Research Permittee Annual Report Example

2019 Annual Report

Research Project Title: Gypsy moth (*Lymantria dispar*) defoliation impacts on forest structure, composition, and productivity, using LANDSAT remote sensing and ground-based measurements.

Principal Investigators:
Name, Title, Affiliation, Contact Info:

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- PI 2: Valerie Pasquarella, Research Scientist, Boston University, valpaq@bu.edu
- PI 3: Joseph Elkinton, Professor, UMass Amherst, elkinton@ent.umass.edu

Activities in 2019

- Sampled eight sites with differing frequencies of gypsy moth defoliation from 2016-2018. At each site, we established 3, 20m x 20m plots. We marked the plot corners with blue-painted
- PVC pipes, each labelled with the plot and research permit number.
- Tagged all trees >5cm dbh using numbered aluminum tags/aluminum nails. Recorded species, diameter, health (crown dieback and mortality)
- Collected 5 soil cores (2 inches wide by 6 inches deep) from each plot.
- Collected 50 gypsy moth larvae from each of the sites, weekly for 5 weeks May-June (we will be rearing these in the lab to assess caterpillar mortality). While collecting larvae, we rated weekly % defoliation per tree.

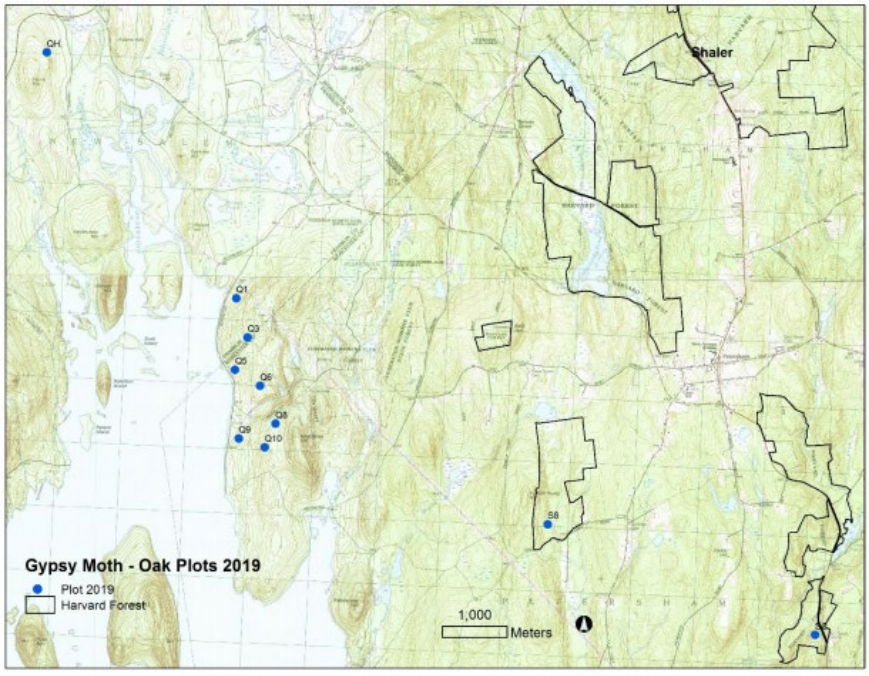

Figure 1. Permanent plot locations. Note that the gypsy moth outbreak (2016-2018) was much more severe at the Quabbin than at the Harvard Forest, which is why most plots are on Quabbin

- In August-September, we collected tree cores (2 per tree for stems >20cm dbh; 1 per tree for stems 10-20cm dbh).
- In January 2019, collected a 2-cm long increment core from the stem and root of each of 40 oaks that are part of a study of non-structural carbohydrate levels in relation to defoliation frequency and severity.
- Assessed gypsy moth egg mass density at each site in April-May 2019 (pre-hatch in 2019), and in November 2019 (density going into 2020).
- Possible measurements continuing beyond 2019-2020: We would like to return to the plots over the next 5+ years to assess tree growth and mortality (including secondary organisms), seedling and sapling regeneration, and changes in vascular plant composition and cover.
- We may want to collect another set of soil cores after 5-10 years
- We may want to repeat the gypsy moth larvae collection/mortality analysis in future years, depending on the outbreak status.

Key Results.

Here are reports from 3 undergraduate who worked on this project in Summer 2019.

Title: The very hungry, lonely, and sick caterpillar: exploring pathogen occurrence within low-density populations of gypsy moth.

- Author: Savanna Brown (Bowling Green State University - Main Campus)
- Abstract:

Gypsy moth (*Lymantria dispar*) has successfully invaded a large portion of North America in a matter of decades, damaging a variety of temperate forest tree species and costing billions of dollars annually in preventative and remediation costs. In 1989 a fungal pathogen native to Japan, *Entomophaga maimaiga*, was accidentally established in North America and may have fundamentally changed the population dynamics of gypsy moth. Although some data exists on pathogen dynamics in high-density outbreak systems, few studies have been done since the introduction of *E. maimaiga* to determine its role in preventing outbreaks and maintaining populations of gypsy moth at low densities. I performed a mortality analysis of gypsy moth larvae in 7 sites at the Quabbin Reservoir in Central Massachusetts in 2019, where after 2-3 years of outbreak populations, larval densities have declined considerably. In spring before neonates hatched, egg mass density was recorded as a proxy of population density at each site. Recording larval mortality and cause of death allowed us to observe if *E. maimaiga* played a unique role among several contemporaneous pathogens and parasitoids in maintaining equilibrium in low density populations. Analysis of larval mortality using marginal attack rates indicated that larval mortality from *E. maimaiga* was proportionally higher in populations with lower egg mass densities. Additionally, of the mortality agents tested, rate of infection by *E. maimaiga* was most strongly correlated with beginning egg mass density of each population.

Title: Does Soil Nitrogen Increase Gypsy Moth Defoliation or Aid Tree Recovery?

- Author: Emma Conrad-Rooney (Wellesley College)
- Abstract:

Trees' critical roles in forest ecosystems are threatened by disturbances such as insect outbreaks. Invasive gypsy moth caterpillars (*Lymantria dispar*), introduced to New England in the mid-1800's, defoliate trees which can result in mortality. Nitrogen is critical for plant recovery from defoliation and is also critical for the defoliators. I am investigating whether oak leaf nitrogen content correlates to soil nitrogen, whether there a relationship between soil nitrogen and gypsy moth defoliation intensity, and how soil nitrogen contributes to tree recovery from defoliation. Twelve red oak (*Quercus rubra*) street trees in Amherst, MA were monitored for percent defoliation. In ten plots in the Quabbin Reservoir watershed that had a range of defoliation intensities, trees were assessed for dieback. Soil samples of the organic horizon were collected from around the Amherst trees and in the Quabbin plots, and leaves were collected from the Amherst trees in 2018. Processed samples were run through an elemental analyzer to measure percent carbon and nitrogen in organic soil and oak leaves. Results indicated a positive correlation between soil and leaf nitrogen content ($p = 0.36$), less herbivory for trees with higher foliar N levels ($p = 0.27$), and more dieback after defoliation in areas with less soil nitrogen ($p = 0.16$). This study suggests that higher nitrogen promotes oak resistance to, and recovery from, gypsy moth defoliation. These results can inform predictions of the northeastern U.S. forests' ability to act as carbon sinks that help to mitigate climate change.

Title: Quantifying Death: Characterizing patterns of oak mortality in North-central Massachusetts in the aftermath of the most recent gypsy moth outbreak.

- Author: Sofia Kruszka (University of Michigan (all campuses))
- Abstract:

The oak genus Quercus is an important species group in the eastern United States, supporting an array of wildlife and contributing nutrients to terrestrial and aquatic ecosystems. Larvae of the invasive gypsy moth *Lymantria dispar* from Europe and Asia defoliate oak tree species, and the weakened oaks are subsequently vulnerable to other forest insects and pathogens. A recent gypsy moth outbreak from 2015-2018 defoliated over 900,000 acres in Massachusetts at its peak in 2017. Despite widespread gypsy moth defoliation in Massachusetts, oak mortality varies among adjacent stands. I investigated the extent of oak mortality in the aftermath of this gypsy moth outbreak. I measured and assessed tree mortality and dieback in ten 0.12-hectare plots in Northcentral Massachusetts. With this data, I ran linear and logistic regression models to determine the variables that most closely predicted tree condition. I found that a combination of species, plot, canopy exposure, and trunk diameter most significantly predicted mortality of trees of all species (AICc(null) = 670.948, AICc(mod) = 531.875). For oaks, canopy exposure and plot most significantly predicted mortality (AICc(null) = 255.135, AICc(mod) =219.119). Canopy exposure and trunk diameter did not closely relate to dieback for *Quercus* species, which is not consistent with previous findings. These results suggest that the dynamics between gypsy moths, oaks, and forest conditions of this outbreak are different from past events.

Sent separately are Excel spreadsheets with plot and tree-level data. We plan to continue this study at a lower level of activity in 2020.