

Analysis of Field Data for the Shawangunks Grassland and Forests Birds Habitat Study

Report #4: Overlooks Wildfire Study

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Summary

The Overlooks Wildfire burned approximately 1,250 ha within Minnewaska State Park Preserve and some adjacent private lands in April of 2008. This was the largest fire in the Shawangunks since the 1947 wildfire that burned over 3,000 ha. To measure the effects of this fire, vegetation and other data were collected from 96 10-m radius circular plots (314 m²) in Minnewaska State Park Preserve from early June to mid-September of 2008. Fifty-five of these were in burned areas mapped as chestnut oak forest and 20 in nearby, unburned chestnut oak forest. Twenty-one plots were located within burned pitch pine-oak-heath rocky summit. In late May and early June of 2008 bird data was collected from 25 points within the boundary of the Overlooks Wildfire and from 15 points in a nearby, unburned chestnut oak forest. These were also included in the above vegetation plots. To provide further comparison of burned vs. unburned areas, data from 1995-96 mapping of the northern Shawangunks by John Thompson (1996), incorporated into New York Natural Heritage Program data (NHP), were also analyzed.

In 2009, bird data was again collected in the two unburned transects and in two of the burned transects. In 2010, we collected vegetation data in 36 plots mapped as chestnut oak forest and 10 plots in the pitch pine-oak-heath rocky summit in the burned area. We also collected bird data from 25 points in the burned area. No data were collected in unburned areas.

The wildfire reduced total canopy cover well below that of unburned plots from this study and NHP data. High intensity fire likely killed many canopy trees, creating open woodland areas distinct from forest types. These open woodland areas were discovered during field work in 2010 and were not observed in 2008. Tree cover substantially recovered in forest plots.

Overall tree density in the chestnut oak forest was 66.2/ha in 2010, compared to 487.7 in 2008. Plots designated as forested had a density of 244.0/ha, compared to 38.9/ha for open woodland plots. Oaks had higher importance value in the burned area in 2010 than in 2008, primarily due to values in open woodland plots where oaks (*Quercus montana*, *Q. rubra*) persisted and red maple did not. This supports the theory that the open woodlands were subject to higher intensity fires than the areas that remained as forest. After two years, more trees died, and it would appear that oaks had a higher survival rate than red maple (*Acer rubrum*) or other species. Pitch pine (*Pinus rigida*) also had a high importance value in these open woodland plots, which may indicate that those areas that became open woodland differed from other chestnut oak forest areas prior to the fire. Red maple continued to have high importance values in burned forested areas.

In the pitch pine-oak-heath rocky summit, tree density was 732.8 trees/ha in 2008 and 273.7 trees/ha in 2010 compared to 414.3 in unburned plots. Again, this community likely experienced high intensity fire. Red maple density and importance value were significantly lower in 2010 than in 2008.

In chestnut oak forest plots, red maple constituted 61.4% and sassafras 26.1% of seedlings. In open woodland plots, these proportions were 7.3% for red maple and 89.0% for sassafras, while in the pitch pine-oak-heath rocky summit, these proportions were 60.9% for red maple and 32.1% for sassafras. Only 15 pitch pine seedlings, representing 2.5% of total seedlings, were counted. In the chestnut oak forest, the total seedling density for all species ranged from 78,309/ha in chestnut forest plots to 96,833 in open woodlands, while overall density in the pitch pine-oak-heath rocky summit was 29,666/ha. By comparison, in a separate study of prescribed fire effects in the Undercliff treatment unit, densities across plots ranged from 5,333 to 18,416/ha prior to the 2010 burn and 7,666 to 31,250/ha following that burn.

In the chestnut oak forest, red maple constituted 50.0% and sassafras 40.0% of saplings. In open woodlands, these proportions were 22.8% for red maple and 69.3% for sassafras. Sapling densities were 476/ha in forested plots, 1,727/ha in open woodlands, and 233/ha in the pitch pine-oak-heath rocky summit.

For the chestnut oak forest, the average total cover of the S1 strata (2-5 m) was significantly lower for burned than unburned plots in 2008, likely the result of high intensity fire burning in mountain laurel (*Kalmia latifolia*). S1 cover for burned plots in 2010 was less than found in burned plots in 2008. There may have been some dieback in this stratum, or the 2010 plots were simply different from the 2008 plots in shrub cover. For the S2 layer (< 2m), total shrub cover in 2008 burned plots was significantly lower than for unburned plots. In addition, S2 cover for burned areas was significantly higher in 2010 than was found in 2008. This is likely the result of recovery of the S2 layer between 2008 and 2010.

For the pitch pine-oak-heath rocky summit the total S1 layer cover in both 2008 and in 2010 vs. NHP data (unburned) was significantly lower. Apparently S2 cover in the burned area was higher than that for the NHP plots. Little recovery in either the S1 or S2 strata seems to have occurred between 2008 and 2010.

Scorch height and the proportion of canopy scorched varied more in the chestnut oak forest than in the pitch pine oak-heath rocky summit. In the chestnut oak forest, the distribution of proportion of canopy scorched was such that most trees recorded either little or no proportion of canopy scorched or over 90% scorched, with a moderate number of trees in between. In the pitch pine-oak-heath rocky summit, most trees had at least 90% of the canopy scorched. This indicates generally high intensity fire in that community, as well as torching of pitch pine whereas the chestnut oak forest was subjected to much greater variation in fire intensity and, hence, effects.

In 2008, there was significantly less leaf litter cover in burned vs. unburned chestnut oak forest plots and significantly more duff in burned plots, indicating that some areas had burned into the upper organic layers of the soil. Litter cover in plots assessed in 2010 was significantly higher, and duff cover significantly lower, than either measurement in 2008 burned plots. However, for data collected in 2010, those plots designated as open woodland had less litter and more duff than those designated as

forested. This may have resulted from greater litter deposition from trees in the forested plots, greater decomposition of litter in open areas, or the occurrence of high intensity fires in 2008 that reduced litter cover.

Forty species of birds were recorded in 2008 in burned areas while 31 were recorded in unburned areas. In 2009, 35 species were recorded in burned areas and 30 in unburned areas. In 2010, 52 species were recorded within the burned area. Changes in mean abundance between burned and unburned areas and between years for birds were inconsistent, both for many individual species as well as for bird guilds. The most consistent findings were for several of the species associated with forests. Ovenbirds, Black-throated Blue Warblers and Black and White Warblers all showed declines from unburned to burned areas. On the other hand, Scarlet Tanagers were also more abundant in burned areas.

For species associated with open habitats, Prairie Warblers were more abundant in burned areas, but also declined in abundance in both burned and unburned areas. Common Yellowthroats, Morning Doves, Chipping Sparrows and Chestnut-sided Warblers increased in both burned and unburned areas.

For cavity nesters, which we would expect would increase with increased abundance of dead trees, Black-capped Chickadees, House Wrens and Eastern Bluebirds increased in abundance in the wildfire area, while the abundance of woodpeckers and Great-crested Flycatchers was more mixed.

Given the open woodland areas where tree mortality was apparently high and the trajectory of the community toward one dominated by sassafras and red maple, I conclude intervention will be needed to restore the chestnut oak forest in the Overlooks Wildfire area. Leaving the area alone will likely lead to the area stabilizing as a shrubland or a woodland dominated by red maple and sassafras. Fire should be introduced as early as possible to reduce seedling numbers for both of these. Mechanical and herbicide treatments will be needed to reduce sassafras and red maple trees and saplings to reduce seed input. It may even be necessary to distribute acorns in areas where oak density is too low to provide sufficient numbers and where rodents and deer reduce acorns and seedlings. These actions can be incorporated into a program of further research and long-term monitoring of fire effects to track changes resulting from the Overlooks Wildfire. This should be integrated into the prescribed fire program contemplated in the recently completed fire management plan for the Shawangunks.

I. Introduction

A. Fire Summary

A discarded cigarette started the Overlooks Fire at Minnewaska State Park Preserve on April 18, 2008. The fire burned approximately 3,100 acres (1,250 ha) and was declared contained on April 22, 2008. This was the largest fire in the Shawangunks since the 1947 wildfire that burned over 3,000 hectares (Hubbs 1995). The approximate boundaries of the fire are shown on Map 1. Fire behavior was intense in many areas due to the accumulation of fuels, including highly flammable shrub fuels such as mountain laurel and huckleberry. Fire effects varied with this highly variable fire behavior (Gabe Chapin, personal communication). Immediately after the fire the Shawangunk Ridge Biodiversity Partnership developed and implemented a plan to collect data on the effects of the wildfire.

B. Methods

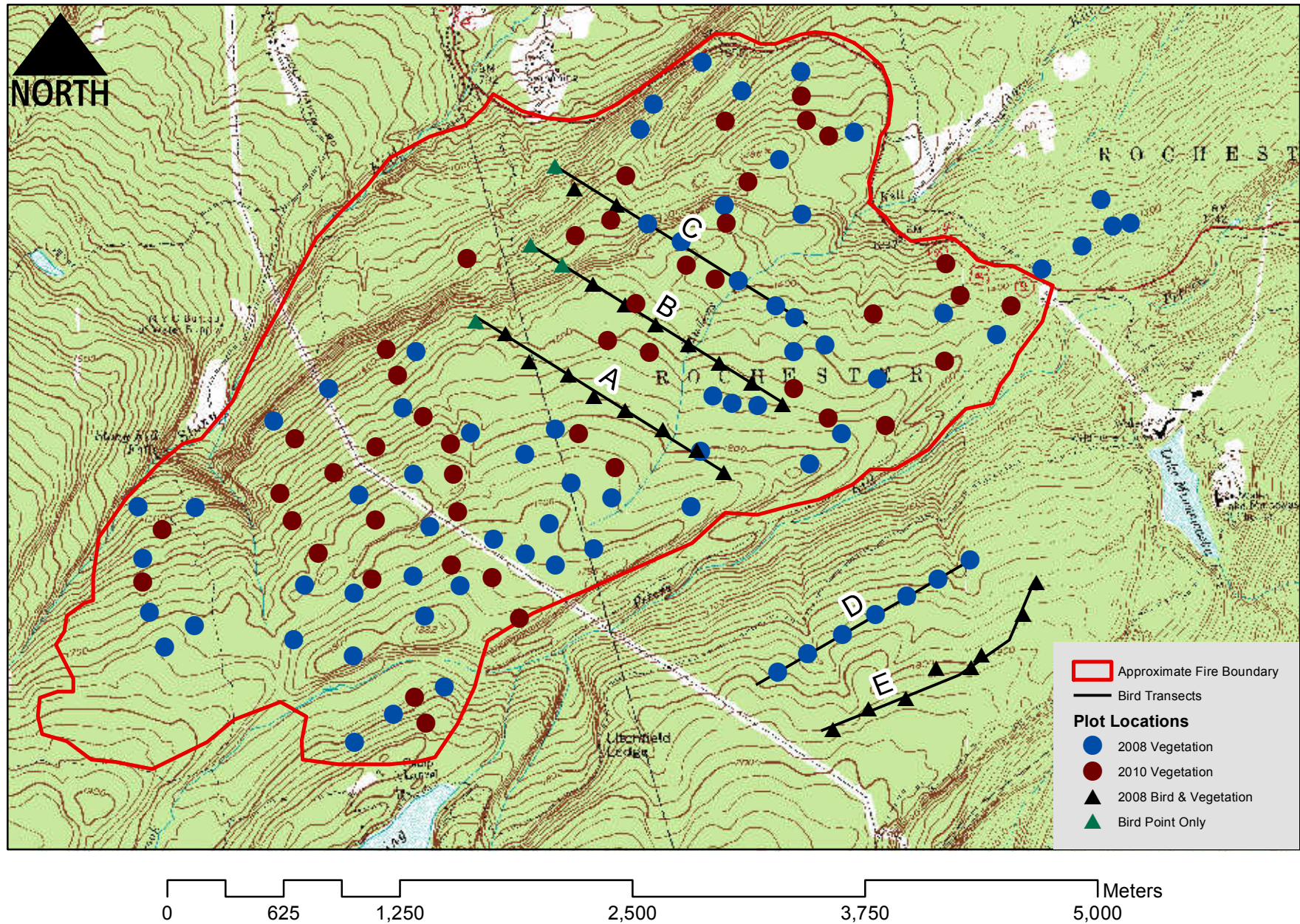
1. Vegetation

Methods were developed to assess the ecological effects of the wildfire based on modifications to standard methods developed by the New York Natural Heritage Program. Specific methods will be briefly described in the analyses sections and are fully described in a separate report (Batcher 2010).

Potential locations for plots were chosen using GIS data to randomly locate plots across the burned area within areas that had previously been mapped as either chestnut oak forest or pitch pine-oak-heath rocky summit (Thompson 1996). Teams were assigned a set of plots and navigated to them using maps, compass and GPS units. Plots were located at least 50 meters from any natural community boundary and the edges of human-dominated land uses (including roads, disturbed areas, fire lines or developed areas). No plots were to be closer than 100 meters of another, though this was apparently violated in at least one case. Using the GPS, a team navigated close to these plots, and stopped once the GPS unit indicated they had “arrived.” This actual location was then recorded and became the center point of a 10 meter radius circular plot (314 m²).

Field crews characterized plots by community type, in this case chestnut oak forest vs. pitch pine-oak-heath rocky summit and chestnut oak forest type. The New York Natural Heritage Program has described three types. The composition and structure of the canopy and subcanopy are the same in each, but ground cover differs. In the tall shrub type, there is a dense shrub layer of mountain laurel (*Kalmia latifolia*), generally 2-5 meters tall. In the short shrub type the shrub layer is 0.5-2 meters tall and is dominated by black huckleberry (*Gaylussacia baccata*) and blueberry (*Vaccinium angustifolium* and *V. pallidum*). Finally, the sedge type has little shrub cover but rather a ground cover of Pennsylvania sedge (*Carex pensylvanica*) (Thompson 1996, Edinger et

Map 1. Plot Locations and
Approximate Boundary of the Overlooks Wildfire



al 2002). Most plots fell into the tall shrub category, and the sedge type was not encountered.

The pitch pine-oak-heath rocky summit is a highly variable community with an open canopy of pitch pine (*Pinus rigida*). Scattered oak (*Quercus* sp.) may be present, usually where this community transitions to chestnut oak forest. The shrub layer may be dominated by black huckleberry or blueberry or may contain some scrub oak (*Quercus ilicifolia*). There is a diverse nonvascular flora, often found on extensive rock outcrops that characterize this community (Thompson 1996, Edinger et al 2002).

In 2008, fifty-five (55) plots were located within the chestnut oak forest with 21 located within the pitch pine-oak-heath rocky summit that had been burned in the wildfire. Of the 55 chestnut oak forest plots in the burned area, 22 corresponded with bird points located at approximately 200 m intervals along transects (total of 25) within the burned chestnut oak forest. The remaining 33 were randomly located (Map 1). However, for the purposes of these analyses, the vegetation plots that correspond with the subjectively located bird points were treated as if they were randomly located.

To allow for comparison of unburned chestnut oak forest, data from 20 plots were collected. Of these 15 corresponded with 15 bird points located along two transects in another section of the park (Map 1). Again, these were treated as if they were randomly located. In addition, another five plots were randomly located in a nearby unburned chestnut oak forest.

In 2010, we again used GIS data to locate potential plots within the burned area, which met the criteria described above. Crews collected data from forty-six plots. Ten of these were within the pitch pine-oak-heath rocky summit and the rest from the chestnut oak forest. However, there was apparent significant tree mortality in the chestnut oak forest, such that field crews characterized 22 plots as “open woodland,” which had little canopy cover and was dominated by shrubs (see Figure 1, in Section II. A.). The rest were characterized as forest. No plots were surveyed in unburned areas in 2010.

Table 1 summarizes the number of plots by community type within the burned area using Thompson (1996), which is based on Edinger et al. (2002), but which includes some Shawangunks variants. Table 2 provides the summary for the unburned area.

Table 1. 2008 and 2010 plots within burned areas by mapped and field designated cover type (Total N=122)

	2008 plots by field designated cover type (N=76)					2010 plots by field designated cover type (N=46)			
Mapped Types	Hemlock-hardwood swamp	Red maple hardwood heath	Chestnut oak forest Short Shrub	Chestnut Oak Forest Tall Shrub	Pitch pine-oak-heath rocky summit	Open Woodland	Chestnut oak forest Short Shrub	Chestnut Oak Forest Tall Shrub	Pitch pine-oak-heath rocky summit
Red maple hardwood heath	0	0	0	1	0	0	0	0	0
Chestnut oak forest	0	1	6	45	6	22	13	1	1
Pitch pine-oak-heath rocky summit	1	0	1	0	15	0	0	0	9
Total	1	1	7	46	21	22	13	1	10

Table 2. 2008 plots within unburned areas by mapped and field designated cover type (N=20)

Mapped Types	Chestnut oak forest Short Shrub	Chestnut oak forest Tall Shrub	Successional forest
Red maple hardwood heath	0	0	0
Chestnut oak forest	3	15	1
Successional forest	0	0	1
Pitch pine-oak-heath rocky summit	0	0	0
Total	3	15	2

One plot was located in an area mapped as red maple-hardwood heath and another in an area mapped as successional forest. A third plot in an area mapped as pitch pine-oak-heath rocky summit was designated in the field as hemlock hardwood swamp. These three plots were not included in any analyses. One plot designated in the field as red maple hardwood heath and mapped as chestnut oak forest was included in the chestnut oak forest group. This left the total number of plots for analyses at 139. Table 3 below shows the final number of plots in each of the cover type categories and within burned or unburned areas by year.

To provide further comparison between burned and unburned areas, I analyzed data from the New York Natural Heritage Program records. NHP scientists generally estimate cover data more precisely than was required in these protocols. In addition, most of that data was collected in 1995-96 as part of mapping of cover types for the Northern Shawangunks (Thompson 1996) though there are more recent observations, so there is as much as ten years difference in when data were collected. These data also come from a wider area, which adds more variation to the data. Data on tree diameters was not available for all plots within the NHP data provided.

Table 3. Number of plots by type based on field designation. Total from 2008 and 2010 is 139. NHP plots indicate total used for cover estimates with number with data on tree dbh in parentheses				
Community Type	2008 Burned	2008 Unburned	2010 Burned	NHP (Various years)
Chestnut oak forest	54	18	14	20 (7)
Open woodland/Chestnut oak forest	0	0	22	
Pitch pine-oak-heath rocky summit	21	0	10	13 (6)
Total	75	18	46	33 (13)

2. Birds

We used a modified version of the Vermont Forest Bird Monitoring Program protocols developed by the Vermont Center for Ecostudies (Faccio 2007). Within the chestnut oak forest, 25 bird observation points were established at approximately 200 m intervals along transects within the burned chestnut oak forest. To allow for comparison of unburned chestnut oak forest, data from 15 points were collected within an unburned chestnut oak forest stand (Map 1).

In 2008, bird observations were collected twice for two replicates at all points, except that two points were not surveyed in replicate 1 in transect B. In 2009, observations were collected in one replicate in burned transects A and B and in unburned transects D and E.

C. Analyses

Throughout this report, I make the following comparisons to address the immediate effects of the wildfire:

- 2008 burned vs. unburned chestnut oak forest
- 2008 burned vs. unburned pitch pine-oak-heath rocky summit

To address changes over the two years since the wildfire, I made the following comparisons:

- 2008 burned vs. 2010 burned chestnut oak forest
- 2008 burned vs. 2010 burned pitch pine-oak-heath rocky summit
- 2010 burned chestnut oak forest vs. 2010 burned open woodland

In addition, I have avoided the use of sophisticated multivariate analyses that might lend themselves to these analyses. My goal has been to produce a report that describes the effects of the wildfire and that provides information that can be used for other studies and for conservation planning. I have provided many tables summarizing results which may be a bit hard to wade through but which I hope will serve useful in the long run.

II. Vegetation Data Analysis

Within the 10 m circular plot, we estimated cover by species to the nearest 5%, or recorded 1% for species with less than 5% cover. Cover by species was recorded in each of the following strata:

T1	Emergent tree
T2	Canopy
T3	Subcanopy
S1	Tall shrub layer 2-5 m
S2	Short shrub layer <2m
H	Herbaceous layer
V	Vines
N	Nonvascular

There was very little cover of vegetation in the T1, H, V or N strata, so I focused my attention on the T2, T3, S1 and S2 layers.

A. Tree Data

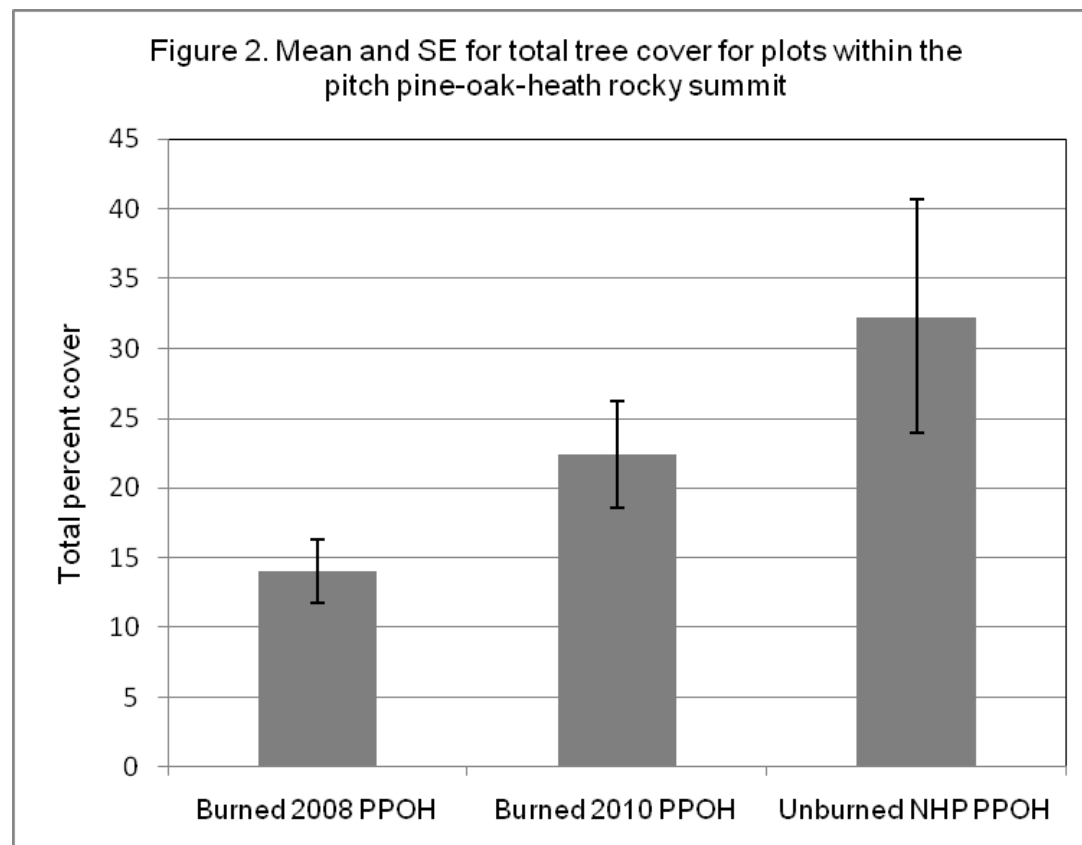
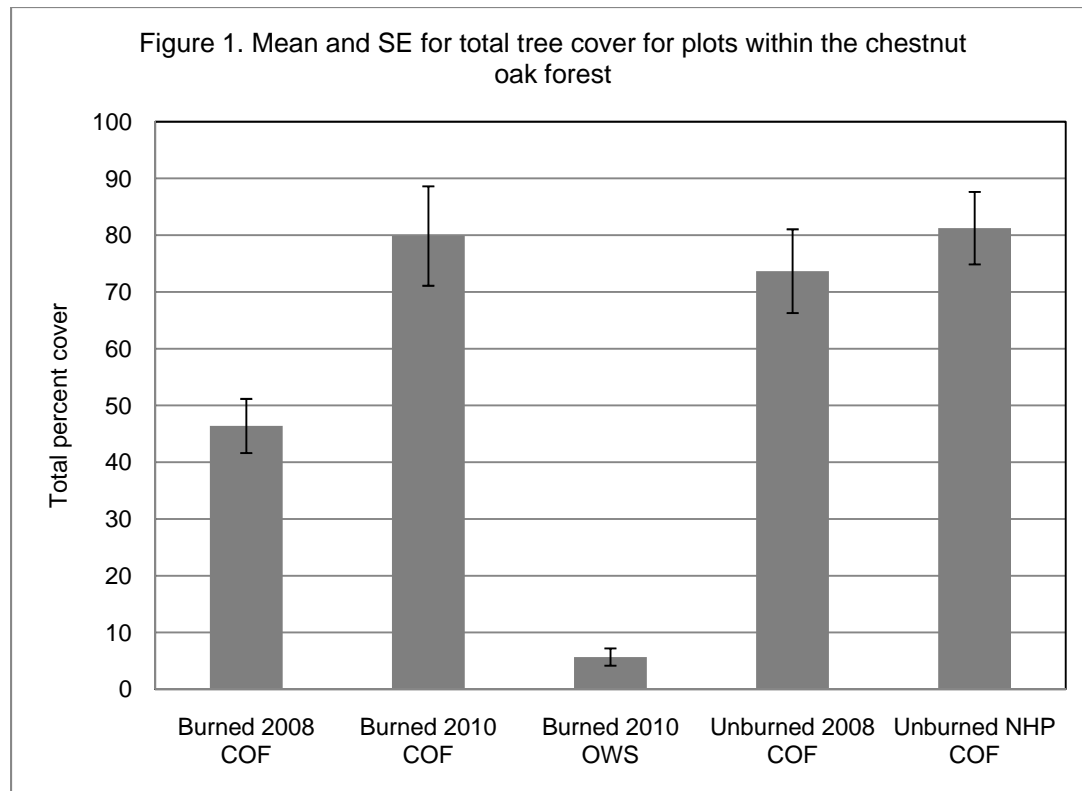
1. Total Canopy Cover

I totaled estimated cover from the three canopy categories (T1, T2, T3) from the Overlooks and NHP plots to contrast differences between burned and unburned areas and changes since 2008. Figure 1 shows the mean and standard error for total tree cover for the chestnut oak forest plot categories. I have not performed statistical comparisons, but the following seem clear:

- In 2008, the wildfire had the immediate effect of reducing total canopy cover well below the mean of unburned plots from this study and NHP data.
- There is a distinct difference between plots designated as forest (COF) vs. open woodland (OWS) in 2010 data. These open woodland areas were not apparent in 2008.
- In 2010, total tree cover of the burned chestnut oak forest, excluding open woodland plots, was similar to that of unburned plots indicating substantial recovery.

Figure 2 contrasts data from the pitch pine-oak-heath rocky summit. The following comparisons are noteworthy:

- Total tree cover in burned areas in 2008 was distinctly lower than unburned NHP plots.
- There has been substantial recovery of tree cover in the burned area since 2008.



2. Analyses of Tree Density and Basal Area

We used the point-center quarter method to measure data on the nearest tree to the plot center in each quadrant. We also measured tree height, scorch height and other characteristics for each of these four trees. Methods of determining tree density and basal area for the point-center quarter method are from Mueller-Dombois (2002). Methods for fixed area plots are from Husch et al. (2003). The number of trees and their size are used to calculate basal area, which is a measure of dominance. By calculating the relative frequency, relative density and relative dominance and summing those values, I calculated the importance value for each species. Appendix I contains tables of these calculations.

Table 4 provides the overall tree density, the density of individual species, their basal area and importance values for data collected in 2008 from burned vs. unburned chestnut oak forest plots, unburned NHP plots and data from the Undercliff treatment unit (Batcher 2011). While that data was taken after the 2010 prescribed fire, there was very little mortality from that burn, so I believe it can be used for comparison purposes.

In 2008 in the burned chestnut oak forest plots, red maple (*Acer rubrum*) and chestnut oak (*Quercus montana*) received the highest importance values. In the unburned area, red maple far exceeded any other species, which indicates that this area was substantially different from the burn area in composition, though with the limited number of plots (18) we may not have adequately sampled the area. The limited number of NHP plots show a higher tree density but similar importance values. Finally, the Undercliff unit showed lower values for red maple and higher values for both red oak and chestnut oak. Clearly, red maple is a dominant tree in the chestnut oak forest in the Shawangunks, though there are areas, as characterized by the Undercliff unit, where red maple abundance is more moderate.

Table 5 repeats the data for the 2008 burned plots along with data from within the burned area collected in 2010. Tree density was to 66.2/ha compared to 487.7 in 2008. Separating out those plots field crews designated as forested results in a density of 244.0/ha in forested areas, which is still a large difference. Tree basal area was slightly higher for red maple, relatively the same for red oak and substantially less for chestnut oak in 2010 plots than 2008 plots

Importance values are typically calculated to compare stands. However, they are based on summing relative values of frequency, dominance (based on basal area) and density of species. So, if the value of one species goes down, that of another will increase, even if density and basal area remain the same for that species. The importance values for chestnut oak is similar between 2008 to 2010 plots and across open woodland and forested types. Red maple and red oak importance is highest in forested areas of the burned chestnut oak forest in 2010.

Assuming the open woodlands had been subject to higher intensity fire than the forested areas, it would appear that, after two years, oaks in those areas had a higher survival rate than red maple or other species. The high importance value of pitch pine (*Pinus rigida*) in the open woodland, which resulted in a higher value overall, is also noteworthy. I think it likely that pitch pine was abundant in the areas where these woodlands formed to begin with, indicating. It is also possible that the low importance value of red maple indicates lower abundance in the open woodlands than forested areas as well. Both of these factors would indicate that there may be other differences between areas where open woodlands formed and forests remained intact than fire behavior, or that the pre-fire vegetation of those areas fostered higher intensity fire. Pitch pine abundance in these open woodlands could signal a shift to a more pitch pine dominated community.

Table 4. Comparison of tree data for burned vs. unburned chestnut oak forest plots												
	Chestnut oak forest Burned 2008 N=54			Chestnut Oak Forest Unburned (2008) N=18			Chestnut Oak forest Unburned NHP Plots N=7			Undercliff Rx Burned (2010) N=16		
Tree Species	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance
<i>Acer pensylvanica</i>	0.0	0.0	0.0	8.0	0.1	5.0	0.0	0.0	0.0	0	0	0
<i>Acer rubrum</i>	173.8	3.5	85.0	353.3	8.4	152.6	192.9	3.8	95.8	62.5	0.6	41.9
<i>Amelanchier sp.</i>	4.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
<i>Betula lenta</i>	2.3	0.0	1.3	8.0	0.7	8.0	0.0	0.0	0.0	10.9	0.1	13.0
<i>Betula papyrifera</i>	11.3	0.5	6.5	16.1	0.3	10.2	0.0	0.0	0.0	0	0	0
<i>Betula populifolia</i>	13.5	0.2	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
<i>Carya sp.</i>	0.0	0.0	0.0	0.0	0.0	0.0	10.7	0.1	16.8	17.2	0.1	10.1
<i>Castanea dentata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	4.0
<i>Nyssa sylvatica</i>	20.3	0.6	13.7	0.0	0.0	0.0	0.0	0.0	0.0	17.2	0.2	13.7
<i>Pinus rigida</i>	9.0	0.6	7.9	24.1	2.4	23.2	0.0	0.0	0.0	0	0	0
<i>Pinus strobus</i>	2.3	0.1	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0
<i>Quercus montana</i>	137.7	8.4	97.6	24.1	1.0	18.0	146.4	5.3	83.3	101.6	4.8	90.6
<i>Quercus rubra</i>	45.2	3.8	40.9	80.3	4.3	57.3	200.0	6.0	104.4	168.8	5.9	116.9
<i>Sassafras albidum</i>	61.0	1.1	31.2	64.2	1.2	26.1	0.0	0.0	0.0	0	0	0
<i>Tsuga canadensis</i>	6.8	0.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.1	9.8
Tree Density	487.7			578.2			550.0			392.2		

Table 5. Comparison of chestnut oak forest and open woodland plots as described within the Overlooks wildfire area from 2010 data												
	Chestnut oak forest Burned 2008 N=54			Chestnut Oak Forest Burned (2010) Including Open Woodland N=36			Chestnut Oak Forest Burned Excluding Open Woodland 2010 N=14			Chestnut Oak Forest Open Woodland Burned (2010) N=22		
Tree Species	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance
<i>Acer pensylvanica</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Acer rubrum</i>	173.8	3.5	85.0	13.8	0.5	52.7	113.3	4.0	112.6	1.8	0.0	15.3
<i>Amelanchier sp.</i>	4.5	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula lenta</i>	2.3	0.0	1.3	0.5	0.1	3.4	4.4	0.6	9.1	0.0	0.0	0.0
<i>Betula papyrifera</i>	11.3	0.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula populifolia</i>	13.5	0.2	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Carya sp.</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Castanea dentata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nyssa sylvatica</i>	20.3	0.6	13.7	4.6	0.3	20.7	13.1	0.7	16.5	3.1	0.2	23.5
<i>Pinus rigida</i>	9.0	0.6	7.9	18.8	1.5	82.1	0.0	0.0	0.0	18.1	1.4	132.8
<i>Pinus strobus</i>	2.3	0.1	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Quercus montana</i>	137.7	8.4	97.6	21.1	1.8	105.1	61.0	4.9	91.3	14.1	1.2	114.0
<i>Quercus rubra</i>	45.2	3.8	40.9	5.1	0.5	27.6	43.6	3.8	63.2	0.4	0.1	6.1
<i>Sassafras albidum</i>	61.0	1.1	31.2	2.3	0.0	8.4	8.7	0.1	7.4	1.3	0.0	9.2
<i>Tsuga canadensis</i>	6.8	0.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tree Density	487.7			66.2			244.0			38.9		

Based on 2008 data, the pitch pine-oak-heath rocky summit in the burned area had a higher tree density than in NHP plots in unburned areas. As with the chestnut oak forest, this is a highly variable community. Based on 2010 data, that density was 273.7 trees/ha compared to from 732.8 trees/ha in 2008. Again, this community likely experienced high intensity fire. Red maple density and importance value were lower in 2010 plots than in 2008 plots.

	Pitch Pine-Oak-Heath Burned 2008 N=21			NHP Pitch Pine-Oak-Heath Unburned N=6			Pitch Pine-Oak-Heath Burned 2010 N=10		
Tree Species	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance	#Trees/Ha	BA/Ha (m2/ha)	Importance
<i>Acer pensylvanica</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Acer rubrum</i>	52.3	1.0	23.0	28.6	0.3	25.1	6.8	0.2	11.4
<i>Amelanchier</i> sp.	17.4	0.4	6.8	4.8	0.1	6.6	0.0	0.0	0.0
<i>Betula lenta</i>	0.0	0.0	0.0	9.5	0.1	13.3	0.0	0.0	0.0
<i>Betula papyrifera</i>	8.7	0.3	5.2	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula populifolia</i>	0.0	0.0	0.0	4.8	0.0	6.6	0.0	0.0	0.0
<i>Carya</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nyssa sylvatica</i>	8.7	0.0	4.1	0.0	0.0	0.0	6.8	0.3	11.9
<i>Pinus rigida</i>	506.0	16.9	187.4	276.2	6.7	158.0	246.3	12.9	252.5
<i>Pinus strobus</i>	8.7	0.5	6.1	9.5	0.3	10.0	0.0	0.0	0.0
<i>Quercus montana</i>	8.7	1.7	10.8	33.3	1.6	37.3	6.8	0.6	13.7
<i>Quercus rubra</i>	17.4	1.9	16.0	9.5	0.4	10.8	0.0	0.0	0.0
<i>Sassafras albidum</i>	96.0	2.0	35.9	19.0	0.3	12.3	6.8	0.1	10.7
<i>Tsuga canadensis</i>	8.7	0.1	4.7	19.0	1.2	20.2	0.0	0.0	0.0
Tree Density	732.8			414.3			273.7		

3. Saplings and Seedlings

Seedlings and saplings were counted in each of three 2x5 m transects in each plot. Totals are provided in Table 7 below, while Table 8 provides density by species.

	Saplings				Seedlings			
	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine- oak-heath	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine- oak-heath
<i>Acer rubrum</i>	26	10	36	1	466	2,018	2,484	542
<i>Amelanchier</i> sp.								8
<i>Betula populifolia</i>	2		2	5	114		114	9
<i>Betula</i> sp.	1		1		49		49	5
<i>Castanea dentata</i>		1	1		3		3	
<i>Liriodendron tulipifera</i>						186	186	1
<i>Nyssa sylvatica</i>					14	47	61	22
<i>Pinus rigida</i>					10		10	15

Table 7. Total numbers of saplings and seedlings by community type within the Overlooks wildfire area in 2010. Note that Total Chestnut Oak=Open Woodland + Chestnut Oak.								
	Saplings				Seedlings			
	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine-oak-heath	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine-oak-heath
<i>Pinus sp.</i>					4	1	5	
<i>Pinus strobus</i>					7	15	22	1
<i>Populus sp.</i>					2		2	
<i>Populus tremuloides</i>					4		4	
<i>Prunus sp.</i>					3	1	4	
<i>Quercus montana</i>	3		3		21	104	125	
<i>Quercus rubra</i>	3	1	4		4	57	61	1
<i>Sassafras albidum</i>	79	8	87	1	5,690	860	6,550	286
Grand Total	114	20	134	7	6,391	3,289	9,680	890
Total Saplings=141					Total Seedlings=10,570			

As can be clearly seen, the number of red maple and sassafras (*Sassafras albidum*) far exceeds that of other species. Of the 10,570 seedlings counted across the burn area, red maple constituted 28.6% and sassafras 64.7% of the total. Of the 141 saplings counted, red maple constituted 26.2% and sassafras 62.4% of that total.

Table 8. Density (number/ha) of saplings and seedlings by community type within the Overlooks wildfire area in 2010								
	Saplings				Seedlings			
	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine-oak-heath	Open Woodland	Chestnut oak	Total Chestnut oak	Pitch pine-oak-heath
<i>Acer rubrum</i>	393.9	238.1	333.3	33.3	7,060.6	48,047.6	23,000.0	18,066.7
<i>Amelanchier sp.</i>	-	-	-	-	-	-	-	266.7
<i>Betula populifolia</i>	30.3	-	18.5	166.7	1,727.3	-	1,055.6	300.0
<i>Betula sp.</i>	15.2	-	9.3	-	742.4	-	453.7	166.7
<i>Castanea dentata</i>	-	23.8	9.3	-	45.5	-	27.8	-
<i>Liriodendron tulipifera</i>	-	-	-	-	-	4,428.6	1,722.2	33.3
<i>Nyssa sylvatica</i>	-	-	-	-	212.1	1,119.0	564.8	733.3
<i>Pinus rigida</i>	-	-	-	-	151.5	-	92.6	500.0
<i>Pinus sp.</i>	-	-	-	-	60.6	23.8	46.3	-
<i>Pinus strobus</i>	-	-	-	-	106.1	357.1	203.7	33.3
<i>Populus sp.</i>	-	-	-	-	30.3	-	18.5	-
<i>Populus tremuloides</i>	-	-	-	-	60.6	-	37.0	-
<i>Prunus sp.</i>	-	-	-	-	45.5	23.8	37.0	-
<i>Quercus montana</i>	45.5	-	27.8	-	318.2	2,476.2	1,157.4	-
<i>Quercus rubra</i>	45.5	23.8	37.0	-	60.6	1,357.1	564.8	33.3
<i>Sassafras albidum</i>	1,197.0	190.5	805.6	33.3	86,212.1	20,476.2	60,648.1	9,533.3
Total Density by Type	1,727.3	476.2	1,240.7	233.3	96,833.3	78,309.5	89,629.6	29,666.7
Total Density				1,474.07				119,296.30

In the Undercliff treatment unit, seedling densities across plots ranged from 5,333 to 18,416/ha prior to the 2010 burn and 7,666 to 31,250/ha following that burn.

Based on density, red maple and Sassafras saplings were more abundant in the open woodland areas likely due to the additional light in the open woodland

encouraging rapid regrowth. In the chestnut oak forest, red maple constituted 50.0% and sassafras 40.0% of saplings. In open woodlands, these proportions were 22.8% for red maple and 69.3% for sassafras.

Red maple, black gum, tulip poplar, white pines and oak seedlings were more abundant within forested areas than open woodlands. Sassafras seedlings were more abundant within open woodlands. In chestnut oak forest plots, red maple constituted 61.4% and sassafras 26.1% of seedlings. In open woodland plots, these proportions were 7.3% for red maple and 89.0% for sassafras. In the pitch pine-oak-heath rocky summit, red maple constituted 60.9% of all seedlings while sassafras constituted 32.1% for sassafras.

We also categorized seedlings and saplings as single stemmed, multiple stemmed, resprouts (from an existing seedling or sapling) or resprouts from a tree. These data are summarized in Appendix II. The great majority of seedlings were single-stemmed, which may indicate that seed germination was a primary source for recruitment after the wildfire.

4. Tree Resprouts

Table 9 shows the proportion of the total number of trees of each species measured with resprouts for the burned and unburned areas in both 2008 and 2010. Only one tree (a red maple) had a resprout in the unburned area. Red maple, sassafras, and black gum showed high proportions, though in all cases, the number of trees with resprouts was generally low. Both oaks and pitch pine have the ability to resprout following disturbance, which is an important source of recruitment. The decline in the number of resprouts from 2008 to 2010 in both the chestnut oak forest and pitch pine-oak-heath rocky summit may have resulted from trees and resprouts dying over the two years following the fire.

Table 9. Proportion of trees by species with resprouts measured in 2008 and 2010. Numbers in parentheses are the number of trees of that species with resprouts. Species indicated as NA were not found in that community in that year; those marked with NR were not recorded.							
	2008			2010			
Species measured	Unburned Chestnut Oak Forest N=72	Burned Chestnut Oak Forest N=195 ⁴	Pitch Pine-Oak-Heath N=76 ⁵	Open Woodland N=88	Chestnut Oak Forest N=56	All Chestnut Oak Forest N=144	Pitch Pine-Oak-Heath N=40
<i>Acer pensylvanicum</i>	0.0	NA	NA	NA	NA	NA	NA
<i>Acer rubrum</i>	2.3 (1)	44.8 (30)	66.7 (4)	50.0 (2)	46.2 (12)	46.7 (14)	0.0
<i>Amelanchier</i> sp.	NA	100.0 (2)	100.0 (2)	NA	NA	NA	NA
<i>Betula lenta</i>	0.0	0.0	NA	NA	0.0	0.0	NA

⁴ Resprouts were not recorded as absent or present on 21 trees

⁵ Resprouts were not recorded as absent or present on 8 trees

Table 9. Proportion of trees by species with resprouts measured in 2008 and 2010. Numbers in parentheses are the number of trees of that species with resprouts. Species indicated as NA were not found in that community in that year; those marked with NR were not recorded.							
	2008			2010			
Species measured	Unburned Chestnut Oak Forest N=72	Burned Chestnut Oak Forest N=195 ⁴	Pitch Pine-Oak-Heath N=76 ⁵	Open Woodland N=88	Chestnut Oak Forest N=56	All Chestnut Oak Forest N=144	Pitch Pine-Oak-Heath N=40
<i>Betula papyrifera</i>	0.0	0.0	0.0	NA	NA	NA	NA
<i>Betula populifolia</i>	NA	33.3 (2)	NA	NA	NA	NA	NA
<i>Nyssa sylvatica</i>	NA	0.0	0.0	85.7 (6)	0.0	60.0 (6)	0.0
<i>Pinus rigida</i>	0.0	0.0	12.7 (7)	4.9 (2)	NA	4.9 (2)	8.3 (3)
<i>Pinus strobus</i>	NA	0.0	0.0	NA	NA	NA	NA
<i>Quercus montana</i>	0.0	25.0 (15)	0.0	21.9 (7)	0.0	15.2 (7)	0.0
<i>Quercus rubra</i>	0.0	41.2 (7)	0.0	100.0 (1)	20.0 (2)	27.3 (3)	NA
<i>Sassafras albidum</i>	0.0	68.0 (17)	33.3 (3)	0.0	0.0	0.0	100 (1)
<i>Tsuga canadensis</i>	NA	NR	NR	NA	NA	NA	NA
Total	1.4 (1)	37.4 (73)	21.1 (16)	20.5 (18)	25.0 (14)	22.2 (32)	10.0 (4)

B. Shrub Cover

1. Chestnut Oak Forest

We estimated cover by species for shrubs within the S1 (2-5 m in height) and S2 (< 2 m in height). I totaled the species cover values for each plot to arrive at a cover for each stratum. Unfortunately, the data were not normally distributed and transformations had little effect. Figures 3 and 4 show a large difference between unburned plots vs. other plot categories for mean cover for both the S1 and S2 shrub strata. Interestingly, the average total cover of the S1 strata for burned plots in 2010 in all categories is less than found in 2008 burned plots. There may have been some dieback in this stratum, or the plots were simply different in shrub cover. For the S2 layer, the total shrub cover for burned areas is higher in 2010 than was found in 2008.

Table 10 shows the results of nonparametric tests of these differences. For the S1 layer, only unburned S1 cover was significantly higher than burned S1 cover. Otherwise, the different chestnut oak cover types are similar with respect to the S1 layer. For the S2 layer, cover in 2008 burned plots was significantly lower than unburned plots and 2010 burned plots. This is likely due to recovery of the S2 layer between 2008 and 2010.

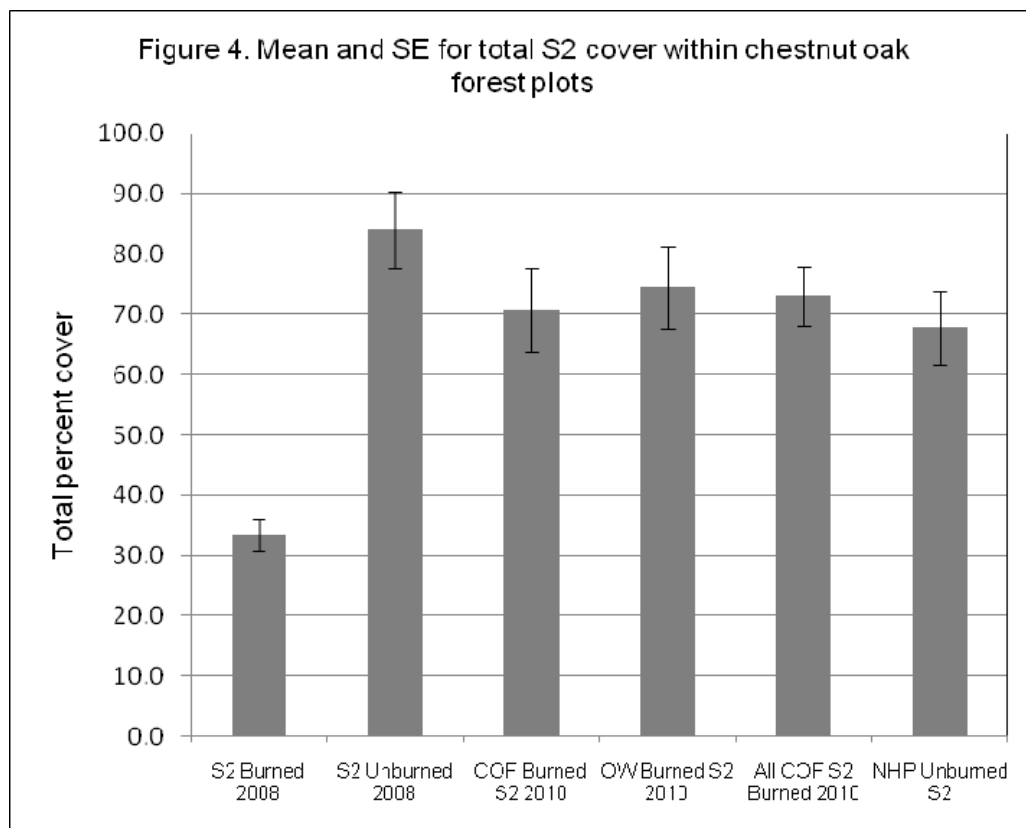
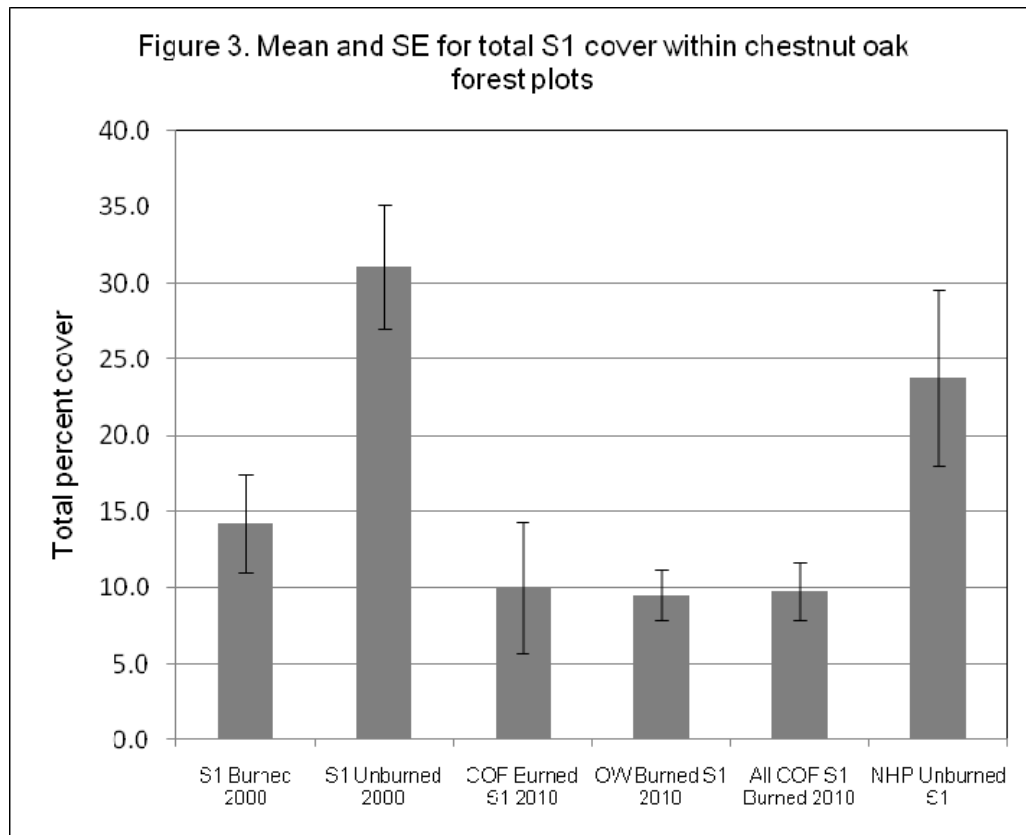


Table 10. Comparisons of total shrub cover in the tall shrub (S1) and short shrub (S2) strata for the chestnut oak forest. Comparisons are between 1) plots in burned vs. unburned plots from 2008 data, 2) chestnut oak forest (COF) vs. open woodland (OW) in 2010, 3) burned COF in 2008 vs. 2010 excluding open woodland plots and 4) burned COF 2008 vs. all 2010 COF plots. Comparisons with $p < 0.05$ are in **bold**.

	Mean Burned	Mean Unburned	SD Burned	SD Unburned	N Burned	N Unburned	Kruskal-Wallis Test Statistic	p
S1 2008 Burned vs. Unburned COF	14.2	31.1	23.2	17.5	54	18	14.469	0.000 (df=1)
S2 2008 Burned vs. Unburned COF	33.4	84.1	19.6	27.4	54	18	30.565	0.000 (df=1)
	Mean Burned	Mean NHP	SD Burned	SD NHP	N Burned	N NHP		
S1 Burned 2008 vs. NHP Unburned	14.2	23.8	23.2	26.1	54	20	4.903	0.027 (df=1)
S2 Burned 2008 vs. NHP Unburned	33.4	67.8	19.6	27.1	54	20	20.409	0.000 (df=1)
	Mean COF	Mean OW	SD COF	SD OW	N COF	N OW		
S1 2010 Burned COF vs. OW	10.0	9.5	16.1	8.1	14	22	0.288	0.591 (df=1)
S2 2010 Burned COF vs. OW	70.8	74.5	26.2	31.7	14	22	2.586	0.108 (df=1)
	Mean 2008	Mean 2010	SD 2008	SD 2010	N 2008	N 2010		
S1 2008 Burned COF vs. 2010 Burned COF	14.2	10.0	23.2	16.1	54	14	1.473	0.225 (df=1)
S2 2008 Burned COF vs. 2010 Burned COF	33.4	70.8	19.6	26.2	54	14	18.830	0.000 (df=1)
	Mean 2008	Mean 2010	SD 2008	SD 2010	N 2008	N 2010		
S1 2008 Burned COF vs. All 2010 Burned COF	14.2	9.7	23.2	11.7	54	36	3.457	0.063 (df=1)
S2 2008 Burned COF vs. 2010 All Burned COF	33.4	73.1	19.6	29.3	54	36	37.464	0.000 (df=1)

2. Pitch Pine-Oak-Heath Rocky Summit

As with the chestnut oak forest, I compared plots from 2008 vs. 2010 in the burned area for the S1 and S2 strata as well as with data from the Natural Heritage Program. Again, the data were not normally distributed, and transformation did not help. Figure 5 graphically shows these comparisons, while nonparametric analyses are summarized in Table 11. The differences between the S1 layer cover in both 2008 and in 2010 vs. NHP data (unburned) was significant. Apparently S2 cover in the burned area was higher than that for the NHP plots. Little recovery in either the S1 or S2 strata seems to have occurred between 2008 and 2010.

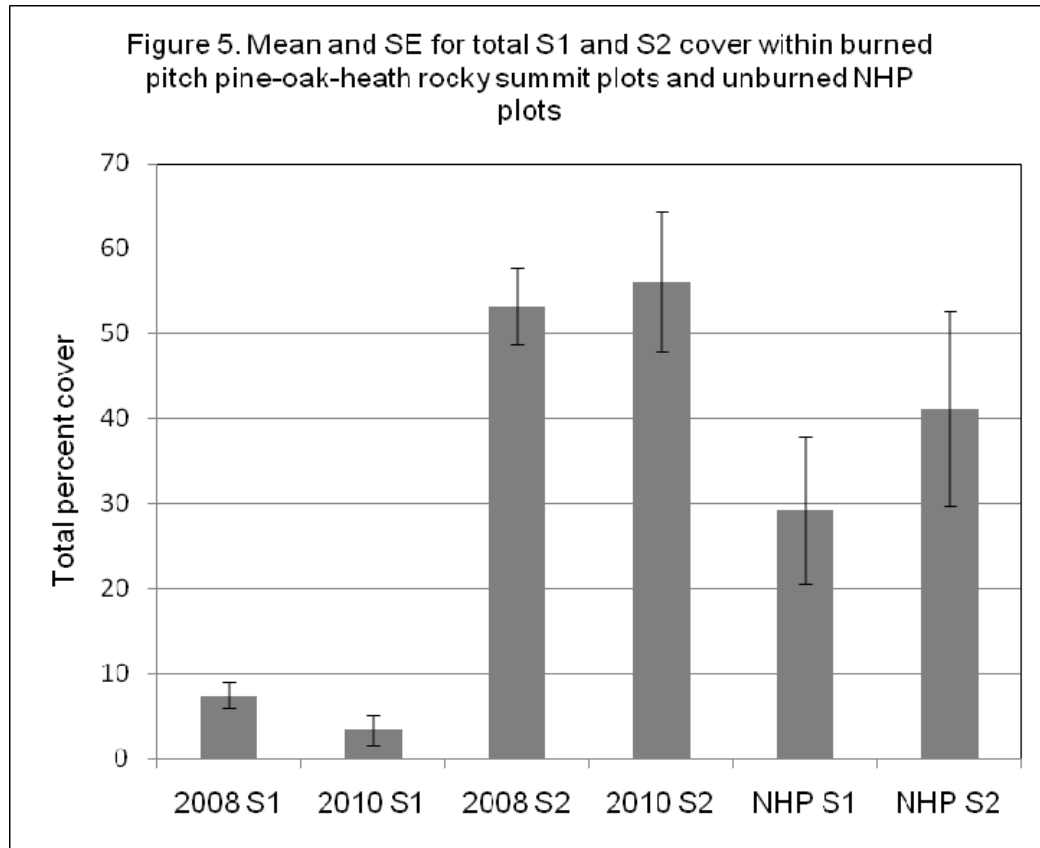


Table 11. Comparisons of total shrub cover in the tall shrub (S1) and short shrub (S2) strata for the pitch pine-oak-heath rocky summit. Comparisons are between 1) plots in burned areas in 2008 vs. 2010, 2) plots in burned areas in 2008 vs. unburned NHP plots and 3) plots in burned areas in 2010 vs. unburned NHP plots. Comparisons with $p < 0.05$ are in **bold**.

	Mean 2008	Mean 2010	SD 2008	SD 2010	N 2008	N 2010	Kruskal-Wallis Test Statistic	p
PPOH 2008 S1 vs. 2010 S1	4.6	6.1	7.1	5.3	21	10	2.784	0.095
PPOH 2008 S2 vs. 2010 S2	49.0	25.8	20.6	8.2	21	10	3.382	0.066
	Mean NHP	Mean 2008	SD NHP	SD 2008	NNHP	N 2008	Kruskal-Wallis Test Statistic	p
NHP S1 vs. 2008 S1	29.2	4.6	31.2	7.1	13	21	10.110	0.001
NHP S2 vs. 2008 S2	64.3	49.0	41.2	20.6	13	21	0.818	0.366
	Mean NHP	Mean 2010	SD NHP	SD 2010	NNHP	N 2010	Kruskal-Wallis Test Statistic	p
NHP S1 vs. 2010 S1	29.2	6.1	31.2	5.3	13	10	4.862	0.027
NHP S2 vs. 2010 S2	64.3	25.8	41.2	8.2	13	10	0.004	0.951

C. Fire Effects

1. FireMon

Each plot was characterized using a modified version of the FireMon methodology (Lutes et al 2006). Appendix III contains a table of these categories, which assess the degree that fire affects the surface, herbaceous, shrub and canopy layers. We made some modifications to incorporate the same strata we used for cover estimates, though we combined the canopy strata and shrub strata into one strata each. Map 2 shows the sum of the values given to fire effects in the T2, T3, S1, S2 and surface layers for each plot. Since the fire occurred before herbaceous vegetation emerged, there was no burned herbaceous vegetation in any plots. Higher numbers indicate greater fire effects (see Appendix III). The maximum possible value is 25 and the minimum 5. Unburned plots were given values of 0. We did not record FireMon data in 2010. Chestnut oak, open woodland and pitch pine-oak-heath rocky summit plots are each symbolized on Maps 2 and 3.

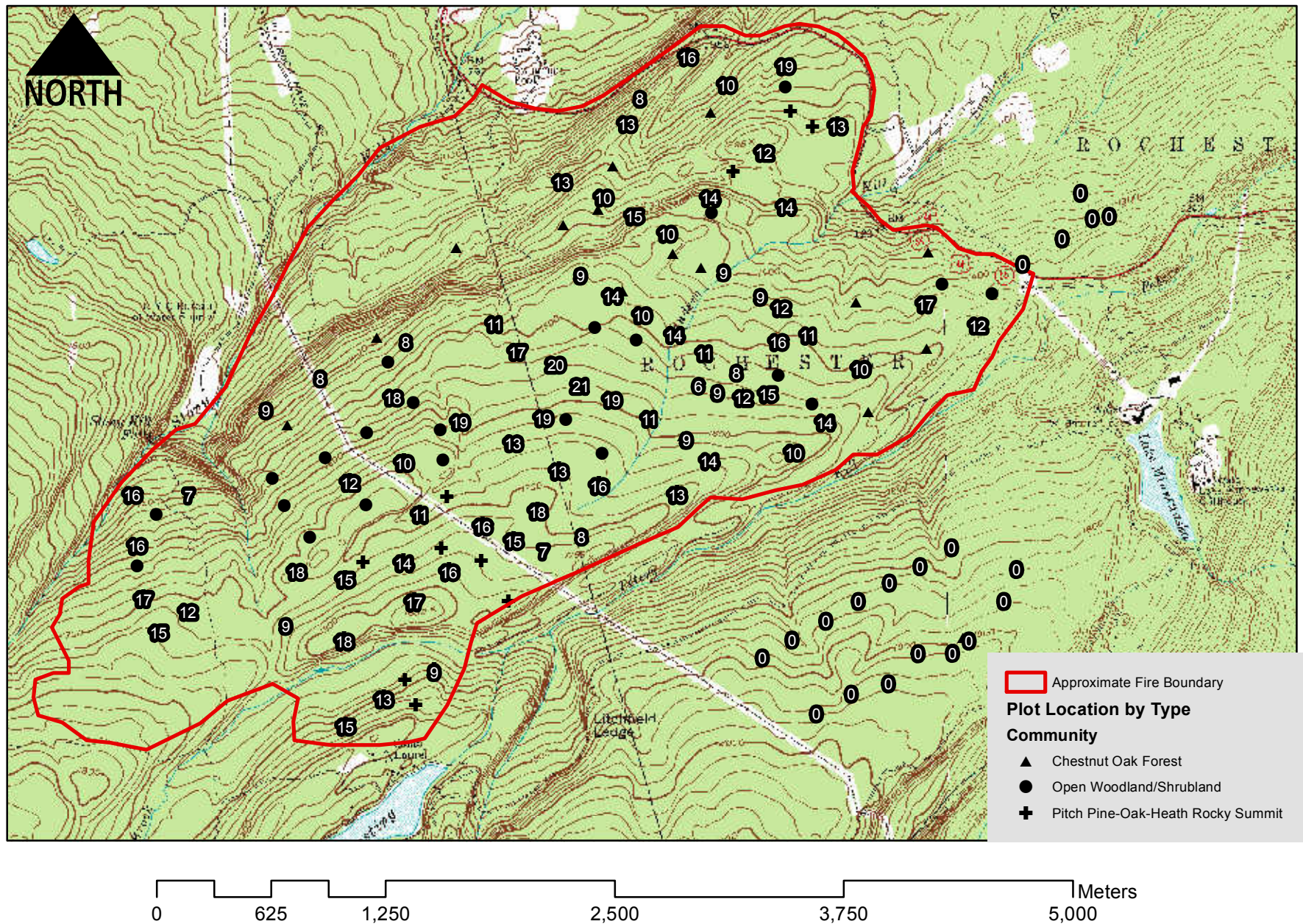
The fire was moving from northeast to southwest until the winds shifted (Gabe Chapin, personal communication). The northern and southern lines represent flanks, and values are somewhat lower there. Plots to the east probably burned earlier in the fire than those to the west. In the field, it appears that the fire burned down the western and northern slopes, which would have resulted in relatively low intensity fire. Map 2 seems to show a high degree of variability, with higher values along the more gently sloping areas in the south-central portion of the fire and lower values along the flanks. On Maps 2 and 3, 2010 forested plots are shown with a triangle and open woodlands with a circle. It would appear that forested plots are more closely associated with the western slopes and near plots with lower FireMon scores. Map 3 shows the data over vegetation types. Some of the higher values correspond with pitch pine-oak-heath rocky summit, which likely burned with greater intensity than the chestnut oak forest.

We also assessed fire effects by estimating scorch height, making a surface cover estimates of litter, duff, soil, rock, and wood cover in two size classes and other means. An entire report could be written on these data, but I am focusing on scorch height and litter and duff cover as these are the most important and commonly used measures of fire effects.

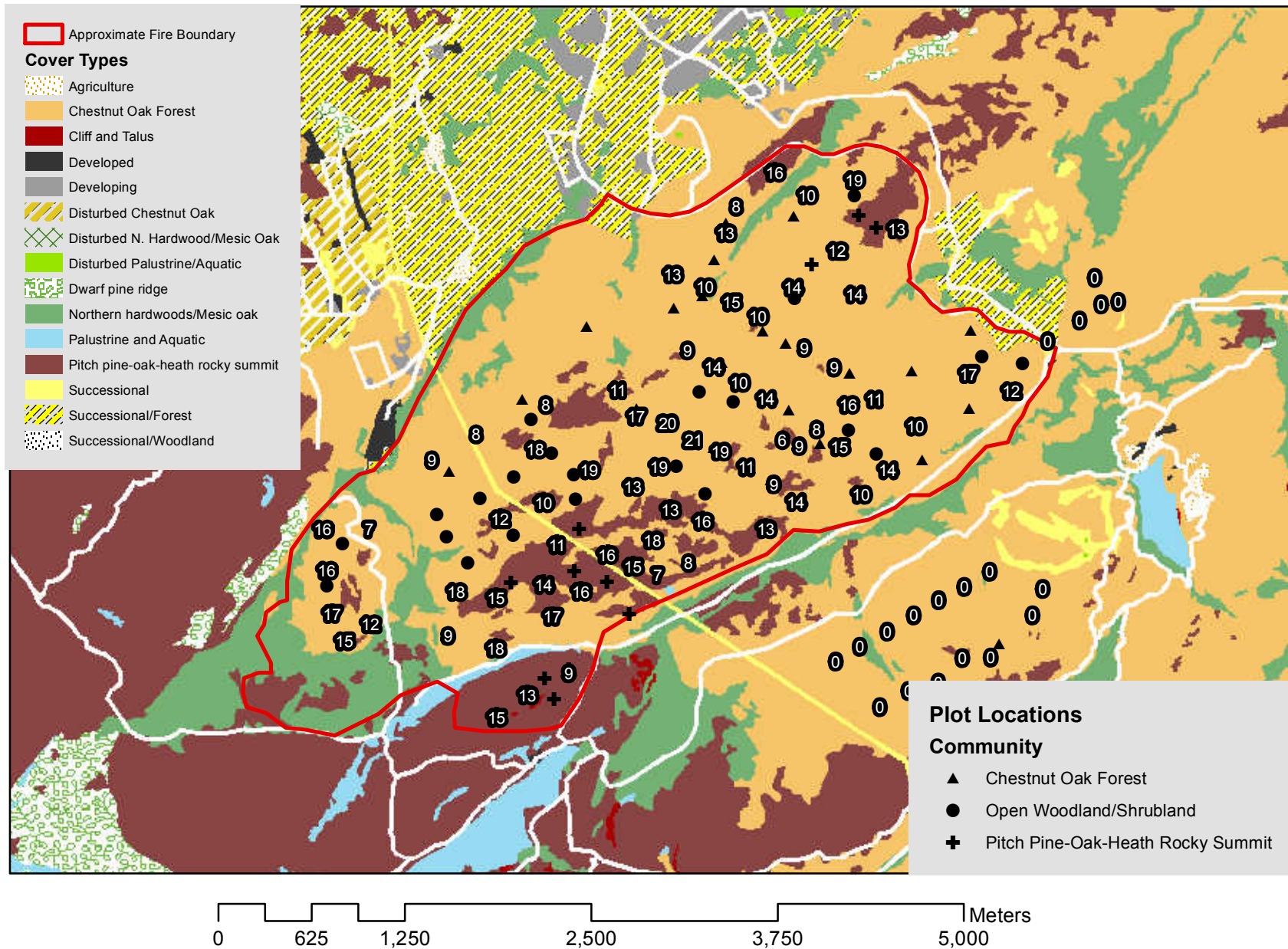
2. Scorch Height

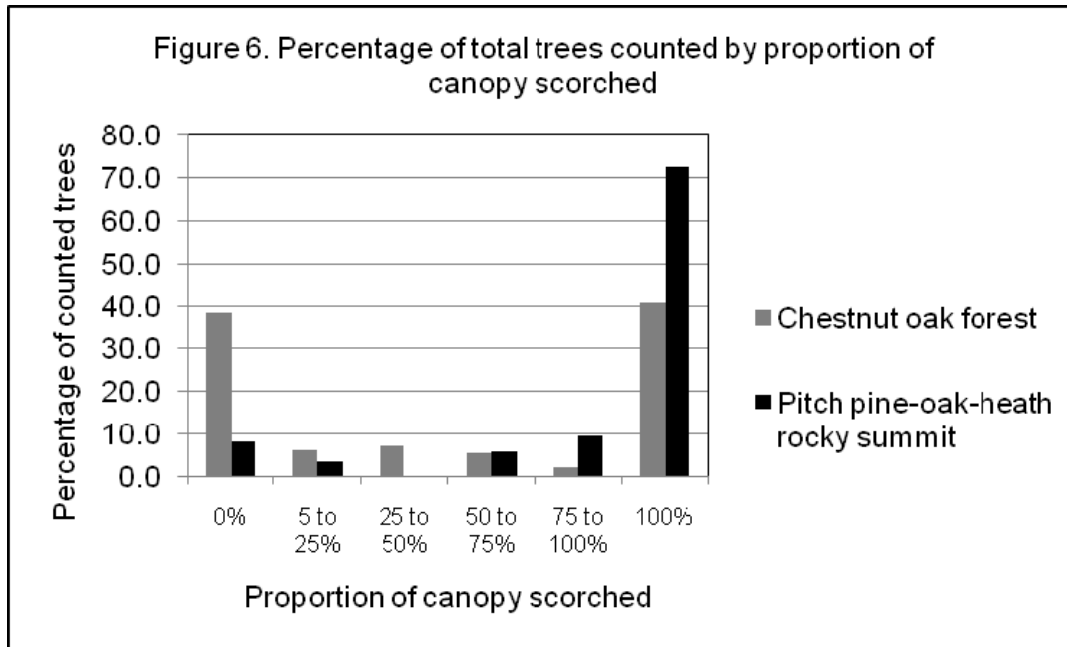
We estimated scorch height, the height of the tree and height of the canopy base. This allowed for a calculation of the proportion of the canopy scorched. Figure 6 provides counts of the number of trees by proportion of canopy scorched for the chestnut oak forest and pitch pine-oak-heath rocky summit.

Map 2. FireMon Total Score and Plots by Type



Map 3. FireMon Total Scores, Plot Locationa and Cover Types





For the chestnut oak forest, there were large numbers of trees where the proportion of the crown scorched was zero as well as where it exceeded 90%. Otherwise, the number of trees scorched by proportions in between was fairly even, and the count of these relatively low. This indicates that some areas were subject to very intense fire behavior, others to low intensity and others to highly varying degrees of intensity. This supports the theory that these differences in fire behavior account for areas of open woodlands vs. areas of chestnut oak forest within the burned area. For the pitch pine-oak-heath rocky summit, most trees had greater than 90% of their crowns scorched, indicating that this community generally was subject to high intensity fire during the Overlooks wildfire.

2. Surface Cover

Those on the fire observed extreme fire behavior exhibited by large flame lengths and rapid spread. At the same time, they observed little long-term smoldering (Gabe Chapin, personal communication). Table 12 provides counts and proportions of the various surface cover types we measured. Litter and duff were encountered in a high proportion of observations, except for duff in the unburned forest. Other categories varied widely. This high degree of variation makes statistical analyses rather difficult, so I focused on litter and duff in the chestnut oak forest. Litter will be consumed in any forest fire. Severe fires are those that consume litter revealing the underlying duff layers. Very severe fires will burn this duff down to soil.

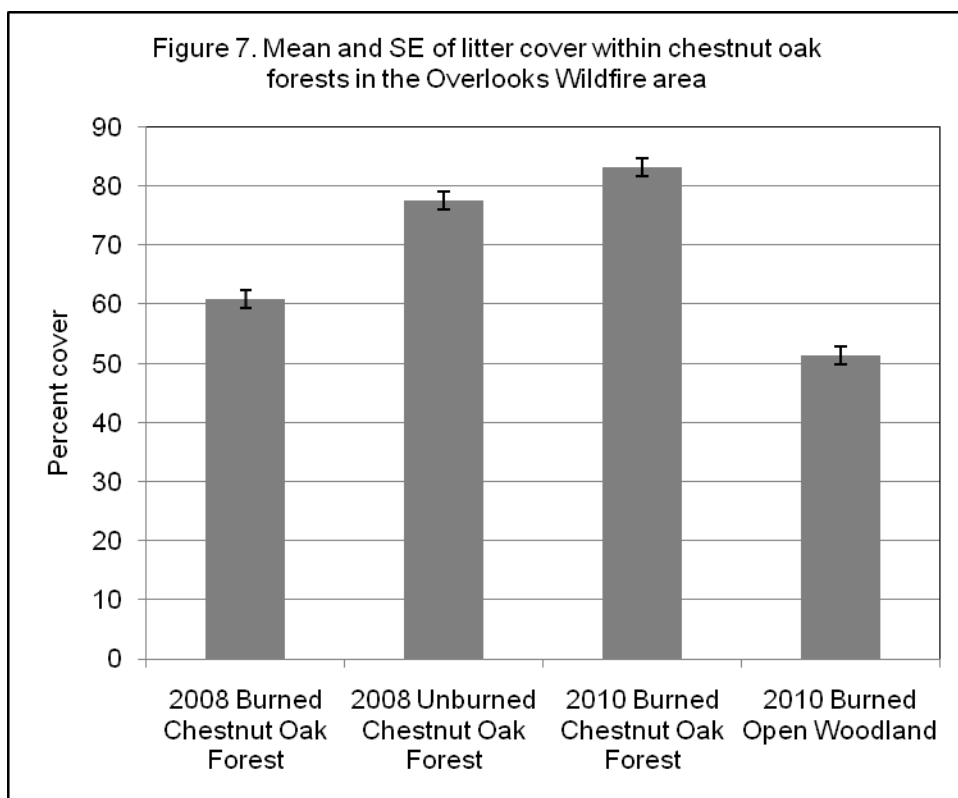
Table 12. Count of observations containing specified cover types. Proportions of total observations in parentheses.										
Type	Status	Year	N	Litter	Duff	Soil	Rock	Wood< 10cm	Wood> 10cm	Total Wood
Chestnut oak forest	Burned	2008	245	245 (100)	229 (93.5)	13 (0.05)	46 (18.7)	240 (97.9)	65 (26.5)	244 (99.6)
Chestnut oak forest	Unburned	2008	90	90 (100)	4 (0.04)	1 (0.01)	12 (13.3)	89 (98.8)	25 (27.7)	90 (100)
All Chestnut oak forest	Burned	2010	180	180 (100)	163 (90.5)	49 (27.2)	34 (18.9)	180 (100)	32 (17.8)	180 (100)
Open woodland	Burned	2010	110	110 (100)	109 (99.1)	33 (30.0)	18 (16.4)	110 (100)	19 (17.3)	110 (100)
Chestnut oak forest excluding open woodland	Burned	2010	70	70 (100)	54 (77.1)	16 (22.9)	16 (22.9)	70 (100)	13 (18.6)	70 (100)
Pitch pine-oak-heath rocky summit	Burned	2008	105	105 (100)	94 (89.5)	1 (0.01)	33 (31.4)	16 (15.2)	94 (89.5)	99 (94.3)
Pitch pine-oak-heath rocky summit	Burned	2010	50	50 (100)	44 (88.0)	26 (52.0)	13 (26.0)	9 (18.0)	42 (84.0)	42 (84.0)

There was significantly less litter in burned compared to unburned plots, as would be expected, but also more duff in burned plots, indicating that some areas had burned into the upper organic layers (Table 13). For data collected in 2010,

Table 13. Comparison of litter and duff cover within chestnut oak forest plots. Comparisons are between 1) plots areas in burned vs. unburned plots from 2008 data, 2) chestnut oak forest (COF) vs. open woodland (OW) in 2010, and 3) burned COF in 2008 vs. 2010 excluding open woodland plots.									
		Mean Burned	Mean Unburned	SD Burned	SD Unburned	N Burned	N Unburned	Kruskal-Wallis Test Statistic	p
Litter	2008 Burned vs. Unburned COF	60.9	77.6	24.3	20.4	245	90	36.232	0.000 (df=1)
Duff	2008 Burned vs. Unburned COF	25.4	0.2	24.3	0.9	245	90	173.300	0.000 (df=1)
		Mean COF	Mean OW	SD COF	SD OW	N COF	N OW		
Litter	2010 Burned COF vs. OW	83.2	51.4	12.8	27.4	70	110	61.907	0.000 (df=1)
Duff	2010 Burned COF vs. OW	4.1	28.6	6.8	25.8	70	110	71.297	0.000 (df=1)
		Mean 2008	Mean 2010	SD 2008	SD 2010	N 2008	N 2010		
Litter	2008 Burned COF vs. 2010 Burned COF	60.9	93.2	24.3	12.8	245	70	58.206	0.000 (df=1)
Duff	2008 Burned COF vs. 2010 Burned COF	25.4	4.1	24.3	6.8	245	70	73.445	0.000 (df=1)

those plots designated as open woodland had less litter and more duff than those designated as forested. The surface in forested areas would likely receive more litter from leaf fall than the open woodlands. Those open woodlands may also have been subjected to high intensity fires that reduced litter cover. Litter cover in plots assessed in 2010 was significantly higher, and duff cover significantly lower, than either measurement in 2008 burned plots.

Figure 6 shows the mean and standard error for litter cover for these comparisons. I interpret the data as indicating that the open woodland type was subject to high intensity fire that killed the canopy trees, reduced the shrub layer and reduced the litter layer as well. Without a source of leaf litter from trees, it may be some time before there are sufficient fine fuels to allow for another fire in these open areas.



III. Bird Data

A. Methods

We used a modified version of the Vermont Forest Bird Monitoring Program protocols developed by the Vermont Center for Ecostudies (Faccio 2007). Within the chestnut oak forest, we established 25 bird observation points at approximately 200 m intervals along transects within the burned chestnut oak forest. Transect starting points and directions were randomly located and selected. To allow for comparison of

unburned chestnut oak forest, data from 15 points were collected within an unburned chestnut oak forest stand.

In 2008, bird observations were collected twice for two replicates at all points. In 2009, observations were collected in one replicate in burned transects A and B and in unburned transects D and E. In 2010, observations were collected in two replicates in burned transects A, B and C. Forty species of birds were recorded in 2008 in burned areas while 31 were recorded in unburned areas. In 2009, 35 species were recorded in burned areas and 30 in unburned areas. In 2010, 52 species were recorded within the burned area. Appendix IV provides the totals for species counted for each year and replicate.

The methods call for recording birds observed within vs. beyond a 50 m radius circle. Tray Biasioli (personal communication) suggested there may have been substantial variation in the estimation of this distance between observers, so I used total counts for all points. I also used only the first replicate as that allowed for the most consistent comparisons between years and between burned and unburned areas.

B. Analyses

The analyses that follow address two questions by comparing the mean abundance of individual species within burned vs. unburned from 2008 to 2010:

1. Did bird species differ between burned and unburned areas?
2. Did the abundance of different bird change between 2008 and 2010 in burned and unburned areas?

Typical methods of analyzing bird point data involve comparisons of abundance and frequency between sites or over time (Betts et al. 2005), species diversity indices (Nur et al. 1999), and associations between species and habitat characteristics (e.g., Sirami et al. 2008, Faccio 2003 and many others). There has also been extensive work in improving bird point count data collection by integrating density estimates and incorporating variation in detection (Farnsworth et al. 2005).

Betts et al. (2005) found that mean abundance (number of birds by species divided by total number of points surveyed) and frequency (number of points a species was found divided by total number of points) were generally the most useful in predicting reproductive activity. By contrast, presence/absence was least effective. Since we are interested in birds that may be breeding in the Overlooks area, I used mean abundance.

I excluded American Crow and Common Raven as they were likely using large habitat areas. I also excluded any species that did not have a frequency of at least ten percent in at least one replicate.

1. Analyses Using Bird Guilds

Birds are often placed into “guilds” based on habitat, nest site selection and foraging, and these can be useful for analyses (Steve Faccio, personal communication). Table 14 lists species found during our surveys, including species codes for use in interpreting the subsequent figures. The guilds are based on numerous sources listed in Table 15 below. I based most on the National Park Service Northeast Temperate Network report (Faccio et al. 2010) supplemented by several articles. For those not well described in the above, I reviewed information by species in Birds of America Online.

The column “Composite” is a combination of habitat and nest site preference for each species. Other possibilities I did not include here are foraging areas (e.g., ground, canopy, etc.) and food preferences (e.g., omnivore, insectivore, etc.). This resulted in 29 guilds for the 65 species. To reduce this total number of guilds, I created a second category, “Community” based on habitat preferences. This resulted in seven guilds.

Species Code	Common Name	Scientific Name	Composite	Community
AMCR	American Crow	<i>Corvus brachyrhynchos</i>	Edge Generalist/Canopy nester	Generalist
AMGO	American Goldfinch	<i>Carduelis tristis</i>	Edge Generalist/Shrub nester	Shrubland/Early Successional
AMRE	American Redstart	<i>Setophaga ruticilla</i>	Forest interior/Canopy nester	Forest interior
AMRO	American Robin	<i>Turdus migratorius</i>	Edge Generalist/Shrub nester	Generalist
BAOR	Baltimore Oriole	<i>Icterus galbula</i>	Edge Generalist/Canopy nester	Generalist
BAWW	Black-and-white Warbler	<i>Mniotilta varia</i>	Forest interior/Forest ground	Forest interior
BCCH	Black-capped Chickadee	<i>Parus atricapillus</i>	Generalist/Cavity nester	Generalist
BDOW	Barred Owl	<i>Strix varia</i>	Forest/Canopy nester	Forest
BGGN	Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	Forest/Canopy nester	Forest
BHCO	Brown-headed Cowbird	<i>Molothrus ater</i>	Edge Generalist/Brood parasite	Generalist
BHVI	Blue-headed Vireo	<i>Vireo solitarius</i>	Forest/Canopy nester	Forest
BLBW	Blackburnian Warbler	<i>Dendroica fusca</i>	Forest interior/Canopy nester	Forest interior
BLJA	Blue Jay	<i>Cyanocitta cristata</i>	Forest/Canopy nester	Forest
BRCR	Brown Creeper	<i>Certhia americana</i>	Forest interior/Canopy nester	Forest interior
BTBW	Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	Forest interior/Shrub nester	Forest interior
BTNW	Black-throated Green Warbler	<i>Dendroica virens</i>	Forest interior/Canopy nester	Forest interior
BWWA	Blue-winged Warbler	<i>Vermivora pinus</i>	Shrub dependent/Ground nester	Shrubland/Early Successional
CANG	Canada Goose	<i>Branta canadensis</i>	Wetland	Wetland
CAWA	Canada Warbler	<i>Wilsonia canadensis</i>	Forest interior/Forest ground	Forest interior
CEDW	Cedar Waxwing	<i>Bombicilla cedrorum</i>	Edge Generalist/Canopy nester	Generalist
CHSP	Chipping Sparrow	<i>Spizella passerina</i>	Edge Generalist/Shrub nester	Generalist
CORA	Common Raven	<i>Corvus corax</i>	Generalist/Canopy nester	Generalist
COYE	Common Yellowthroat	<i>Geothlypis trichas</i>	Shrub dependent/Shrub nester	Shrubland/Early Successional
CSWA	Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	Shrub dependent/Shrub nester	Shrubland/Early Successional
DEJU	Dark-eyed Junco	<i>Junco hyemalis</i>	Open woodlands/shrublands/Forest ground	Open woodlands/shrublands
DOWO	Downy Woodpecker	<i>Picoides pubescens</i>	Forest/Cavity nester	Forest
EABL	Eastern Bluebird	<i>Sialia sialis</i>	Edge Generalist/Cavity nester	Generalist
EAPH	Eastern Phoebe	<i>Sayornis phoebe</i>	Edge Generalist/Climb/Structure nester	Generalist
EATO	Eastern Towhee	<i>Pipilo erythrophthalmus</i>	Forest ground/Shrub nester	Forest
EAWP	Eastern Wood-Pewee	<i>Contopus virens</i>	Forest/Canopy nester	Forest

Table 14 Bird species found in the Overlooks wildfire area and adjacent unburned areas and assigned guilds

Species Code	Common Name	Scientific Name	Composite	Community
FISP	Field Sparrow	<i>Spizella pusilla</i>	Shrub dependent/Edge/Open	Shrubland/Early Successional
GCFL	Great Crested Flycatcher	<i>Myiarchus crinitus</i>	Forest/Edge/Cavity nester	Forest
GRCA	Gray Catbird	<i>Dumetella carolinensis</i>	Shrub dependent/Shrub nester	Shrubland/Early Successional
HAWO	Hairy Woodpecker	<i>Picoides villosus</i>	Forest interior/Cavity nester	Forest interior
HETH	Hermit Thrush	<i>Catharus guttatus</i>	Forest interior/Forest ground	Forest interior
HOWA	Hooded Warbler	<i>Wilsonia citrina</i>	Forest interior/Shrub nester	Forest interior
HOWR	House Wren	<i>Troglodytes aedon</i>	Edge Generalist/Cavity nester	Generalist
INBU	Indigo Bunting	<i>Passerina cyanea</i>	Shrub dependent/Shrub nester	Shrub dependent
MODO	Mourning Dove	<i>Zenaida macroura</i>	Edge Generalist/Canopy nester	Shrubland/Early Successional
MOWA	Mourning Warbler	<i>Oporornis philadelphia</i>	Shrub dependent/Forest ground	Shrubland/Early Successional
NAWA	Nashville Warbler	<i>Vermivora ruficapilla</i>	Forest edge/Forest ground	Forest edge
NOCA	Northern Cardinal	<i>Cardinalis cardinalis</i>	Forest/Shrub nester	Forest
NOFL	Northern Flicker	<i>Colaptes auratus</i>	Forest edge/Open woodland/Cavity nester	Forest
NOMO	Northern Mockingbird	<i>Mimus polyglottos</i>	Edge Generalist/Shrub nester	Shrubland/Early Successional
OVEN	Ovenbird	<i>Seiurus aurocapillus</i>	Forest interior/Forest ground	Forest interior
PISI	Pine Siskin	<i>Spinus pinus</i>	Open Forest/Canopy nester	Open Forest
PIWA	Pine Warbler	<i>Dendroica pinus</i>	Forest interior/Canopy nester	Forest interior
PIWO	Pileated Woodpecker	<i>Dryocopus pileatus</i>	Forest interior/Cavity nester	Forest interior
PRAW	Prairie Warbler	<i>Dendroica discolor</i>	Shrub dependent/Shrub nester	Shrub dependent
PUFI	Purple Finch	<i>Carpodacus purpureus</i>	Forest/Edge/Canopy nester	Forest/Edge
RBNU	Red-breasted Nuthatch	<i>Sitta canadensis</i>	Forest interior/Cavity nester	Forest interior
REVI	Red-eyed Vireo	<i>Vireo olivaceus</i>	Forest/Shrub nester	Forest
RTHA	Red-tailed Hawk	<i>Buteo jamaicensis</i>	Forest/Edge/Canopy nester	Forest
RUGR	Ruffed Grouse	<i>Bonasa umbellus</i>	Successional forest/Forest ground	Successional forest
SCTA	Scarlet Tanager	<i>Piranga olivacea</i>	Forest interior/Canopy nester	Forest interior
TUTI	Tufted Titmouse	<i>Parus bicolor</i>	Forest/Cavity nester	Forest
UNWO	Unknown Woodpecker	<i>Unknown woodpecker</i>	Forest/Cavity nester	Forest
VEER	Veery	<i>Catharus fuscescens</i>	Forest interior/Forest ground	Forest interior
WBNU	White-breasted Nuthatch	<i>Sitta carolinensis</i>	Forest interior/Cavity nester	Forest interior
WIWR	Winter Wren	<i>Troglodytes troglodytes</i>	Forest interior/Cavity nester	Forest interior
WOTH	Wood Thrush	<i>Hylocichla mustelina</i>	Forest/Shrub nester	Forest
WPWI	Whip-poor-will	<i>Caprimulgus vociferus</i>	Forest/Open woodland/Forest ground	Forest/Open woodland
YBSA	Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	Successional forest/Cavity nester	Successional forest
YRWA	Yellow-rumped Warbler	<i>Dendroica c. coronata</i>	Forest/Canopy nester	Forest
YWAR	Yellow Warbler	<i>Dendroica petechia</i>	Shrub dependent/Shrub nester	Shrubland/Early Successional

Table 15 Sources of information on bird guilds

Source	Authors and date
General Sources	
National Park Service Breeding Landbird Monitoring Protocol	Faccio et al. 2010
Shrubland birds	Dettmers 2003
Forest birds	Keddy and Drummond 1996
References from Birds of America Online	
Barred Owl	Mazur and James 2000
Blackburnian Warbler	Morse 2004
Black-capped Chickadee	Foote et al. 2010

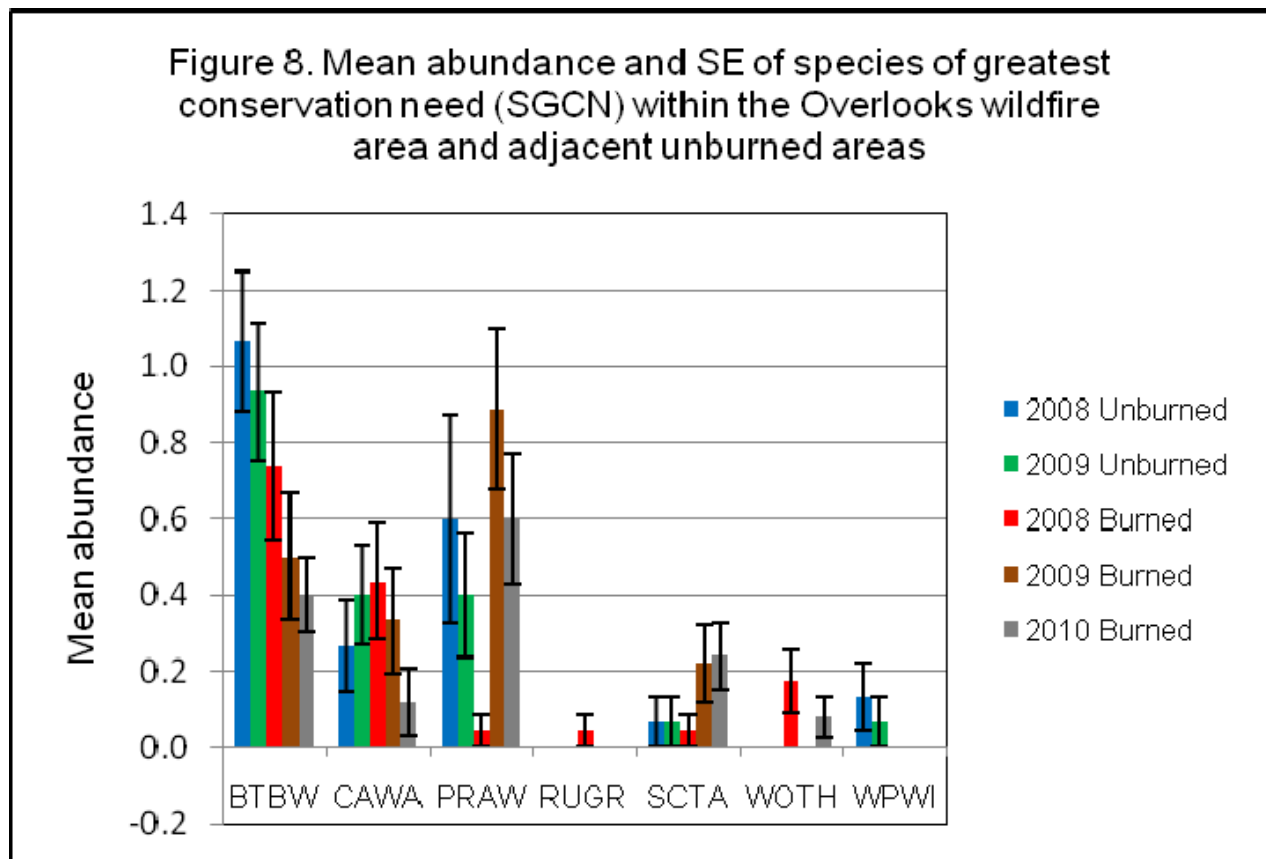
Table 15 Sources of information on bird guilds	
Source	Authors and date
Blue-headed Vireo	Ross 1998
Brown Creeper	Hejl et al. 2002
Common Raven	Boarman and Heinrich 1999
Dark-eyed Junco	Nolan et al. 2002
Eastern Phoebe	Weeks 1994
Field Sparrow	Carey et al. 2008
Great Crested Flycatcher	Lanyon 1997
House Wren	Johnson 1998
Nashville Warbler	Williams 1996
Northern Flicker	Wiebe and Moore 2008
Pine Siskin	Dawson 1997
Purple Finch	Wootton 1996
Red-tailed Hawk	Preston and Beane 2009
Ruffed Grouse	Rusch et al. 2000
Tufted Titmouse	Grubb and Pravasudov 1994
Yellow-rumped Warbler	Hunt and Flaspohler 1998

Some species fit better into certain guilds than others. Scarlet Tanagers are associated with large, unfragmented forests and are most often encountered well within forested blocks. Hermit Thrush, also generally associated with forests, can be found in more open areas at higher elevation. For this report, my real purpose in associating birds is to place species into groups to more easily graph differences from 2008 to 2010 in burned vs. unburned areas and to try to discern trends in birds that may use similar habitats.

Most studies use either simple parametric or nonparametric tests for to compare species abundances between habitats or time period by species or develop more sophisticated analyses of variance or models. I have chosen to portray the data in a series of graphs of mean abundance and standard errors for species within the following groups: species of greatest conservation need, forest species, cavity nesters and generalist and shrubland species. There is some overlap in these graphs as species may be found in more than one graph.

2. Species of Greatest Conservation Need

The six SGCN species encountered were Black-throated Blue Warbler (BTBW), Canada Warbler (CAWA), Prairie Warbler (PAWA), Ruffed Grouse (RUGR), Scarlet Tanager (SCTA), Wood Thrush (WOTH) and Whip-poor-will (WPWI) (NYSDEC undated). Figure 8 below shows mean abundance for each in 2008 and 2009 unburned points and 2008 through 2010 burned points. Black-throated Blue Warbler abundance declined over time in both burned and unburned areas, but abundance was greater in unburned areas. Canada Warblers were more abundant in unburned areas except in 2008, but declined in burned areas steadily. Prairie Warblers were more abundant in burned areas. Interestingly, Scarlet Tanager, Wood Thrush and Whip-poor-will were more abundant in burned areas.



3. Forest Birds

Figures 9 and 10 contrast mean abundance for forest and forest interior birds. The former were described as associated with forest habitats while the latter were specifically considered by the literature, particularly the NPS report (Faccio et al. 2010), as interior species. In general, especially for forest interior birds, abundance was greater in unburned than burned areas.

Eastern Towhee (EATO) are considered shrub nesters but are associated with forested habitats. Their abundance in the burned area has fluctuated, possibly as habitat has changed dramatically since 2008 as described in the above sections on vegetation analysis. Eastern Wood Peewee (EAWP), a typical forest species was more abundant in burned than unburned areas. This may be due to the wide variation in habitat found there as described in the vegetation analyses above. Ovenbirds (OVEN), Black-throated Blue Warblers (BTBW) and Black and White Warblers (BAWW) all showed declines from unburned to burned areas, but also declines in general from 2008 to 2010. Veery (VEER) abundance was greater in burned areas in 2008, then decreased in 2009. Pine Warblers (PIWA) may have increased in the burned area due to the continued presence of pitch pine there.

Figure 9. Mean abundance and SE of forest birds within the Overlooks wildfire area and nearby unburned areas

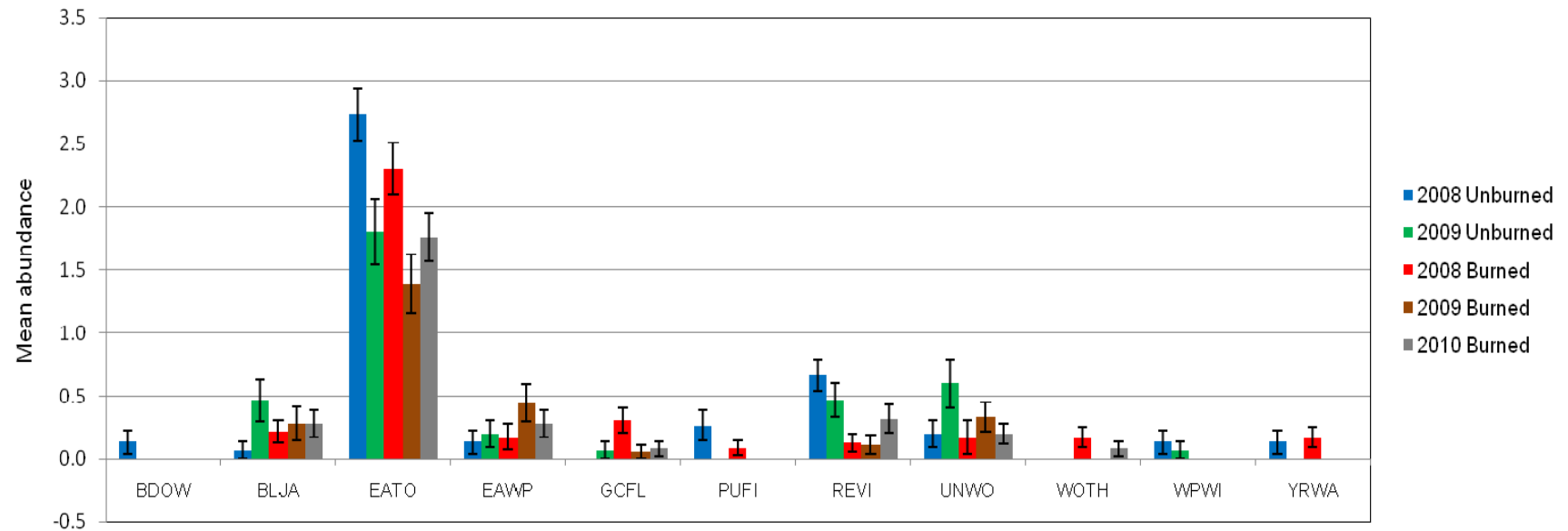
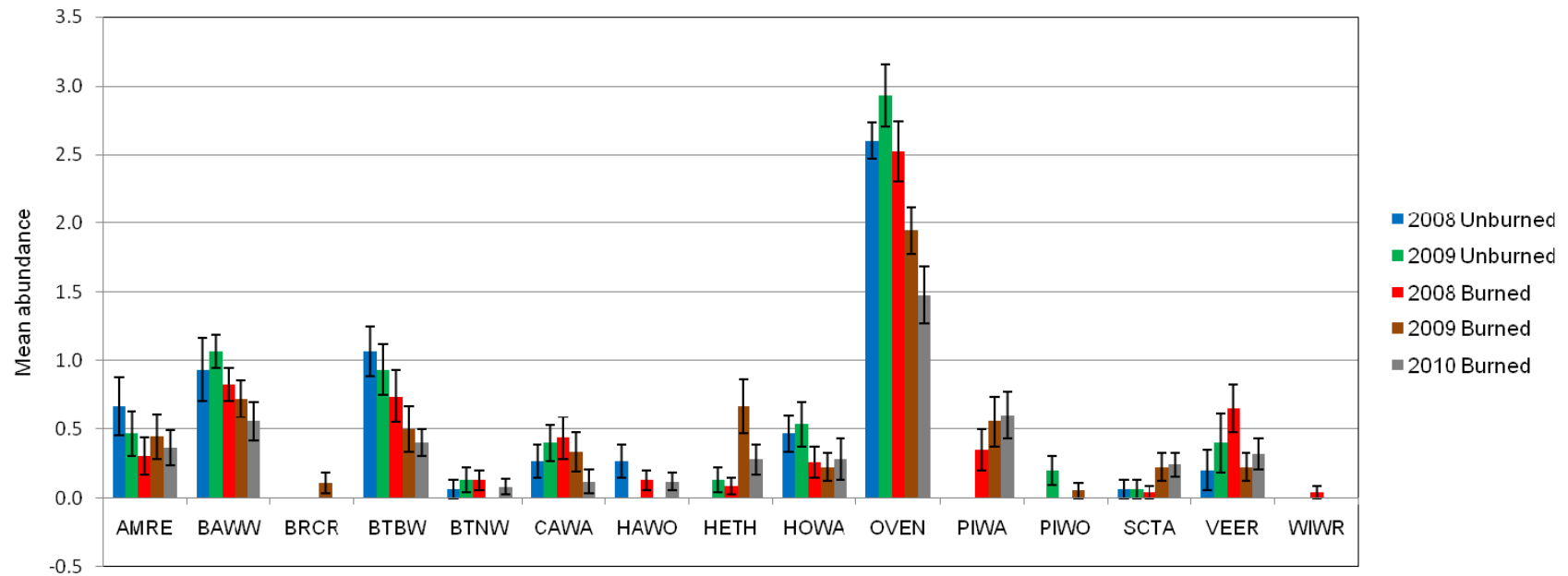
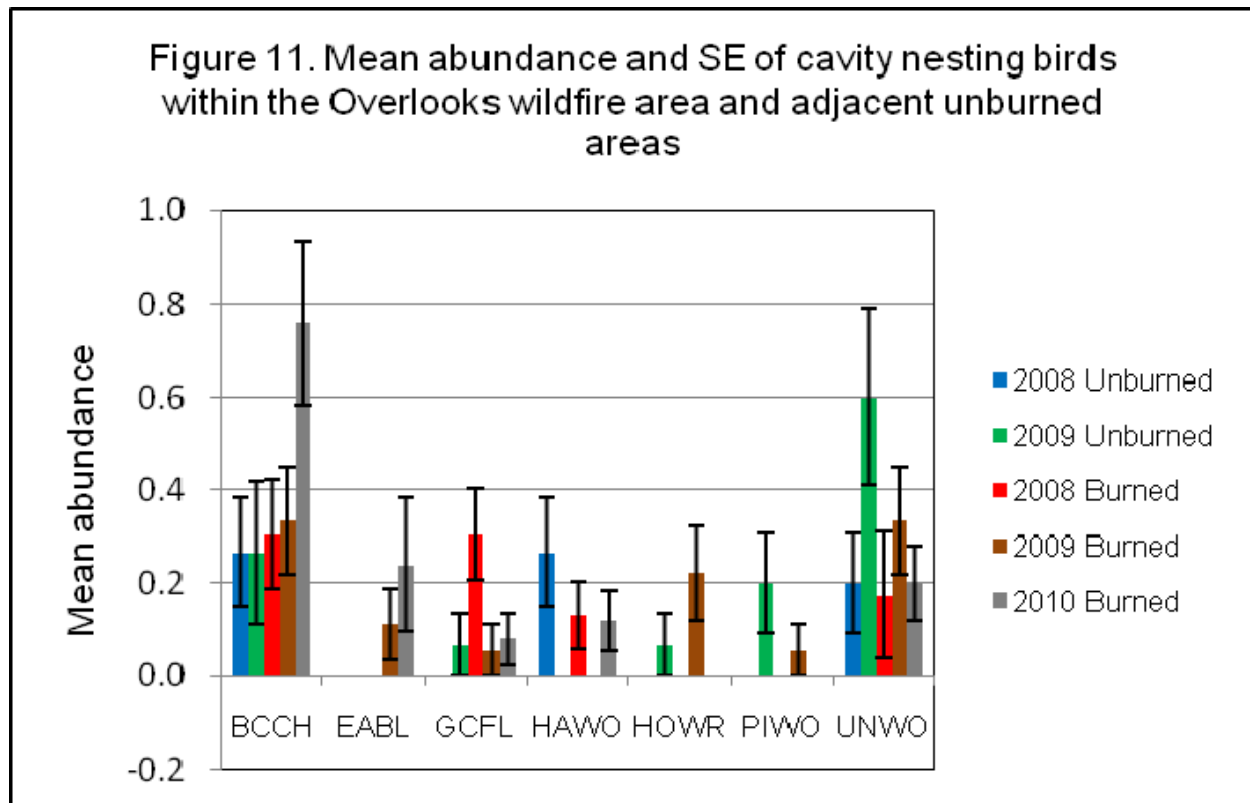


Figure 10. Mean abundance and SE of forest interior birds within the Overlooks wildfire area and nearby unburned areas



4. Cavity Nesters

We did not collect data on snags, but there were numerous dead standing trees in the burned area in 2010. Black-capped Chickadees (BCCH), House Wrens (HOWR) and Eastern Bluebirds (EABL) increased in abundance in the wildfire area, while the abundance of woodpeckers and Great-crested Flycatchers (GCFL) was more mixed (Figure 11). The “unknown” woodpecker (UNWO) is most likely either Downy (DOWO) or Hairy Woodpecker (HAWO), and abundance fluctuated in unburned areas. This may be due to preference of most woodpeckers for snags within forested areas as opposed to open woodlands.

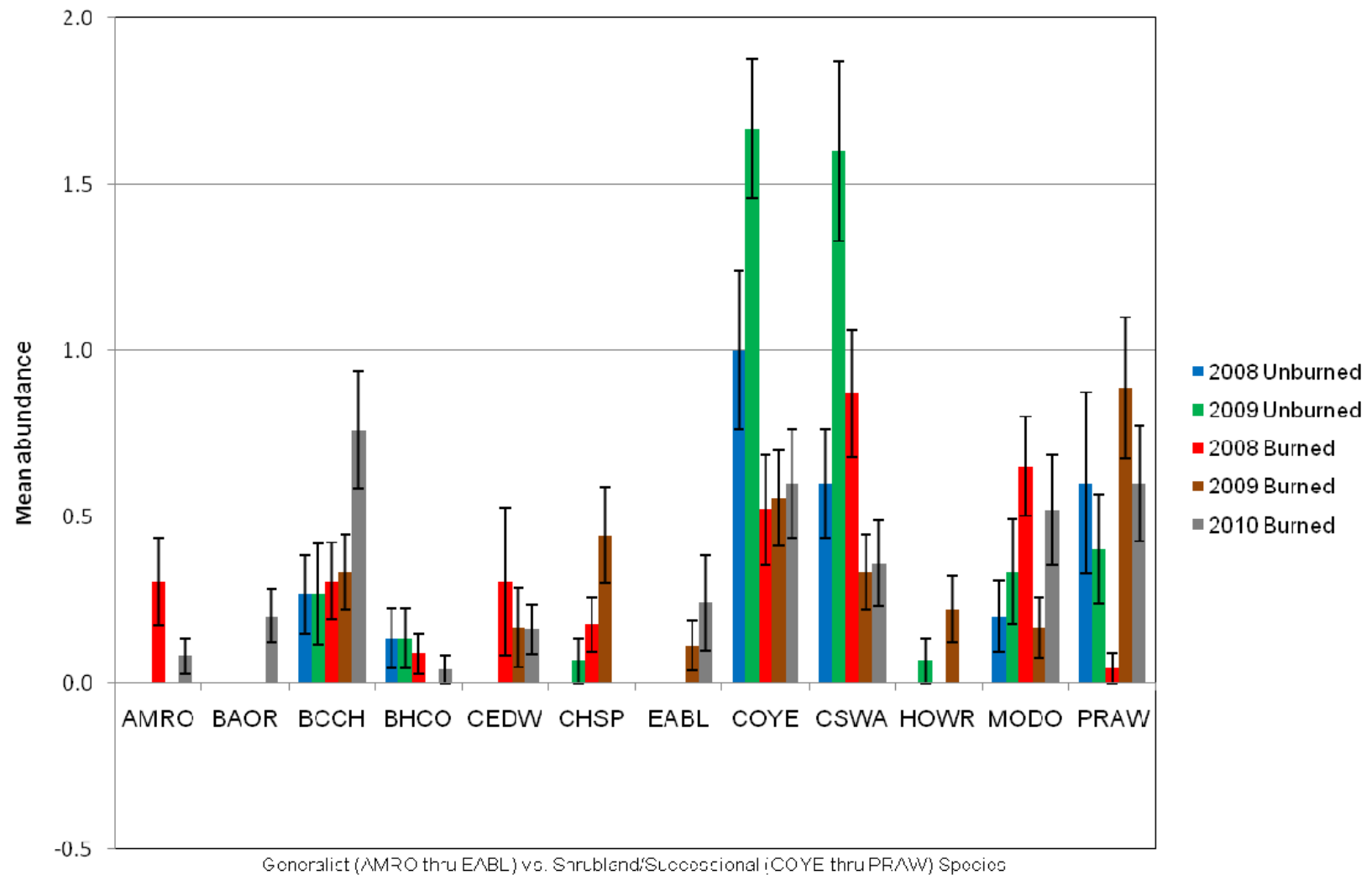


5. Birds of Shrublands and Successional Habitats and Habitat Generalists

Figure 12 shows abundance of generalist and shrubland/successional birds. For most species, abundance was greater in the burned areas, though there were fluctuations. The differences in recovery between areas that remained forested and those that shifted to open woodland may be impacting species differently.

Prairie Warbler (PRAW)) were more abundant in burned than unburned areas with a dramatic increase from 2008 to 2009 in the burned area.. Common Yellowthroats (COYE), Morning Doves (MODO), Chipping Sparrows (CHSP) and Chestnut-sided Warblers (CWSA) increased in both burned and unburned areas.

Figure 12. Mean abundance and SE of generalist and shrubland/early successional birds within the Overlooks wildfire area and adjacent unburned areas



Some changes may be due to larger scale factors such as conditions in overwintering habitats or loss during migration. Just as likely is that three years of data are too little to discern clear or consistent trends.

One complicating factor is the territories of these species. A 50 m circular bird point encompasses 0.78 ha. These points sometimes fell along edges of open shrubland and forest, so birds from either type of habitat could be recorded, depending on their territory size and the size of the habitat patches. Table 16 provides territory areas, which for some species can be less than the size of a bird point. In addition, the habitat characteristics of the unburned area included a dense shrub layer. In areas with open canopy, shrubland nesters may find appropriate nesting and foraging habitat. So, the types of habitat we studied share many similarities that allow birds of different habitat preferences to attempt to nest in either. Finally, while used extensively, bird point count data are subject to variation from differences in the capabilities of the observers and detectability of individual species.

Table 16. Habitat area requirements of birds with high mean abundance. Source: DeGraaf and Yamasaki 2001	
Shrubland/Successional Species	Area
Chestnut-sided Warbler	
Chipping Sparrow	0.3-3 ha
Common Yellowthroat	0.3-0.7 ha
Pine Warbler	2 ha
Prairie Warbler	1.7 ha
Generalists	
Black-capped Chickadee	3-9 ha
Chipping Sparrow	0.4 to 3 ha
Forest Species	
American Redstart	0.1-0.5 ha
Black-and-white Warbler	2-5 ha
Black-throated Blue Warbler	2 ha
Eastern Towhee	0.2-1.7 ha
Hooded Warbler	0.5-40 ha
Ovenbird	0.2-2 ha
Red-eyed Vireo	0.3-1.2 ha
Veery	0.1-3 ha

IV. Discussion and Conclusions

A. Changes to Community Composition and Structure

The Overlooks Wildfire significantly reduced tree density, canopy cover and shrub cover in both the chestnut oak and pitch pine-oak-heath rocky summit. The fire also increased abundance of red maple and sassafras seedlings and saplings, which will have the likely effect of altering the future species composition of the area.

The most dramatic change was the apparent conversion of areas of chestnut oak forest to open woodland. While we have not reviewed aerial imagery, field surveys show that, over the two years following the fire, tree mortality was extensive and covered a wide area. While reduced in density and basal area, oak and pitch pine had both had relatively high importance values in the open woodlands, probably due to their ability to survive intense fires more successfully than other species including red maple. However, the abundance of pitch pine may also indicate that areas that transitioned to open woodlands were different to begin with, as pitch pine was not abundant in burned or unburned plots in 2008, nor in NHP plots, nor in forest plots in 2010.

In addition to the reduction of canopy cover, shrub cover, particularly in the tall shrub strata was significantly lower in burned areas in 2008 than unburned areas. There appears to have been little recovery in the succeeding two years. Short shrub cover was also significantly lower in burned vs. unburned areas in 2008, but appears to have recovered by 2010.

In forested areas, the fire was not severe with respect to the duff layer, leaving an intact litter layer. In the open woodland, litter cover was significantly lower in 2010, possibly as intense fires may have generated enough heat to burn litter down to duff and due to reduced input from leaf fall from trees. Consumption of duff may have occurred in limited circumstances. Typically there is little smoldering in spring fires due to the high moisture content of the lower litter and duff layers. This was observed on this fire, and these findings would be expected.

Sapling densities were dramatically higher in the open woodlands than chestnut oak forest while seedling densities in both areas were more similar. The two intervening years appear to have allowed for extensive recruitment in both, especially when compared to pre and post burn data from the Undercliff treatment unit. Red maple and sassafras dominate both the sapling and seedling layers, with red maple densities high in chestnut oak forest plots, but low in open woodlands. There, sassafras was, by far, the dominant seedling

Sassafras seedlings observed after prescribed fires, where sassafras is not in the canopy, are typically from root suckers (Todd Hutchinson, personal communication). I observed that I could pull sassafras seedlings out, root and all, as if they were individual plants and not suckers. As noted in the tree analyses, sassafras was present in 2008 and 2010 in burned and unburned plots, though not in NHP plots. Sassafras has the ability to reside in the soil seed bank, primarily in leaf litter, for 4-6 years, so seedlings in the Overlooks Wildfire may be from suckers, new seeds and from the seedbank. Red maple apparently does not have this seed banking capability. Both species put out abundant seeds and can begin setting seed at four years of age and resprout prolifically following disturbance (Bonner and Karrfalt 2008).

So, in addition to dramatic changes in community structure within the wildfire, the future composition will be very different from pre-fire conditions if these two species become dominant. The end result may be the conversion of the forest to a

woodland/shrubland. An early ecological model predicted three possibilities following intense fire: 1) conversion of the chestnut oak forest to a pitch pine-oak-heath rocky summit with colonization after fire by pitch pine, 2) conversion to a heath rocky summit with intense fires killing pitch pine and oak and limited or no recruitment of trees and increasing dominance by heath species and 3) conversion to a red maple hardwood heath with colonization by hardwoods, primarily red maple, following fire (Batcher 2000). Given the tree, seedling and sapling data, this latter transition seems the most likely, unless the presence of pitch pine leads to greater pitch pine recruitment.

As with the chestnut oak forest, tree density in the pitch pine oak-heath rocky summit was dramatically lower in 2010 than in either burned plots in 2008 or NHP plots. Pitch pine was the dominant tree species in both cases, and most of the reduction was due to loss of pitch pine, most likely from high intensity fires in that community. Tall shrub layer cover was significantly lower in both 2008 and 2010 from unburned NHP plots. Short shrub cover was similar in both 2008 and 2010, though higher than NHP plots. As with the chestnut oak forest, both red maple and sassafras saplings and seedlings were dominant.

There is little evidence of pitch pine-oak-heath rocky summit areas transitioning to maple and sassafras dominated woodlands. So, the seedlings and saplings there now may die back as shallow soils can lead to very droughty conditions in that community (Batcher 2000). Alternatively, we could be seeing something new as a result of both the wildfire and the input of red maple and sassafras propagules either from within or outside of the rocky summit community.

These comparisons of burned and unburned plots are clouded by our limited picture of the pre-fire community within the area of the Overlooks burn. While both the burned and unburned areas we surveyed were mapped as chestnut oak forest, there is a high degree of variation in that community. Observers noted that the unburned area appeared to be very open and somewhat moister than the burned chestnut oak stands (Tray Biasioli, personal communication). This may explain, in part, the abundance of red maple there. In addition, we did not have the opportunity to explore the area to select plot locations based on a stratification of cover types. We likely did not have enough plots to capture the degree of variation immediately following the burn or in 2010.

That abundance of red maple is an important indicator of the status and viability of the chestnut oak forest. Russell (2001) noted increasing abundance of red maple, which were rare in the pre-colonial forest. Red maple is an indicator of the continued process of “mesophication” of eastern forests resulting from fire suppression. Mesophication represents the conversion of fire dependent communities with species that are tolerant of periodic fire and favoring open conditions to fire intolerant, shade tolerant species with fuels of low flammability (Nowacki and Abrams 2008).

B. Changes to Bird Species

Changes in mean abundance for birds were inconsistent, both for many individual species as well as for bird guilds. While we were able to clearly document changes between burned and unburned areas, we were not able to document clear changes in species composition, probably as we did not distinguish between the types of habitat created by the wildfire. However, the overall species richness of the burned area increased from 40 species in 2008 to 52 in 2010 whereas the unburned area remained relatively static with 31 species recorded in 2008 and 30 in 2009, though the survey effort for 2009 was lower than 2008. The most consistent findings were for several of the species associated with forests. Ovenbirds, Black-throated Blue Warblers and Black and White Warblers all showed declines from unburned to burned areas. On the other hand, Scarlet Tanagers were also more abundant in burned areas.

For species associated with open habitats, Prairie Warblers were more abundant in burned areas, and increased dramatically from 2008 to 2009 in the burned area. Common Yellowthroats, Morning Doves, Chipping Sparrows and Chestnut-sided Warblers increased in both burned and unburned areas.

For cavity nesters, which we would expect would increase with increased abundance of dead trees, Black-capped Chickadees, House Wrens and Eastern Bluebirds increased in abundance in the wildfire area, while the abundance of woodpeckers and Great-crested Flycatchers was more mixed.

C. Research and Management Recommendations

Based on the results the 2008-2010 field work as well as research in other oak forests, it would appear that the chestnut oak forest in the Shawangunks has reached a tipping point beyond which it will not persist without restoration that may require actions beyond just the use of fire. For example, Signell (2005) determined from studies of sites subjected to frequent prescribed burns that oak saplings were only found where the overstory density was less than 400 stems/ha and understory density less than 200 stems/ha. We found densities in unburned areas of between 500 and 600 stems. Red maple is highly competitive and repeated fires are necessary to reduce density significantly (Blankenship and Auerthur 2006). Sassafras, another highly competitive species, has actually shown post-fire increases (Iverson et al. 2008). Mountain laurel has been shown to outcompete oaks after fire and increasing post-fire shrub density may reduce the ability of acorns to germinate and oaks to reach the size required to ultimately reach the canopy (Moser et al. 1996, Chiang et al. 2005). In old growth stands, oaks reached the canopy primarily through either large, infrequent, stand level disturbance or smaller repeated canopy gaps. This also resulted from persistence of oaks in the understory, which does not appear to occur in the present day due to competition from more mesic species (Rentch et al 2003).

The importance of fire in the Shawangunks has been clearly documented (Laing 1994, Hubbs 1995, Batchner 2000). Some studies indicate that chestnut and red oaks

dominate in forests where fires occur every 30 to 70 years (Tirmenstein 1991, Carey 1992). However, a more frequent return interval, averaging every ten years, has been documented in an old growth chestnut oak forest in Maryland (Shumway et al. 2001). Changes in the fire regime (i.e., reduction in frequency) can cause oak forest to gradually transition to northern hardwoods, and fire suppression has clearly lead in this direction in the Shawangunks as has occurred in oak forests throughout the eastern and central United States (Abrams 1992, Abrams 1998, Nowacki and Abrams 2008).

Leaving the area alone will likely lead to the area stabilizing as a shrubland or a woodland dominated by red maple and sassafras. Therefore, I believe that management will be needed to restore the chestnut oak forest in the wildfire area. Fire should be introduced as early a possible to reduce seedling numbers for both sassafras and red maple. Mechanical and herbicide treatments will also be needed. It may even be necessary to distribute acorns in areas where oak density is too low to provide sufficient numbers and where rodents and deer reduce acorns and seedlings.

The Overlooks fire presents several opportunities to both test restoration strategies and investigate the trajectory of the forest following that fire. I would propose a four staged approach. We would need to acquire some form of imagery and map the extent of current cover types to compare size and configuration of post fire cover to pre-fire types. This will allow for a design of continued studies to assess how the area is changing over time and what kinds of management actions will be needed to restore the chestnut oak forest. So, first, I would suggest using the field data collected thus far, along with imagery from before and after the fire to map post-fire cover types. We may also be able to better map the variation in fire intensity across the burned area. This effort would likely require some additional fieldwork and follow-up work to confirm the classification.

Second, over the wide area of the burn, I would propose that we collect data using a modified version of the methods used in 2008 and 2010. These plots would be stratified based on cover types mapped from the imagery. The primary goals would be to document changes in tree and shrub composition and on saplings species abundance. I would avoid the time-consuming effort of counting seedlings as what is important is what species are likely to dominate the canopy layers. If resources were available, we might establish permanent plots (see Batchner 2005 for possible methods), again stratified based on the imagery, and used to more accurately measure tree mortality, shrub cover and height, and regeneration. We would also measure shrub cover and height by species along with canopy closure using either hemispherical photography or some form of light meter (Newton 2007). All of these measures would track recovery of the various strata, but in particular, tree regeneration.

Third, I would suggest setting up a series of experimental treatment units to determine what set and sequence of techniques could reduce red maple and sassafras and increase oak regeneration. Treatments should include the use of fire and herbicides and mechanical removal of red maple and sassafras saplings and trees.

Studies of the effects of prescribed fire on birds have noted increases in species richness but declines in some species. For example, Hooded Warblers, Wood thrush, Worm-eating Warbler, and Ovenbird were all absent from sites burned vs. unburned sites (Arman et al. 2001, Blake 2004). We have noted some changes since the fire, and some species may begin to use the area that we have yet to record. We noted clear differences between bird composition at burned vs. unburned sites. At the same time, several of the birds found in unburned sites, such as Eastern Towhee, are considered shrubland nesters.

So, fourth, I would propose continuing point counts but reallocating them according to cover types. Optimally, we would locate these in areas where we surveyed vegetation. We could allocate plots in a way to track changes in forest structure to determine if we can correlate these with trends in bird species composition and abundance. Confer has suggested more intensive methods using “spot mapping” and the Mohonk Preserve has bird census information for several areas.

Deer browse is a significant factor affecting regeneration. Ed McGowan (personal communication) has suggested establishing a large, fenced area within the burn to track vegetation changes absent deer browse, and this could easily be integrated into these suggested studies.

These projects should be linked methodologically with the prescribed burn program being initiated to investigate the effects of prescribed fire on forest birds and on chestnut oak forest composition and structure. That program is slated to continue and is being addressed through fire management planning for the Northern Shawangunks (Chapin 2010).

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Appendices

I. Tree Data Analysis Tables

2008 Burned Chestnut oak forest plots								
Burned 2008	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
Chestnut oak forest								
<i>Acer pensylvanica</i>		0						
<i>Acer rubrum</i>	77	40	173.8	35.6	18.6	30.8	85.0	3.5

2008 Burned Chestnut oak forest plots								
Burned 2008	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Amelanchier sp.</i>	2	2	4.5	0.9	0.3	1.5	2.7	0.0
<i>Betula lenta</i>	1	1	2.3	0.5	0.1	0.8	1.3	0.0
<i>Betula papyrifera</i>	5	2	11.3	2.3	2.6	1.5	6.5	0.5
<i>Betula populifolia</i>	6	4	13.5	2.8	1.2	3.1	7.0	0.2
<i>Nyssa sylvatica</i>	9	8	20.3	4.2	3.4	6.2	13.7	0.6
<i>Pinus rigida</i>	4	4	9.0	1.9	3.0	3.1	7.9	0.6
<i>Pinus strobus</i>	1	1	2.3	0.5	0.4	0.8	1.7	0.1
<i>Quercus montana</i>	61	33	137.7	28.2	44.0	25.4	97.6	8.4
<i>Quercus rubra</i>	20	15	45.2	9.3	20.1	11.5	40.9	3.8
<i>Sassafras albidum</i>	27	17	61.0	12.5	5.6	13.1	31.2	1.1
<i>Tsuga canadensis</i>	3	3	6.8	1.4	0.8	2.3	4.5	0.2
Mean Distance (m)	4.5							
Tree Density	487.7							
Number of plots	54.0							

2008 Unburned chestnut oak forest plots								
Unburned 2008	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
Chestnut Oak Forest								
<i>Acer pensylvanica</i>	1	1	7.6	1.4	0.7	2.9	5.0	0.1
<i>Acer rubrum</i>	44	16	353.3	61.1	45.8	45.7	152.6	8.4
<i>Amelanchier sp.</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula lenta</i>	1	1	8.0	1.4	3.7	2.9	8.0	0.7
<i>Betula papyrifera</i>	2	2	16.1	2.8	1.7	5.7	10.2	0.3
<i>Betula populifolia</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nyssa sylvatica</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pinus rigida</i>	3	2	24.1	4.2	13.3	5.7	23.2	2.4
<i>Pinus strobus</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Quercus montana</i>	3	3	24.1	4.2	5.2	8.6	18.0	1.0
<i>Quercus rubra</i>	10	7	80.3	13.9	23.3	20.0	57.3	4.3
<i>Sassafras albidum</i>	8	3	64.2	11.1	6.4	8.6	26.1	1.2
<i>Tsuga canadensis</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
Mean Distance (m)	4.2							
Tree Density	578.2							
Number of plots	18							

Analysis I – All Burned 2010 Chestnut Oak Forest Plots								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Acer pensylvanica</i>								
<i>Acer rubrum</i>	30	16	13.8	20.8	10.3	21.6	52.7	0.5
<i>Amelanchier sp.</i>								

Analysis I – All Burned 2010 Chestnut Oak Forest Plots								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Betula lenta</i>	1	1	0.5	0.7	1.4	1.4	3.4	0.1
<i>Betula papyrifera</i>								
<i>Betula populifolia</i>								
<i>Nyssa sylvatica</i>	10	6	4.6	6.9	5.6	8.1	20.7	0.3
<i>Pinus rigida</i>	41	16	18.8	28.5	32.0	21.6	82.1	1.5
<i>Pinus strobus</i>								
<i>Quercus montana</i>	46	25	21.1	31.9	39.4	33.8	105.1	1.8
<i>Quercus rubra</i>	11	7	5.1	7.6	10.5	9.5	27.6	0.5
<i>Sassafras albidum</i>	5	3	2.3	3.5	0.9	4.1	8.4	0.0
<i>Tsuga canadensis</i>								
Mean Distance (m)	12.3							
Tree Density	66.2							
Number of plots	36.0							

Analysis II - Burned 2010 Chestnut oak forest excluding open woodland								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Acer pensylvanica</i>								
<i>Acer rubrum</i>	26.0	12.0	113.3	46.4	28.9	37.5	112.8	4.0
<i>Amelanchier sp.</i>								
<i>Betula lenta</i>	1.0	1.0	4.4	1.8	4.3	3.1	9.2	0.6
<i>Betula papyrifera</i>								
<i>Betula populifolia</i>								
<i>Nyssa sylvatica</i>	3.0	2.0	13.1	5.4	4.9	6.2	16.5	0.7
<i>Pinus rigida</i>								
<i>Pinus strobus</i>								
<i>Quercus montana</i>	14.0	10.0	61.0	25.0	35.3	31.2	91.6	4.9
<i>Quercus rubra</i>	10.0	6.0	43.6	17.9	26.8	18.7	63.4	3.8
<i>Sassafras albidum</i>	2.0	1.0	8.7	3.6	0.7	3.1	7.4	0.1
<i>Tsuga canadensis</i>								
Mean Distance (m)	6.4							
Tree Density	244.0							
Number of plots	14							

Analysis II Burned 2010 Open Woodland								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Acer pensylvanica</i>								
<i>Acer rubrum</i>	4	4	1.8	4.5	1.3	9.5	15.3	0.0
<i>Amelanchier sp.</i>								

Analysis II Burned 2010 Open Woodland								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Betula lenta</i>								
<i>Betula papyrifera</i>								
<i>Betula populifolia</i>								
<i>Nyssa sylvatica</i>	7	4	3.1	8.0	6.0	9.5	23.5	0.2
<i>Pinus rigida</i>	41	16	18.1	46.6	48.1	38.1	132.8	1.4
<i>Pinus strobus</i>								
<i>Quercus montana</i>	32	15	14.1	36.4	41.9	35.7	113.9	1.2
<i>Quercus rubra</i>	1	1	0.4	1.1	2.6	2.4	6.1	0.1
<i>Sassafras albidum</i>	3	2	1.3	3.4	1.1	4.8	9.2	0.0
<i>Tsuga canadensis</i>								
Mean Distance (m)	16.0							
Tree Density	38.9							
Number of plots	22							

Burned 2008 Pitch pine-oak-heath rocky summit								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Acer pensylvanica</i>								
<i>Acer rubrum</i>	6.0	4.0	52.3	7.1	4.1	11.8	23.0	1.0
<i>Amelanchier sp.</i>	2.0	1.0	17.4	2.4	1.5	2.9	6.8	0.4
<i>Betula lenta</i>								
<i>Betula papyrifera</i>	1.0	1.0	8.7	1.2	1.0	2.9	5.2	0.3
<i>Betula populifolia</i>								
<i>Nyssa sylvatica</i>	1.0	1.0	8.7	1.2	0.0	2.9	4.1	0.0
<i>Pinus rigida</i>	58.0	17.0	506.0	69.0	68.3	50.0	187.4	16.9
<i>Pinus strobus</i>	1.0	1.0	8.7	1.2	2.0	2.9	6.1	0.5
<i>Quercus montana</i>	1.0	1.0	8.7	1.2	6.7	2.9	10.8	1.7
<i>Quercus rubra</i>	2.0	2.0	17.4	2.4	7.7	5.9	16.0	1.9
<i>Sassafras albidum</i>	11.0	5.0	96.0	13.1	8.1	14.7	35.9	2.0
<i>Tsuga canadensis</i>	1.0	1.0	8.7	1.2	0.6	2.9	4.7	0.1
Mean Distance (m)	3.7							
Tree Density	732.8							
Number of plots	21							

Burned 2010 Pitch pine-oak-heath rocky summit								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Acer pensylvanica</i>		0						
<i>Acer rubrum</i>	1	1	6.8	2.5	1.7	7.1	11.4	0.2
<i>Amelanchier sp.</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula lenta</i>		0	0.0	0.0	0.0	0.0	0.0	0.0

Burned 2010 Pitch pine-oak-heath rocky summit								
	# Trees by Species	#Plots Species Found	#Trees/Ha	Relative Density	Relative Dominance	Relative Frequency	Importance	BA/Ha (m2/ha)
<i>Betula papyrifera</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Betula populifolia</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nyssa sylvatica</i>	1	1	6.8	2.5	2.3	7.1	11.9	0.3
<i>Pinus rigida</i>	36	10	246.3	90.0	91.1	71.4	252.5	12.9
<i>Pinus strobus</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Quercus montana</i>	1	1	6.8	2.5	4.1	7.1	13.7	0.6
<i>Quercus rubra</i>		0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Sassafras albidum</i>	1	1	6.8	2.5	1.0	7.1	10.7	0.1
<i>Tsuga canadensis</i>		0						
Mean Distance (m)	6.04							
Tree Density	273.74							
Number of plots	10							

II. Seedlings and Saplings by Type

Species	Saplings			Sapling Total	Seedlings				Seedling Total
	Resprout	Resprout from tree	Single stem		Multiple stem	Resprout	Resprout from tree	Single stem	
<i>Acer rubrum</i>	14	23		37		27	52	2947	3026
<i>Amelanchier</i> sp.					1			7	8
<i>Betula populifolia</i>	4	2	1	7		2	3	118	123
<i>Betula</i> sp.		1		1		1		53	54
<i>Castanea dentata</i>	1			1		3			3
<i>Liriodendron tulipifera</i>								187	187
<i>Nyssa sylvatica</i>						1	3	79	83
<i>Pinus rigida</i>						3	1	21	25
<i>Pinus</i> sp.								5	5
<i>Pinus strobus</i>								23	23
<i>Populus</i> sp.								2	2
<i>Populus tremuloides</i>								4	4
<i>Prunus</i> sp.								4	4
<i>Quercus montana</i>		3		3		3	12	110	125
<i>Quercus rubra</i>	1	3		4		1	1	60	62
<i>Sassafras albidum</i>	6	9	73	88	30	846	4	5956	6836
Total	26	41	74	141	31	887	76	9576	10711

III. FireMon Categories

Modified fire effect ratings from FireMon Table PD-12. Source: Lutes et al. 2006.				
Fire Severity Code	Surface	Canopy and Subcanopy (T2-T3)	Shrub (S1 and S2)	Herbaceous Vegetation (H)
Unburned (1)	Not burned	Not burned	Not burned	Not burned

Modified fire effect ratings from FireMon Table PD-12. Source: Lutes et al. 2006.				
Fire Severity Code	Surface	Canopy and Subcanopy (T2-T3)	Shrub (S1 and S2)	Herbaceous Vegetation (H)
Scorched or Partially burned (2)	Litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged. Nonvascular flora generally burned but still identifiable as moss or lichen	Green leaves (excluding new leafout) or needles within at least 50% of the canopy. Foliage scorched and attached to supporting twigs OR scorched foliage has fallen and is clearly visible on the ground.	Foliage scorched (brown) and attached to supporting twigs OR scorched foliage has fallen and is clearly visible on the ground.	Foliage scorched but genus or species still recognizable.
Lightly Burned (3)	Litter charred to partially consumed; upper duff layer may be charred but the duff is not altered over the entire depth; surface appears black; where litter is sparse charring may extend slightly into soil surface but soil is not visibly altered; woody debris partially burned; logs are scorched or blackened but not charred; rotten wood is scorched to partially burned.	Foliage mostly to completely consumed; Green leaves (excluding new leafout) or needles evident only in upper 25% of canopy; Lower twigs and branches charred but mostly intact.	Foliage mostly to completely consumed; twigs and branches charred but mostly intact.	Forbs and graminoids with approximately two inches of stubble; foliage and smaller twigs of associated species partially to completely consumed; some plant parts may still be standing; bases of plants are not deeply burned and are still recognizable.
Moderately Burned (4)	Litter mostly to entirely consumed, leaving coarse, light colored ash (ash soon disappears, leaving mineral soil); duff deeply charred, but not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned out stump holes are evident.	Foliage twigs and small twigs (<0.25 in) consumed; small branches still present. No leaves, though some new leaf out may occur.	Foliage twigs and small twigs (0.25-0.50 in) consumed; small branches still present.	Unburned forb/graminoid stubble usually less than two inches tall, and mostly confined to an outer ring; for other species, foliage completely consumed, plant bases are burned to ground level and obscured in ash immediately after burning.
Heavily burned (5)	Litter and duff completely consumed, leaving fine white ash (ash disappears leaving mineral soil); mineral soil charred and/or visibly altered, often reddish; sound logs are deeply charred, and rotten logs are completely consumed.	Entire plant surface is deeply charred. All foliage, twigs and small branches up to 0.5 in completely consumed.	All plant parts <0.5 in consumed leaving only short stubs of stems greater than 0.5 in. in diameter.	No unburned forbs/graminoids above the root crown; for other species, all plant parts consumed.
Not Applicable (NA)	Only inorganic material on site before burn.	None present at time of burn.	None present at time of burn.	None present at time of burn

IV. Bird Data

			Unburned			Burned				
		Replicate	1	2	1	1	2	1	1	2
Common Name	Scientific Name	Species Code	2008	2008	2009	2008	2008	2009	2010	2010
American Crow	<i>Corvus brachyrhynchos</i>	AMCR				2	1	1	8	7
American Goldfinch	<i>Carduelis tristis</i>	AMGO	1			1			3	2
American Redstart	<i>Setophaga ruticilla</i>	AMRE	10	3	7	7	12	8	9	10
American Robin	<i>Turdus migratorius</i>	AMRO				7	2		2	3
Baltimore Oriole	<i>Icterus galbula</i>	BAOR							5	
Black-and-white Warbler	<i>Mniotilta varia</i>	BAWW	14	8	16	19	15	13	14	12
Black-capped Chickadee	<i>Parus atricapillus</i>	BCCH	4	2	4	7	7	6	19	14
Barred Owl	<i>Strix varia</i>	BDOW	2							
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	BGGN							1	
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	2		2	2	2		1	1
Blue-headed Vireo	<i>Vireo solitarius</i>	BHVI						1	1	
Blackburnian Warbler	<i>Dendroica fusca</i>	BLBW							2	
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	1	1	7	5	8	5	7	8
Brown Creeper	<i>Certhia americana</i>	BRCR						2		2
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	BTBW	16	15	14	17	16	9	10	9
Black-throated Green Warbler	<i>Dendroica virens</i>	BTNW	1	2	2	3	3		2	2
Blue-winged Warbler	<i>Vermivora pinus</i>	BWWA								1
Canada Goose	<i>Branta canadensis</i>	CAGO	1							
Canada Warbler	<i>Wilsonia canadensis</i>	CAWA	4	4	6	10	7	6	3	5
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW		2		7	1	3	4	
Chipping Sparrow	<i>Spizella passerina</i>	CHSP		1	1	4	12	8		8
Common Raven	<i>Corvus corax</i>	CORA	2	11	9	8	8	11	3	14
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	15	14	25	12	13	10	15	14
Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	CSWA	9	8	24	20	13	6	9	11
Dark-eyed Junco	<i>Junco hyemalis</i>	DEJU			1		2	1	3	3
Downy Woodpecker	<i>Picoides pubescens</i>	DOWO							1	1
Eastern Bluebird	<i>Sialia sialis</i>	EABL						2	6	3
Eastern Phoebe	<i>Sayornis phoebe</i>	EAPH								1
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	EATO	41	41	27	53	62	25	44	55
Eastern Wood-Pewee	<i>Contopus virens</i>	EAWP	2	3	3	4	7	8	7	1
Field Sparrow	<i>Spizella pusilla</i>	FISP			1					
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL			1	7	2	1	2	
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA								1
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	4	2		3			3	9
Hermit Thrush	<i>Catharus guttatus</i>	HETH			2	2	4	12	7	10

			Unburned			Burned				
		Replicate	1	2	1	1	2	1	1	2
Common Name	Scientific Name	Species Code	2008	2008	2009	2008	2008	2009	2010	2010
Hooded Warbler	<i>Wilsonia citrina</i>	HOWA	7	3	8	6	8	4	7	6
House Wren	<i>Troglodytes aedon</i>	HOWR			1			4		
Indigo Bunting	<i>Passerina cyanea</i>	INBU						1		
Mourning Dove	<i>Zenaida macroura</i>	MODO	3		5	15	8	3	13	10
Mourning Warbler	<i>Oporornis philadelphia</i>	MOWA								1
Myrtle Warbler	<i>Dendroica c. coronata</i>	MYWA	2			4	3			
Nashville Warbler	<i>Vermivora ruficapilla</i>	NAWA	1	2						
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA				1				
Northern Flicker	<i>Colaptes auratus</i>	NOFL								1
Northern Mockingbird	<i>Mimus polyglottos</i>	NOMO								1
Ovenbird	<i>Seiurus aurocapillus</i>	OVEN	39	37	44	58	72	35	37	58
Pine Siskin	<i>Spinus pinus</i>	PISI						3		
Pine Warbler	<i>Dendroica pinus</i>	PIWA				8	11	10	15	9
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO			3		3	1		1
Prairie Warbler	<i>Dendroica discolor</i>	PRAW	9	6	6	1	1	16	15	22
Purple Finch	<i>Carpodacus purpureus</i>	PUFI	4			2	3			
Red-breasted Nuthatch	<i>Sitta canadensis</i>	RBNU							1	4
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	10	4	7	3	3	2	8	11
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RTHA							1	
Ruffed Grouse	<i>Bonasa umbellus</i>	RUGR				1				
Scarlet Tanager	<i>Piranga olivacea</i>	SCTA	1	1	1	1	1	4	6	5
Tufted Titmouse	<i>Parus bicolor</i>	TUTI				1				3
Unknown Woodpecker		UNWO	3		9	4		6	5	
Veery	<i>Catharus fuscescens</i>	VEER	3	4	6	15	20	4	8	16
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU				1	1	1	1	2
Winter Wren	<i>Troglodytes troglodytes</i>	WIWR				1				
Wood Thrush	<i>Hylocichla mustelina</i>	WOTH				4	1		2	2
Whip-poor-will	<i>Caprimulgus vociferus</i>	WPWI	2		1					
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA			1			1	1	
Yellow Warbler	<i>Dendroica petechia</i>	YWAR								1
	Total Counts		213	174	244	326	332	233	311	360
Number of species by replicate			29	22	30	38	33	35	41	43
Number of species by year		2008 Unburned	31	2009 Unburned	30	2010 Burned		52		
		2008 Burned	40	2009 Burned	35					