DCR Division of Water Supply Protection
Office of Watershed Management

Research Permit Proposal Example

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

(This is an expansion of the 2018 project R-152, 'LANDSAT and gypsy moths' and January 2019 update R-166)

Goals and objectives of research study, including values to DCR DWSP:

For most of the 20th century, gypsy moth (*Lymantria dispar*) was the most serious insect threat to forests and shade trees in the northeastern United States, but outbreaks have been sporadic and light since 1989, after the successful establishment of a fungal pathogen, *Entomophaga maimaiga*. However, in 2015 a surprising new outbreak of gypsy moth began in southern New England. A combination of drought and a failure of *E. maimaiga* or other organisms to control the gypsy moth may explain the current, ongoing outbreak, in which oak mortality is exacerbated by secondary mortality agents such as native wood-boring insects and fungal diseases.

Our study sites are primarily located in the Quabbin Watershed Forest because the gypsy moth outbreak is severe and widespread on this land (see map below). We hope that this study will add to DCR DWSP's knowledge of and management strategies for gypsy moth outbreaks. We also will include 2-3 study sites on Harvard Forest land, but at least through 2018, defoliation has been limited at Harvard Forest.

Our research questions fall into the following main categories:

1) What are the patterns and causes of oak defoliation and mortality?
2) What are the patterns and causes of gypsy moth mortality?

What is the seasonal pattern of defoliation, and how do field measurements correspond with satellite (LANDSAT) near-real-time imagery?

We propose to establish a set of permanent plots at the Quabbin Forest and the Harvard Forest, in oak forests with differing intensities of defoliation over the past 3 years. In these plots, we will take weekly ground measurements of defoliation. The dates of measurement will coincide with the day that LANDSAT8 makes its cyclical passage overhead.

What are the long-term consequences of gypsy moth defoliation on oak forest productivity, structure, and composition?

We would like to explore the consequences of current and past (e.g., 1981) defoliation events on forest productivity (wood growth) by collecting and analyzing tree cores. We would like to track changes in tree composition, tree regeneration, and vascular flora in the plots over the next 5-10 years. Is carbon starvation a proximal cause of oak mortality? (Audrey Barker Plotkin, Meaghan Blumstein)

Methods and Equipment:

In 2019 (note NSC collection in January 2020, and possible tree-core collection in 2020 instead of 2019), at each site:

- Establish three, 20m x 20m plots (0.04 ha squares, which are just about 0.1 acre); mark corners with PVC pipe (plot number, corner, and permit # on each pipe)
- Tag all trees >5cm dbh (we typically use aluminum tags/nails, but we can use paint instead if you prefer). Record species, diameter, health
- Record tree sapling and seedling densities, and vascular plant cover from sub-plots (temporarily marked with a sampling frame of measuring tape)
- Collect 5 soil cores (2 inches wide by 6 inches deep) from each plot.
- Collect 50 gypsy moth larvae from 8 of the sites, weekly through June (we will be rearing these in the lab to assess caterpillar mortality). While collecting larvae, rate weekly % defoliation.
- For oaks that die, assess presence of secondary organisms, especially 2-lined chestnut borer and/or Armillaria fungus. We are still figuring out how to efficiently assess trees for these organisms.
- We may use burlap fabric bands to capture gypsy moth larvae. These bands would be wrapped around individual trees for a period of 24-48 hours at a time (photo to right).

Identify specific areas or habitat types to be used (be as specific as possible; indicate proposed study sites on map:

Our objective is to establish plots along a gradient of defoliation frequency. Table 1 identifies eleven sites, eight of which are on Quabbin land. Differing subsets of plots will be used for the different proposed measurements. The plot locations/ potential locations are shown on Figure 2.

Table 1. Potential plot characteristics. For 2016, 2017, 2018, 'Y' means that LANDSAT imagery identified the plot as defoliated, and 'N' means the plot was not defoliated. 'Y' in the NSC column indicates sites in which we are tracking non-structural carbohydrates in individual oak trees. Salvage area was identified from a July 2018 map provided by Rich MacLean.

Owner	Location	Plot	2016	2017	2018	NSC	salvage area?	WGS84_LAT	WGS84_LON
Quabbin	Gate 35	Q1	N	Y	N	Y	N	42.4970762	-72.2771696
Quabbin	Gate 35	Q5	N	Y	Y	Y	Y	42.48709	-72.2773038
Quabbin	Gate 35	Q6	Y	Y	Y	Y	Y	42.4848728	-72.2725523
Quabbin	Gate 35	Q8	N	N	N	Y	Y	42.4796265	-72.2696061
Quabbin	Gate 35	Q9	N	Y	Y	Y	Y	42.477518	-72.2764984
Quabbin	Gate 35	Q3	N	Y	Y	N	N	42.4916132	-72.2750153
Quabbin	Gate 35	Q10	Y	Y	Y	N	Y	42.4763201	-72.2715725
Quabbin	TBD*		N	N	Y	N	?	TBD	TBD
Harvard Forest	Slab City	SC3	N	Y	Y	N	N	42.4507	-72.1676
Harvard Forest	Simes	S8	N	Y	N	N	N	42.466	-72.2181
Harvard Forest	Lyford	L2	N	N	N	N	N	42.5313	-72.1785

*Potential areas that showed defoliation only in 2018:

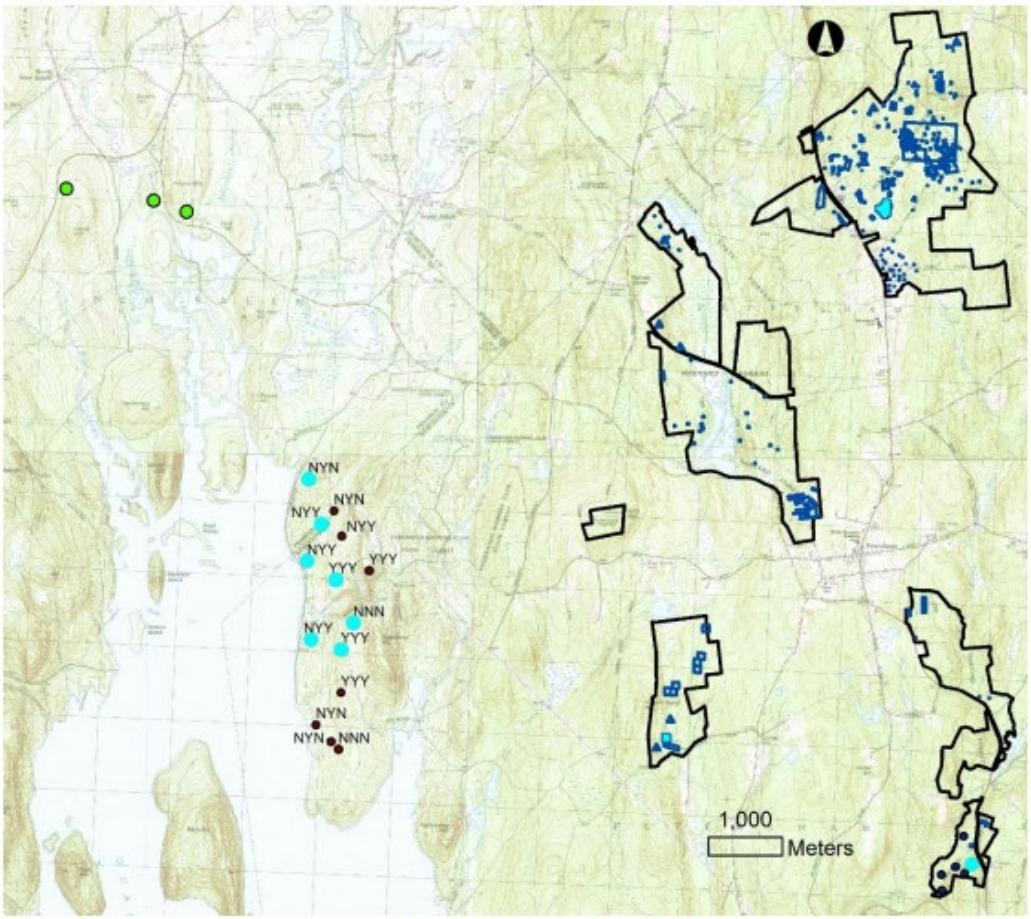

Figure 2. Overview of potential plot locations. The turquoise circles and polygons (Quabbin and Harvard Forest) indicate plots included in 2018 or prior research. The three green circles indicate possible locations for a new plot. We would like to choose one of these 3 locations for a plot representing forest that was defoliated in 2018 but not prior.

Specify final report or product that will be submitted to DWSP (a brief annual report is required):

We will submit an annual report that summaries all findings, a map of the sampling locations, and a copy of the field data in spreadsheet format, including plot GPS locations.