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

Report #1: Summary Report

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The Nature Conservancy
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I. Study Purpose and Design

Upland Sandpiper

In early 2008, The Nature Conservancy, in partnership with the Mohonk Preserve and the U.S. Fish and Wildlife Service, initiated a series of coordinated research projects to test the efficacy of several management strategies to achieve specific goals for habitat management for both grassland and forest nesting birds. The studies focused on several species listed as Species of Greatest Conservation Need (SGCN) by the New York State Department of Environmental Conservation (Table 1).

Grassland treatment units were established at the Mohonk Preserve and at Shawangunks Grassland National Wildlife Refuge managed by the U.S. Fish and Wildlife Service. A forest treatment unit was established in the Mohonk Preserve to assess the effects of prescribed fire on bird habitat within the chestnut oak forest, the largest forest type in the northern Shawangunks and one of the largest examples of that community in New York.

Table 1. Bird species of greatest conservation need (SGCN)[4]	
Grassland Nesting Birds	
Common Name	Scientific Name
Bobolink	*Dolichonyx oryzivorus*
Eastern Meadowlark	*Sturnella magna*
Savannah Sparrow[5]	*Passerculus sandwichensis*
Upland Sandpiper	*Bartramia longicauda*
Forest Nesting Birds	
Black-throated Blue Warbler	*Dendroica caerulescens*
Canada Warbler	*Wilsonia canadensis*
Scarlet Tanager	*Piranga olivacea*
Wood Thrush	*Hylocichla mustelina*
Worm-eating Warbler	*Helmitheros vermivorus*

In April of 2008, just before initiation of this study, there was a major wildfire in the Overlooks area in Minnewaska State Park Preserve which burned approximately 3,000 acres (1,250 ha) within the Park and some adjacent private lands. This was the largest fire in the Shawangunks since the 1947 wildfire that burned over 7,000 acres (3,000 ha). Given this opportunity, we established both vegetation and bird monitoring

[4] We also observed Prairie Warblers (*Dendroica discolor*), Ruffed Grouse (*Bonasa umbellu*s) and Whip-poor-will (*Caprimulgus vociferous*) in the Overlooks plots.

[5] Savannah Sparrow is not listed as a SGCN species, but is considered an important grassland indicator, and is known to nest at Shawangunk Grasslands NWR.

plots within the wildfire area and in some unburned areas nearby for comparison. The locations of treatment units and of the wildfire are shown on Maps 1 and 2.

A series of reports including reviews of relevant literature, monitoring protocols and analyses of field data were completed for this study. Full citations are provided in the references sections and copies are available from The Nature Conservancy's Shawangunk Ridge Program. Table 2 lists literature and monitoring protocols.

Table 2. Literature review and monitoring protocols

Title	Date	Type
Effects of prescribed fire on bird habitat of selected oak forest bird species		Literature review and recommendations for monitoring forest habitat
Grassland monitoring protocols for Shawangunk Grasslands NWR and the Mohonk Preserve Version 2.1	2010	Monitoring protocols for grassland habitat at Shawangunk Grasslands NWR and the Mohonk Preserve
Observation Point Field Form Instructions Version 2.2	2010	Monitoring protocols for the Overlooks wildfire
Undercliff Oak Forest Burn Unit Protocols at the Mohonk Preserve, Version 3.5	2010	Monitoring protocols for the Undercliff treatment units

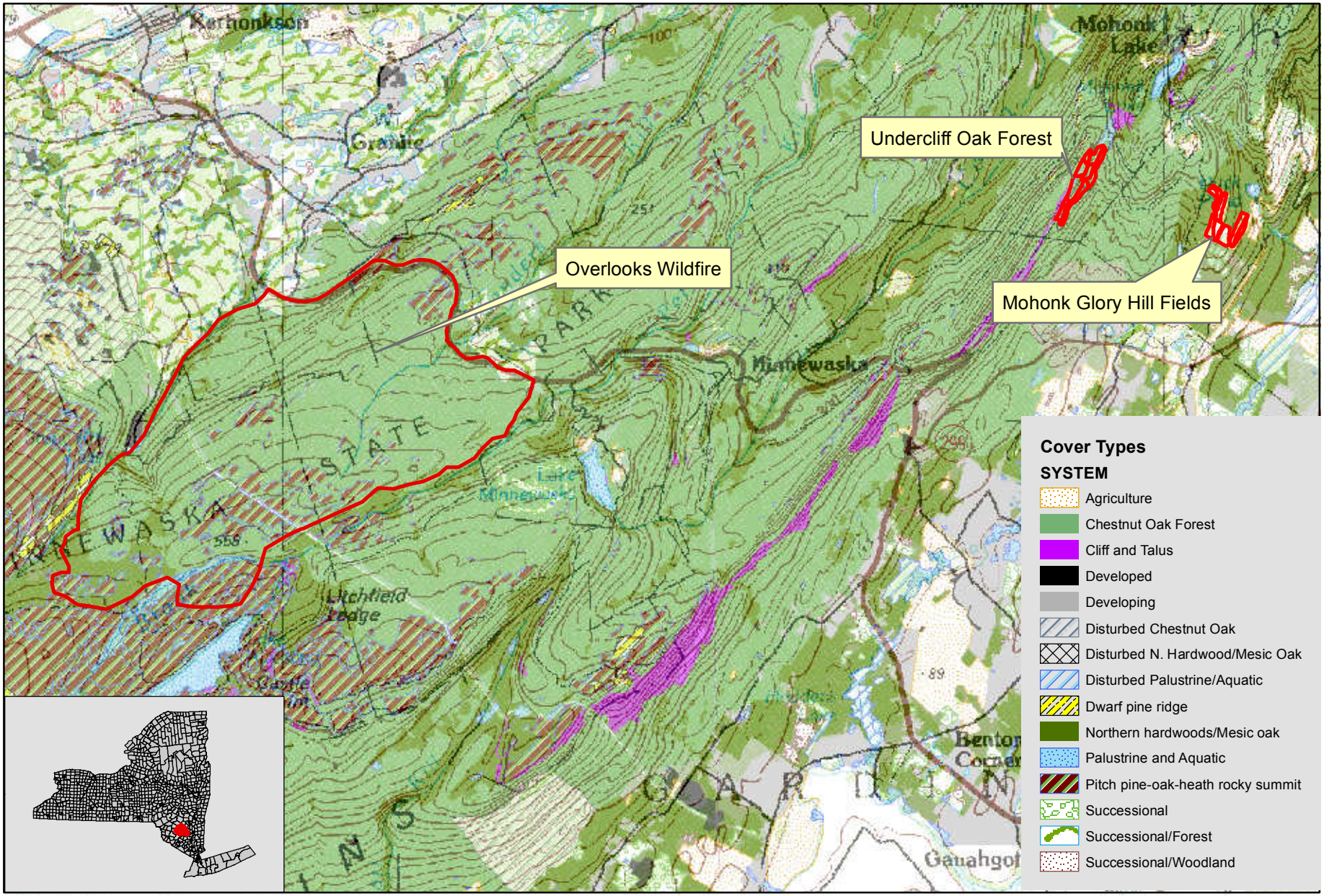
A. Shawangunk Grasslands National Wildlife Refuge and the Mohonk Preserve

Data collection in field K-24 at the Mohonk Preserve

We established plots and collected data in the summer of 2009 at both the Mohonk Preserve and Shawangunk Grasslands National Wildlife Refuge (SGNWR) to assess management on several grassland variables important for managing old fields at the Mohonk Preserve and for managing grassland bird habitat at SGNWR.

The original, planned treatments included mowing both at mid-summer (July) and late summer (September) and for mowing followed by a prescribed burn. One field at the Mohonk Preserve was burned in the spring of 2009, but weather and other conditions prevented any other prescribed burns. Summer (July) mowing was completed in two of the SGNWR units and September mowing was completed in two of the Mohonk fields. The September mow at SGNWR did not occur. A spring mow was substituted and completed in one field at the Mohonk Preserve.

Map 1. Northern Shawangunks Study Areas



Map 2. Shawangunks Grassland National Wildlife Refuge Treatment Areas

B. Undercliff Treatment Units

The Nature Conservancy and the Mohonk Preserve established a 35.7 acre (14.4 ha) treatment unit off Undercliff Road in the Preserve. We established 16 plots within this unit in 2009 and collected data on the composition and abundance of trees, shrubs, saplings and seedlings. This included data specific to shrub nesting birds with measurements of shrub cover within 0.5 m height increments from zero to three meters. We burned the unit in late April and early May of 2010 and then resurveyed all 16 plots that summer.

Field data collection in the Undercliff treatment unit

C. Overlooks Wildfire Study

Overlooks Wildfire area immediately after the fire

The Overlooks Wildfire provided an opportunity to look at the effects of the largest wildfire in over fifty years on the chestnut oak forest. To measure the effects of this fire, vegetation and other data were collected from 93 points, representing ten meter radius circular plots (314 m^2) in Minnewaska State Park Preserve from early June to mid-September of 2008.[6] Fifty-four of these were in burned areas mapped as chestnut oak forest and 18 in nearby, unburned chestnut oak forest. Twenty-one plots were located within areas of burned pitch pine-oak-heath rocky summit.

In late May and early June of 2008 bird data was collected using point counts (Faccio 2007) from 25 points within the boundary of the Overlooks Wildfire and from 15 points in a nearby, unburned chestnut oak forest. Field crews also measured vegetation at these points.

[6] We actually collected data in 96 plots, but data from three were not included as they were in cover types other than chestnut oak forest or pitch pine-oak-heath rocky summit.

In 2009, bird data was again collected in the two unburned transects (N=15) and in two of the burned transects (N=18). 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 three transects in the burned area. No data were collected in unburned areas. To provide further comparison of burned vs. unburned areas, data from the New York Natural Heritage Program and from the 1995-96 mapping of the northern Shawangunks by John Thompson (1996) (hereinafter referred to as NHP plots or data) were also analyzed.

II. Key Findings

Canada Warbler

This section summarizes the key findings from studies in both grassland sites (SGNWR and the Mohonk Preserve), in the Undercliff treatment unit and within the Overlooks wildfire area. Table 3 lists the reports analyzing the above data. Complete references are provided in the reference section of this report and copies are available from The Nature Conservancy's Shawangunks Program.

Table 3. Reports completed as part of analyses of field data for the Shawangunks Grassland and Forests Birds Habitat Study		
Report #2: Grassland Management	2011	Analyses of data from grassland management and monitoring
Report #3: Undercliff Oak Forest Management	2011	Analyses of data from the Undercliff treatment units
Report #4: Overlooks Wildfire Study	2011	Analyses of data from the Overlooks wildfire

A. Grasslands

A critical objective for grassland bird habitat and for the Mohonk Preserve in their field management is to reduce and maintain low amounts of woody species cover, primarily shrubs. Most grassland birds prefer shrub cover of less than 10% (Morgan and Burger 2008). We found that total shrub abundance was reduced by all treatments, with significant results from spring burning and summer mowing. However, in many cases, short shrubs (< 0.5 m) remained stable or increased. Since these will enter taller height classes quickly, treatment effectiveness is temporary. One field at the Mohonk Preserve received two treatments in the same year: a spring burn and a late summer mow, which resulted in the most dramatic reductions in shrub cover.

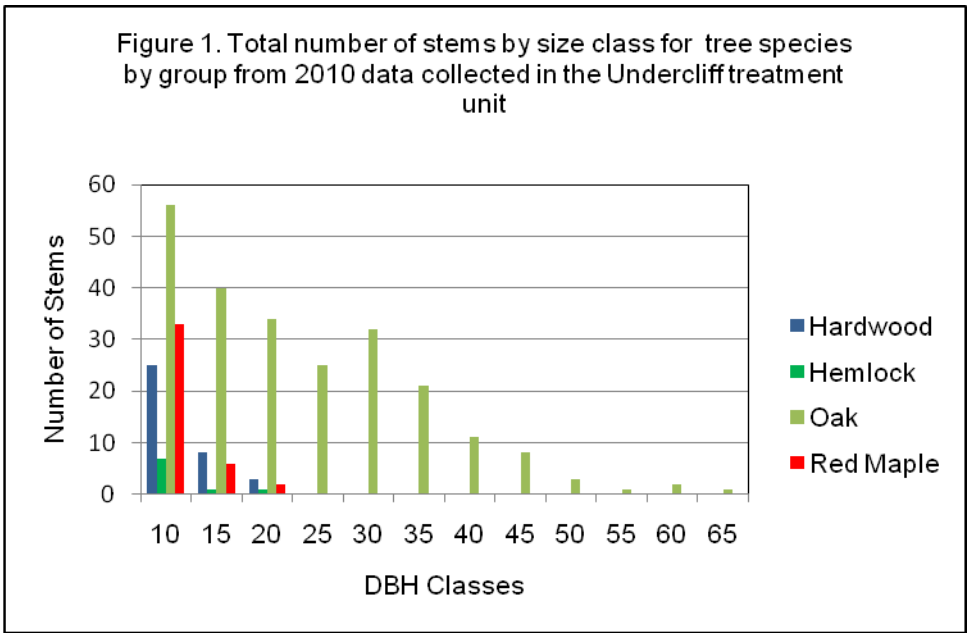
At SGNWR, we measured height-density, a variable correlated in other studies with grassland bird habitat. The value was significantly reduced following mowing treatments at SGNWR. As with most of the variables we measured, management shifted the values toward the ranges preferred by grassland bird species, but did not achieve the thresholds we had established. The fields would need longer term treatments than allowed for within the time frame of this study.

Invasive species abundance generally increased, though slightly. This is possibly due to disturbance from management creating additional light favoring some invasives, but longer term tracking is needed to determine this.

In some cases the results of treatments were different across treated fields. For example, optimal grassland bird habitat includes grass as a dominant with forb cover of 0-20%. Our management trials resulted in mixed changes in grass and forb abundance with most treatments increasing forb abundance. Some treatments resulted in increases in grass in one field and decreases in another at the same site.

B. Undercliff Oak Forest

The chestnut oak forest in the Undercliff treatment unit is dominated by oaks, primarily red oak (*Quercus rubra*) and chestnut oak (*Q. montana*). Figure 1 below shows the distribution of size classes.



The tall shrub variant of the chestnut oak forest is dominated by mountain laurel (*Kalmia latifolia*) which can range over three meters in height and have a cover of greater than 50% (Edinger et al. 2002). We counted live and dead woody stems and leaves at 0.5 m height intervals from one to three meters and found live woody stems and leaves relatively evenly distributed by height class prior to treatment in 2009. Most

mountain laurel stems and leaves were found at a height of between 0.5 and 1.5 meters. Following the burn, shrubs were top killed, so that nearly all live woody material was relegated to less than 0.5 m as plants resprouted. The photographs below of Plot 8-18-A-1 show the contrast between the plot in 2009 prior to the burn and after the burn in 2010. The live woody material, which was primarily mountain laurel, has been reduced to standing dead stems.

2009 (left) and 2010 photographs of Plot 8-18-A-1

Total seedling density in the 16 plots ranged from 5,333 to 18,416/ha prior to treatment and 7,666 to 31,250 after treatment. Oaks were the dominant seedling constituting 86.7% of total seedlings in 2009 and 77.5% in 2010. Red maple was a distant second with 4.9% in 2009 and 7.9% in 2010. Both oaks and red maple seedlings showed significant increases in density between pre and post treatment. Saplings are vulnerable to fire and sapling density decreased following the prescribed burn. Total sapling density ranged from 500 to 2,166/ha, prior to treatment and 0 to 750/ha after treatment. Oaks constituted 54.0% of total saplings in 2009 and 38.1% in 2010 while red maple constituted 14.6% in 2009 and 31.7% in 2010. Declines for both species were significant. It is likely that the number of sapling stems will increase as the living ones resprout and seedlings grow into that size class.

Both Black-throated Blue and Canada Warblers nest in the dense shrub layers of 1-3 meters that were reduced in height and cover by the prescribed fire. Clearly the fire was not favorable to those habitat characteristics needed for those species. While we can anticipate that growth of saplings and regrowth of mountain laurel will likely result in suitable habitat again, we cannot predict the time frame for that from this study. Two years after the Overlooks wildfire area, the short shrub (< 2 m) layer appears to have recovered to cover values comparable to unburned areas, but the tall shrub layer (2-5 m) has not.

There was negligible change in tree density or canopy cover one year post fire, Scarlet Tanagers require large, unbroken forests with closed canopy, so their habitat requirements remain unchanged. Wood Thrush nest in shrubs or low in the canopy, so changes for them are mixed. Based on observations from the Overlooks fire, there may

be substantial delayed tree mortality over the next several years. Litter cover remained relatively unchanged, and new litter will fall to replace what was burned. Therefore, habitat for Worm-eating Warblers should also remain relatively unchanged.

C. Overlooks Wildfire

1. Changes to Community Structure and Composition

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. Overall tree density in the chestnut oak forest was 66.2/ha in 2010, compared to 487.7 in 2008. Within open woodlands, tree density was 38.9/ha, compared to plots in areas forested where the density was 244.0/ha.

Changes in species composition were also surprising. One measure of tree composition is called “importance,” which is a combination of density, frequency, and dominance (measured by basal area). Throughout the wildfire area, 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 (*Acer rubrum*) did not. Red maple continued to have high importance values in burned forested areas.

It is highly likely that open woodlands were subject to higher intensity fires than areas that remained as forest. After two years, more trees died, and oaks had a higher survival rate than red maple or other species. Pitch pine (*Pinus rigida*) also had a high importance value in these open woodland plots, most likely as it was present in those areas before the fire. In fact, the low abundance of red maple and high abundance of pitch pine indicates that areas that transitioned to open woodland likely differed in composition from other areas of chestnut oak forest prior to the Overlooks wildfire.

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. Pitch pine density was reduced by the fire, but overall it increased in importance.

In 2010, we also counted seedlings and saplings within the plots in the burned area. In burned area, 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.

In chestnut oak forest plots, red maple constituted 61.4% and sassafras 26.1% of total 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, 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. There were only seven saplings in the pitch pine-oak-heath rocky summit. 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. Increased light in these open woodlands likely fostered both seedling and sapling growth.

The proportion of trees with resprouts ranged from 1.4% in unburned chestnut oak forest to 37.4% in burned chestnut oak forest and 21.1% in burned pitch pine-oak-heath rocky summit in 2008. By 2010, tree resprout proportions were 25.0% in the burned chestnut oak forest, 20.5% in open woodlands and 10.0% in pitch pine-oak-heath rocky summit.

For the chestnut oak forest, the average total cover of the tal shrubs (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*). Tall shrub 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 short shrubs (< 2m), total cover in 2008 burned plots was significantly lower than for unburned plots. In addition, short shrub cover for burned areas was significantly higher in 2010 than was found in 2008 indicating strong recovery of short shrubs between 2008 and 2010.

For the pitch pine-oak-heath rocky summit the tall shrub cover in both 2008 and in 2010 vs. NHP data (unburned) was significantly lower. Apparently short shrub cover in the burned area was higher than that for the NHP plots. Little recovery in either tall or short shrub cover 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 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. 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.

2. Changes to Bird Species Abundance

Bird species richness was higher in the wildfire area than in nearby unburned areas, and appeared to increase between 2008 and 2010. 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. The unburned area was not surveyed.[7]

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. Guilds assessed included species of greatest conservation need (SGCN), forest birds, cavity nesters and shrubland/early successional species. 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.

The seven SGCN species encountered were Black-throated Blue Warbler, Canada Warbler, Prairie Warbler, Ruffed Grouse, Scarlet Tanager, Wood Thrush and Whip-poor-will. 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 far more abundant in burned areas. Interestingly, Scarlet Tanager, Wood Thrush and Whip-poor-will were more abundant in burned areas. Worm-eating Warblers were not detected

For species associated with open habitats, Prairie Warblers were more abundant in burned areas, though they declined in abundance in burned areas after a dramatic increase in 2009 as well as in 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

[7] Survey effort in 2009 was less than in either 2008 or 2010.

woodpeckers and Great-crested Flycatchers was more mixed. Many cavity nesting woodpeckers prefer forested areas, so they may have avoided areas of sparse canopy.

III. Conclusions and Recommendations

The results of studies at each of these sites compose parts of a picture of what we have learned about managing grassland and oak forest habitat. Below I summarize the main conclusions and provide recommendations on further research and management, including management objectives.

A. Oak Forest Management

1. Overlooks Wildfire

The major outcomes of the Overlooks Wildfire:

- Extensive open woodland areas were created where tree mortality was apparently high due to high intensity wildfire. Left unmanaged, these areas will likely stabilize either as shrubland or woodland dominated by red maple and sassafras. Recovery of an intact chestnut oak forest may never occur.

- Dominance by sassafras and red maple was accelerated. From 2008 data, it appears that red maple was already becoming dominant, but overwhelming dominance of red maple and sassafras over oak in the seedling and sapling strata indicates this trend may become much more rapid.

- Red maple and sassafras produce litter with low flammability compared to oak leaf litter. As a result, the use of prescribed fire in a stabilized shrubland or woodland dominated by either or both of these species would be difficult.

The 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 in her surveys, whereas presettlement records indicated red maple was uncommon. Abrams (1992, 1998) has described the maintenance of oak forests by periodic surface fires reducing tree density and allowing for high amounts of light to foster forbs, shrubs and oak regeneration. He has attributed the increase of red maple to the lack of these recurrent fires and has labeled red maple as 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). The abundance of red maple and sassafras would strongly indicate this process is unfolding in many areas of the Shawangunks and may have accelerated in the Overlooks wildfire area.

Clearly the potential for large-scale wildfires should be reduced through the use of mechanical treatments and prescribed fire. The recently completed fire management

plan for the Shawangunks prioritizes areas for fuel reduction and management integrating the need for ecological management to restore and maintain both pitch pine and oak dominated communities (Chapin 2010).

Within the area of the Overlooks fire, there are several actions that should be implemented to both test restoration strategies and investigate the trajectory of the forest following that fire. I would propose a four staged approach:

- Use 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.

- Over the wide area of the burn, collect data using a modified version of the methods used in 2008 and 2010 to assess change over the next five to ten years. These plots would be stratified based on cover types mapped from the imagery. The objective would be to document changes in tree and shrub composition and on saplings species abundance. Sapling data should be collected to determine what species are likely to dominate the canopy layers. If resources were available, we might establish permanent plots, again stratified based on cover types, and used to more accurately measure tree mortality, shrub cover and height, regeneration and possibly. shrub cover and height by species along with canopy closure or measures of light.

- Establish experimental treatment units to determine what set and sequence of techniques could reduce red maple and sassafras and increase oak regeneration. Sassafras has shown up in abundance in other experimental treatments, and it is not known whether it will persist (Hutchinson, personal communication), so this is an important species to track. Treatments should include the use of fire and herbicides and mechanical removal of red maple and sassafras saplings and trees. Fire should be introduced as early a 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.

- Continue point counts for bird species but reallocate them according to cover types. Some of the inconsistencies in our results on bird abundance in the wildfire were likely the result of the locations of our points falling sometimes

within and sometimes on the edges of open woodlands or chestnut oak forest cover types. We may want to find other, unburned areas of the chestnut oak forest to do point counts as well for comparison. 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 (2008) has suggested more intensive methods using "spot mapping" and these should be used if resources are available.

2. Undercliff

By contrast to Overlooks, the results from Undercliff indicate that prescribed fire can be applied with negligible tree mortality and large increases in seedling regeneration. If we can determine that tree mortality was indeed low by continuing to track delayed mortality over time, this strongly favors the use of prescribed fire to prevent large scale and undesirable changes in forest composition and area that could potentially result from wildfires.

Tracking regeneration will be important. At a minimum, tree mortality should be tracked over the next five years to determine the degree of change. We tagged trees greater than 10 cm dbh in each plot, so this should be relatively easy. The management objectives for the use of prescribed fire should be to:

- Minimize mortality of the number of canopy oaks greater than 20 cm in diameter to 10% or less of pre-treatment numbers.
- Minimize mortality for oaks of 10-20 cm to 20% or less of pre-treatment numbers
- Reduce red maple and sassafras in all size classes by 90% of pre-treatment numbers

Prescribed burns have caused significant mortality to oaks, but stems greater than 20 cm in diameter seem to survive (Hutchinson et al. 2005, Blankenship and Arthur 2006). As shown in Figure 1 above, 41% of oak stems were less than 20 cm dbh.

Other studies have suggested that tree density (Signell et al. 2005), the creation of gaps (Chiang et al. 2005), canopy gaps (Rentch et al. 2003), canopy cover or openness (Blankenship and Arthur 2006), and site conditions such as moisture (Iverson et al.2008) are important for oak regeneration. Further literature review and contact with these researchers should be pursued to develop objectives for those factors. These can also be tracked through long-term monitoring at Undercliff. These may also be investigated in the Overlooks wildfire area, where gaps were created by that fire, and canopy cover is highly variable. However, some issues, such as canopy gaps and soil characteristics, will require study at other, larger treatment units.

Other studies have begun to suggest seedling numbers needed to maintain oaks (Iverson et al. 2008), but seedling and sapling counts are time consuming. Counting only saplings would reduce field time and focus on those individuals more likely to enter the subcanopy and canopy. Using saplings only, the management objectives should be:

- Assure dominance by oak saplings and minimal numbers of red maple and sassafras saplings by establishing a ratio of oaks to red maple of at least 10:1.

The average pre-burn ratio of oak to red maple saplings was approximately 3.7:1. This was reduced to approximately 1.2:1 post burn. Further research is needed on an optimal ratio, but I would recommend an initial objective for the ratio of oaks to red maple and to sassafras of 10:1.

3. Oak Forest Bird Habitat

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). From our Overlooks bird data we found an increase in species richness in and general declines in forest nesting birds within the burned area. In both Undercliff and Overlooks we also found that fire can significantly reduce shrub habitat for Black-throated Blue and Canada Warblers and other species depending on tall shrubs within forests. We need to know the time frame for recovery of shrub habitat to determine the appropriate timing of management burns. Mountain laurel is slow growing, so the timing of colonization by these species is dependent on the recovery of shrubs forming nesting and foraging habitat. This is also the likely timing of application of fire to prevent the more devastating consequences of uncontrolled wildfires

At the same time, areas of dense and tall shrubs can be allowed to recover providing nesting habitat without increasing the potential for large scale, high intensity wildfires. It should be possible to establish objectives for the minimum area and distance between tall shrub patches by well-designed breeding bird studies. The Undercliff unit would be a good place to establish such studies to allow us to characterize habitat that is colonized as shrubs recover.

At Undercliff, bird habitat and shrub height and cover should be remeasured after five years. Some of the cover categories could be eliminated to save field time with measurements of live vs. dead woody and live vs. dead mountain laurel retained. This would provide a measure of recovery following burning which would be useful to determine how long it takes for habitat to recover and how much time is needed between burns to maintain a given amount of shrub cover by height class. Other studies have indicated that mountain laurel can recover quickly, and outcompete oak seedlings and saplings (Moser et al. 1996).

Based on the data from Undercliff, the following should be initial management objectives:

- The range of cover of mountain laurel (stems and leaves) at 0.5 m in height should be between 35% and 45% (mean 40%), AND at 1.0 m of between 20% and 30% (mean 25%)

- The range of cover of other woody shrubs and trees in the shrub strata at 0.5 m should be between 35% and 45% (mean 40%) AND at 1.0 m between 15 and 25% (mean 20%).

- Minimum patch size of these shrub areas should be five hectares; however smaller patches of dense tall shrubs can remain.

- The overall cover of shrubs between 0.5 and 2.0 m should range from 50% to 75%

The above heights are basically the height where Black-throated Blue Warblers nest (Traynor Biasiolli, personal communication, Holmes et al. 2005), and the minimum patch size is 2.5 times the minimum habitat area for Black-throated Blue Warblers (DeGraaf and Yamasaki 2001).

The overarching goal should be to provide for habitat for shrub dependent forest birds while reducing the potential for widespread, high intensity wildfires in these volatile shrubs, particularly mountain laurel. The forest would have areas of 100% or more shrub cover separated by areas (30-50%) of no, sparse, or small patches of dense shrub cover. This contrasts with the nearly impenetrable thickets of tall mountain laurel and other shrubs characteristic of much of the chestnut oak forest in the Shawangunks. These objectives would have to be met within individual or multiple contiguous management units. The configuration could be highly variable, provided there were some dense patch of shrubs and areas with more sparse cover of shrubs along with forbs, graminoids and litter for ground cover. The objectives should be adjusted with experience and study.

4. Cavity Nesters and Birds of Shrubland and Open Woodland Habitat

Results from the Overlooks study were mixed on cavity nesters and birds of shrubland and woodland habitat. Management of oak forests will likely create snags suitable for nesting by cavity nesters. Reductions in canopy cover may also create gaps suitable for shrubland birds. Some shrubland nesters, such as Eastern Towhee and Prairie Warbler were observed in unburned areas of chestnut oak forest. Whip-poor-wills are also associated with relatively open forests. Further work on how chestnut oak forest management may affect these species is needed.

The total area of pitch pine-oak-heath rocky summit and dwarf pine ridge community is approximately 8,000 acres, compared to 25,600 for chestnut oak forest (Shawangunk Ridge Biodiversity Partnership 2003). Programs for management of these existing shrublands and open woodlands should also incorporate managing for shrubland bird habitat.

5. Other Issues

While not addressed in this study, we know that deer browse is a significant factor affecting regeneration. Ed McGowan (personal communication) has suggested establishing a large, fenced area within the Overlooks burn to track vegetation changes absent deer browse, and this could easily be integrated into these suggested studies.

B. Grasslands Management

The key findings of this study that is important to sites managing for grassland nesting birds are:

- Treatments will need to be implemented at least annually to reduce shrub cover due to the rapid regrowth of shrubs.

- Multiple treatments in a given year will be necessary to reduce shrubs and control invasives to a point where annual maintenance is sufficient.

While we clearly were able to significantly alter habitat characteristics important to grassland nesting birds, management over many years, and possibly involving multiple treatments within a given year will be needed to restore and establish grassland bird habitat. Since different fields responded differently to similar treatments, management objectives should be developed for each field or treatment unit with a prescription or set of protocols for achieving the desired status. In cases where shrub cover is high, fields should be placed in a restoration rather than a management category where extensive treatment is implemented to achieve management objectives. Once those are achieved, management intensity can be reduced to maintain the desired status.

A high cover of grass (70%) relative to forbs (30%) has been identified as important for grassland nesting birds (Morgan and Burger 2008). Given the short period of time of this study, our results tell us little about how to alter the relative abundance of grasses vs. forbs. Mowing multiple times may encourage grass cover and decrease forb cover. Mowing before seed set of forbs may also reduce their abundance over the long term (Morgan and Burger 2008). Zuckerberg and Vickery (2006) found higher grass abundance in mowed then burned fields. The key is attaining grass dominance during the nesting season, as increased abundance by forbs in the late summer or fall is likely irrelevant to nesting birds. More radical actions may be necessary including replanting fields with a high proportion of grasses to achieve the low forb cover preferred by many grassland nesting birds. In addition, habitat characteristics such as litter cover and

depth and height-density should also be considered in choosing management techniques, depending on the target bird species.

The abundance of invasive species increased following mowing or burning, probably as they were able to take advantage of the additional space from those disturbances. Invasive species will likely require the use of herbicides as mechanical treatments are generally ineffective against species such as purple loosestrife (*Lythrum salicaria*) or knapweed (*Centaurea* spp.). Mechanical treatment of bush honeysuckle (*Lonicera* spp.) may be effective if the entire plant is removed. Dormant season cutting or burning are generally ineffective for invasive species control. However, growing season application of either or both can be applied, but may require many year of treatment (Richburg 2005). Invasive species control will likely require annual treatments and monitoring of results to keep invasives from expanding.

If opportunities arise for the use of fire, then fire should be used along with mechanical treatments. Fire in the growing season could be used following earlier mowing if conditions are sufficiently dry. This strategy could quickly reduce shrub cover in a field.

Monitoring should be focused to address the specific management objectives of each field. So, using the shrub cover example, it may only be necessary to monitor shrub cover and not the other variables such as grass or forb cover as we did in this study. This will allow for an adaptive management approach based on solid information on management effectiveness while minimizing resource expenditures for monitoring.

1. Shawangunk Grasslands National Wildlife Refuge

Managing for grassland birds requires avoiding treatments during their breeding seasons which can run from April through July with possible second broods in August. However, individual fields or subareas can be treated in the spring provided sufficient area for breeding is left undisturbed. Mowing multiple times and/or mowing before the seed set of forbs may encourage grass cover and decrease forb cover. However, it may also be necessary to completely replant fields with a high proportion of grasses to achieve the low forb cover preferred by many grassland nesting birds. Fire can also be used if opportunities arise and resources are adequate. Invasive species control will require any of a series of methods including mechanical treatment and/or the use of fire in the growing season and the use of herbicides. Invasive species control will likely require annual treatments and monitoring of results to keep invasives from expanding.

<u>For SGNWR to establish and maintain grassland bird habitat, the management objectives should be to establish and maintain</u>:

- an average frequency of 70% graminoid to 30% forb cover
- an average height-density (measured using a Robel Pole) of 25 cm with sufficient diversity for target species

- an average woody frequency of less than 5%

- an average litter depth of 3 cm with some areas less litter for species such as Upland Sandpiper

- an average frequency of invasive species of less than 10%

Management and monitoring will need to be more intensive than for the Mohonk Preserve. In addition, there will need to be some way to correlate vegetation monitoring and management with breeding bird data. The refuge has permanent markers for point counts. While these provide a good overall gauge of breeding birds, they may not be appropriate for determining the effectiveness of actions within treatment units as there are not enough points in a given unit. More intensive monitoring of nesting for SGCN species may be needed within treatment units, and this will depend on how the refuge delineates treatment units in the future.

SGNWR will require extensive restoration to create grasslands where grasses actually dominate. Invasive species in those grasslands also present significant challenges. In both cases, land managers must adopt a restoration rather than a management approach with clear objectives and adaptation of actions through careful monitoring to assure those objectives are achieved. At some point in the future, long-term management can then be implemented.

2. Mohonk Preserve

While the quantitative monitoring can be somewhat time-consuming, by focusing on woody and invasive species, quantitative data can be gathered relatively quickly. At the Preserve monitoring need only be focused on woody and invasive species. I would recommend the following management objectives:

- The total shrub cover should be of 20% or less.

- The total cover for total invasives should be 10% or less.

This latter objective may be modified for specific invasive species. For example, every effort should be made to eradicate species such black swallow-wort (*Cynanchum louiseae*) as it can spread so rapidly.

Once the above objectives are achieved for a given field or group of fields, monitoring should continue to determine how long, following treatment, invasives and shrubs take to recover to levels specified in the objectives. This will help determine appropriate treatment regimes and timing and may save resources in the long run.

Based on the results from field K-24 where two treatments were implemented in one season, it is likely that all of the fields at the Preserve should be treated twice each season until management objectives are achieved. If fire can be used, it should be, but

if not, mowing should be substituted. In addition, as stated above, the Preserve will need to develop and implement invasive species management.

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