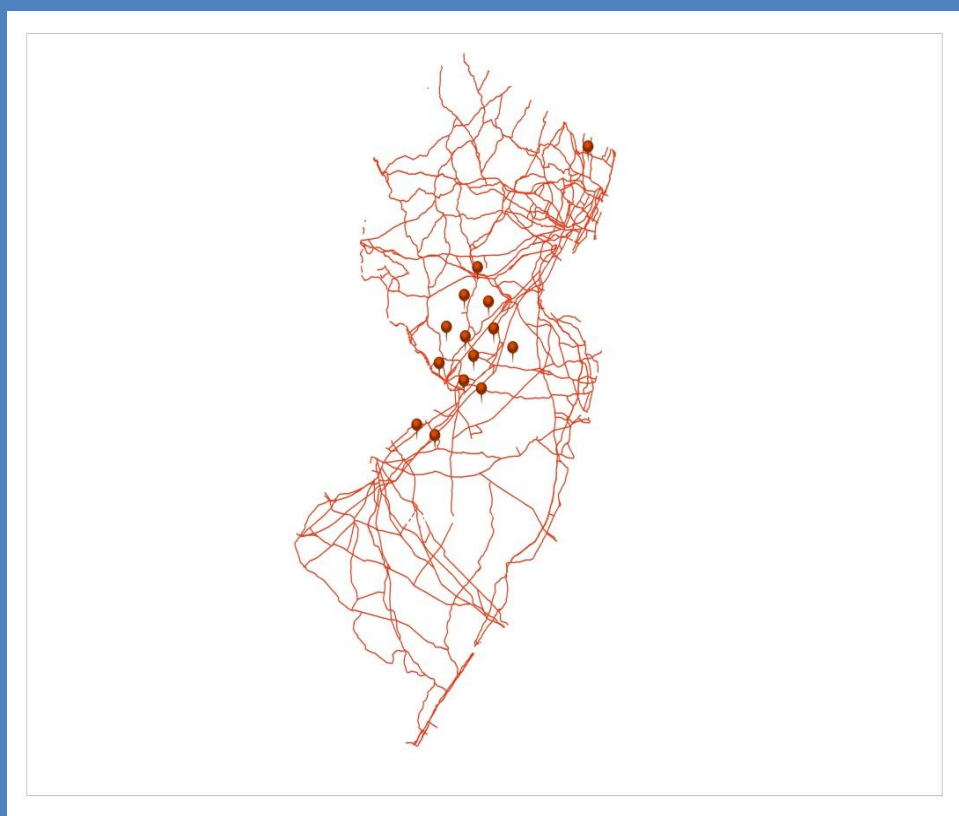
Major highways

Environmental Factors

Elevation

Water bodies

Ash basal area