Comparing vegetative fuel loading and developing custom fuel models for Brookhaven National Laboratory

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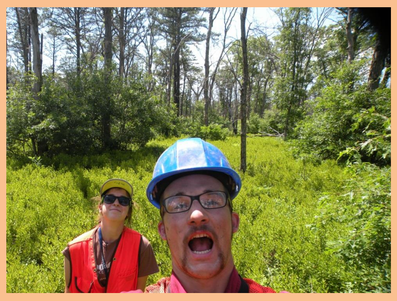
Abstract



Where fire occurs, it shapes the form and function of ecosystems; however, as a method of ecosystem maintenance, fire has largely been suppressed. This study was conducted to collect and analyze fuel loading data in Brookhaven National Laboratory (BNL) and to assess potential fire behavior. Our study was focused on two stands (D and A) in the eastern complex of the northeastern corner of BNL. Vegetative surveys were conducted in 2006 and 2016, and the resulting fuel loading data was entered into BehavePlus 5.0.5 to create custom fuel models of the stands. The results showed that stand D had a 17%, 77%, and 44% decrease in 1-, 10-, and 100-hour dead fuels respectively, and a 227% increase in live woody fuel from 2006 to 2016. Stand A had a 29% and 73% decrease in 1 and 10-hour dead fuels respectively, and a 2,886% increase in 100-hour dead fuels from 2006 to 2016. We believe that the herbivory of the orange striped oakworm (Anisota senatoria) and the gypsy moth (Lymantria dispar), in stand D opened the canopy and increased live woody fuel values, thereby increasing rate of spread and flame length values. We also believe that the moderate-to-high intensity fire that top-killed many oaks in stand A, in 2012, caused the increase in the number of 100-h dead fuels and the decrease in the 1- and 10- h dead fuels. The decrease in these fine fuels in stand A would explain the lower predicted rate of spread and flame length values in 2016 as compared to 2006.

Introduction

Fire, from an ecological perspective, is a human induced or naturally occurring phenomenon that explicitly deals with the combustion and conversion of complex organic compounds (oxygenated fuels) to mineral and organic products (1). Where human populations are high and large amounts of property are owned, managing fire in general with fire suppression as an objective not only negatively impacts an ecosystems natural successional habits but increases the buildup of fine and coarse woody fuels as well. The increased fuel loading drastically increases the likelihood of a high intensity and high severity fire, neither of which are adaptations to non-pine barren surrounding woodlands. By analyzing BNL's portion of CPB land, we aim to quantify the risk of repeated fire suppression and showcase the direct impacts on BNL land and surrounding communities.

Objectives:

- Analyze data collected from 2006 and 2016 to assess the vulnerability to fire (wildfire and prescribed fire, respectively) of the BNL CPB region on Long Island, New York.
- Interpret the effects of type and amount of fuel loading in the northeast quadrant of BNL land based on fire history and current fuel loading.
- Emphasize fires importance in today's forests, calculating fire risk attributes (rate of spread, flame height, etc.) with the creation of a custom fuel model within BehavePlus 5.0.5; applicable for pitch pine and mixed oak Pine Barren ecosystems.

Plot photos show our field work in the northeastern corner of BNL

Methods

Study Site:

- Conducted on the BNL site located in Upton, New York. BNL rests on 2,153.33 hectares that are positioned within Long Island's (approximately 40,468.56 hectares) Central Pine Barrens ecosystem. (2)
- Our research sites were specifically located in the northeastern corner of BNL that is divided into two subunits; north and east. The north complex consists of 45 hectares and the east complex consists of 23.88 hectares. (3)

Sampling Design:

- Ninety-three points each associated with unique GPS coordinates were established across the northern and eastern complexes using ArcGIS® (10.0) fishnet application.
- A modified Brown's transect was used to inventory downed woody fuels, and a variable radius plot was used to assess the basal area and volume at each plot center, and a 40cm x 40cm harvest plot. (4,5,6)

Data Analysis:

- BehavePlus 5.0.5 was used to create custom fuel models to analyze fire behavior. (7)

Results

Table 1: Table representing the flame length (m) for stand D, in 2006, in the east block of Brookhaven National Laboratory, Upton, NY.

1-h Moisture	Midflame Wind Speed (upslope) km/h											
%	3.218688	6.437376	9.656064	12.874752	16.09344	19.312128	22.530816	25.749504	28.968192	32.18688	35.405568	38.624256
4	0.9	1.4	1.7	2.1	2.4	2.7	3	3.3	3.6	3.9	4.1	4.4
5	0.9	1.3	1.6	2	2.3	2.6	2.9	3.1	3.4	3.6	3.9	4.1
6	0.8	1.2	1.5	1.9	2.2	2.4	2.7	3	3.2	3.5	3.7	3.9
7	0.8	1.2	1.5	1.8	2.1	2.3	2.6	2.8	3.1	3.3	3.5	3.8
8	0.8	1.1	1.4	1.7	2	2.3	2.5	2.7	3	3.2	3.4	3.6
9	0.7	1.1	1.4	1.7	1.9	2.2	2.4	2.7	2.9	3.1	3.3	3.5
10	0.7	1.1	1.4	1.6	1.9	2.1	2.4	2.6	2.8	3	3.2	3.4
11	0.7	1	1.3	1.6	1.9	2.1	2.3	2.5	2.8	3	3.2	3.4
12	0.7	1	1.3	1.6	1.8	2.1	2.3	2.5	2.7	2.9	3.1	3.3
13	0.7	1	1.3	1.5	1.8	2	2.2	2.5	2.7	2.9	3.1	3.2
14	0.7	1	1.3	1.5	1.7	2	2.2	2.4	2.6	2.8	3	3.2
15	0.7	1	1.2	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1
16	0.6	0.9	1.2	1.4	1.7	1.9	2.1	2.3	2.5	2.7	2.8	3
17	0.6	0.9	1.1	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.9
18	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.4	2.6	2.7

Table 2: Table representing the flame length (m) for stand D, in 2016, in the east block of Brookhaven National Laboratory, Upton, NY.

1-h Moisture	Midflame Wind Speed (upslope) km/h											
%	3.218688	6.437376	9.656064	12.874752	16.09344	19.312128	22.530816	25.749504	28.968192	32.18688	35.405568	38.624256
4	1.9	2.8	3.7	4.4	5.1	5.7	6.3	6.9	7.5	8.1	8.6	9.1
5	1.9	2.7	3.5	4.2	4.8	5.4	6	6.6	7.1	7.7	8.2	8.7
6	1.8	2.6	3.3	4	4.6	5.2	5.8	6.3	6.8	7.3	7.8	8.3
7	1.7	2.5	3.2	3.8	4.5	5	5.6	6.1	6.6	7.1	7.5	8
8	1.7	2.4	3.1	3.7	4.3	4.9	5.4	5.9	6.4	6.8	7.3	7.7
9	1.6	2.4	3	3.6	4.2	4.7	5.2	5.7	6.2	6.7	7.1	7.5
10	1.6	2.3	3	3.6	4.1	4.6	5.1	5.6	6.1	6.5	6.9	7.4
11	1.5	2.3	2.9	3.5	4	4.5	5	5.5	5.9	6.4	6.8	7.2
12	1.5	2.2	2.8	3.4	3.9	4.5	4.9	5.4	5.8	6.3	6.7	7.1
13	1.5	2.2	2.8	3.4	3.9	4.4	4.8	5.3	5.7	6.1	6.5	6.9
14	1.5	2.1	2.7	3.3	3.8	4.3	4.7	5.2	5.6	6	6.4	6.8
15	1.4	2.1	2.7	3.2	3.7	4.2	4.6	5.1	5.5	5.9	6.3	6.6
16	1.4	2	2.6	3.1	3.6	4.1	4.5	4.9	5.3	5.7	6.1	6.5
17	1.3	2	2.5	3	3.5	3.9	4.4	4.8	5.1	5.5	5.9	6.2
18	1.3	1.9	2.4	2.9	3.3	3.8	4.2	4.6	4.9	5.3	5.6	6

Table 3: Table representing the flame length (m) for stand A, in 2006, in the east block of Brookhaven National Laboratory, Upton, NY

1-h Moisture	Midflame Wind Speed (upslope) km/h											
%	3.218688	6.437376	9.656064	12.874752	16.09344	19.312128	22.530816	25.749504	28.968192	32.18688	35.405568	38.624256
4	1.1	1.6	2.1	2.5	2.9	3.3	3.6	4	4.3	4.6	4.9	5.2
5	1	1.5	1.9	2.3	2.7	3.1	3.4	3.7	4	4.3	4.6	4.9
6	1	1.4	1.8	2.2	2.6	2.9	3.2	3.5	3.8	4.1	4.4	4.7
7	0.9	1.4	1.8	2.1	2.5	2.8	3.1	3.4	3.7	3.9	4.2	4.5
8	0.9	1.3	1.7	2	2.4	2.7	3	3.3	3.5	3.8	4	4.3
9	0.9	1.3	1.6	2	2.3	2.6	2.9	3.2	3.4	3.7	3.9	4.2
10	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1	3.3	3.6	3.8	4.1
11	0.8	1.2	1.6	1.9	2.2	2.5	2.8	3	3.3	3.5	3.8	4
12	0.8	1.2	1.5	1.9	2.2	2.4	2.7	3	3.2	3.5	3.7	3.9
13	0.8	1.2	1.5	1.8	2.1	2.4	2.7	2.9	3.2	3.4	3.6	3.8
14	0.8	1.2	1.5	1.8	2.1	2.3	2.6	2.9	3.1	3.3	3.6	3.8
15	0.8	1.1	1.4	1.7	2	2.3	2.5	2.8	3	3.2	3.5	3.7
16	0.8	1.1	1.4	1.7	2	2.2	2.5	2.7	2.9	3.1	3.4	3.6
17	0.7	1	1.3	1.6	1.9	2.1	2.4	2.6	2.8	3	3.2	3.4
18	0.7	1	1.3	1.5	1.8	2	2.3	2.5	2.7	2.9	3.1	3.3

Table 4: Table representing the flame length (m) for stand A, in 2016, in the east block of Brookhaven National Laboratory, Upton, NY.

1-h Moisture	Midflame Wind Speed (upslope) km/h														
%	3.218688	6.437376	8.04672	9.656064	11.265408	12.874752	14.484096	16.09344	17.702784	19.312128	20.921472	22.530816	24.14016	25.749504	27.358848	28.968192
4	0.8	1.2	1.4	1.6	1.7	1.9	2	2.2	2.3	2.5	2.6	2.7	2.9	3	3.1	3.3
5	0.8	1.2	1.3	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.6	2.7	2.9	3	3.1
6	0.8	1.1	1.3	1.4	1.6	1.7	1.9	2	2.1	2.3	2.4	2.5	2.6	2.7	2.9	3
7	0.7	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.7	2.8	2.9
8	0.7	1	1.2	1.3	1.5	1.6	1.7	1.9	2	2.1	2.2	2.3	2.5	2.6	2.7	2.8
9	0.7	1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6	2.7
10	0.7	1	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2	2.1	2.2	2.3	2.5	2.6	2.7
11	0.7	1	1.1	1.3	1.4	1.5	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6
12	0.7	1	1.1	1.2	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.6
13	0.7	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5
14	0.6	0.9	1.1	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5
15	0.6	0.9	1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4
16	0.6	0.9	1	1.1	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4
17	0.6	0.9	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3
18	0.6	0.8	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2	2.1	2.2

Discussion

- Stand D had higher rate of spread and flame length values, because the herbivory and defoliation from the gypsy moth and the orange striped oakworm caused tree mortality, opening the canopy.
- Stand A had lower rate of spread and flame length values, because the wildfire in 2012 reduced the 1h and 10h fuel load.

Literature Cited

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