PROJECTED TRENDS IN FOREST HABITAT CLASSES UNDER CLIMATE AND LAND USE CHANGE SCENARIOS

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Abstract.—Wildlife species have diverse and sometimes conflicting habitat requirements. To support diverse wildlife communities, natural resource managers need to manage for a variety of habitats across a large area and to create long-term management plans to ensure this variety is maintained. In these efforts, managers would benefit from assessments of potential climate and land use change effects on habitats. As part of the U.S. Forest Service's Northern Forest Futures Project (NFFP), we assessed climate and land use driven changes in the areas of forest (≥66% canopy cover) and woodland (66% > canopy cover ≥ 10%) habitat across the Northeast and Midwest by 2060. Our assessments were made using NFFP projections based on three future storylines developed by the Intergovernmental Panel on Climate Change (IPCC). The total area of forest and woodland habitat is currently 173.4 million acres and is evenly split between forest and woodland (49% and 51%, respectively). Our assessments suggest that total forest and woodland habitat area will decrease in the future, but the magnitude of habitat loss differed among IPCC storylines, ranging from 5.9 to 11 million acres. Regardless of storyline, forest habitat was projected to gain area and woodland habitat was projected to lose area. As a result, forest was projected to represent a slight majority of the total habitat area (55% vs. 45% for woodland). Projected declines in woodland habitat represent a continuation of historical trends and have the potential to negatively affect woodland-dependent wildlife via reduced patch sizes, patch isolation, and edge effects.

INTRODUCTION

A significant challenge in natural resources management is providing sufficient habitat for wildlife species that have diverse and sometimes conflicting habitat needs (Noon et al. 2009). Suites of species are associated with particular forest habitat classes characterized by different compositions, ages, and structures (Patton 2011). For example, some species (e.g., Cerulean warbler, *Setophaga cerulea*) are associated with mature, deciduous forests while others (e.g., Kirtland's warbler, *Setophaga kirtlandii*) are found in disturbance-dependent, early successional, coniferous habitat. Successful conservation and management of species with different habitat associations requires management plans that are large scale and long term in scope; such plans are necessary to ensure that diverse habitat needs are simultaneously met and maintained through time (Hamel et al. 2005).

Efforts to conserve diverse groups of wildlife would benefit from assessments of projected climate and land use change effects on a suite of forest habitat classes. The Northern Forests Futures Project (NFFP), a joint effort by the U.S. Forest Service and several partners, is projecting and assessing the potential impacts of climate and land use changes on forest extent, composition, and structure across 20 states in the Northeast and Midwest. As part of the NFFP effort,

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we used projections of 2060 forest conditions and ancillary datasets to assess potential changes in areas of forest and woodland habitat classes.

DATA AND METHODS

Using a wildlife-habitat matrix developed by NatureServe (2011), we identified six current forest and woodland habitat classes: forest-hardwood, forest-conifer, forest-mixed, woodland-hardwood, woodland-conifer, and woodland-mixed. NatureServe defines forest habitats as having ≥66 percent total canopy cover and woodland habitats as having 40 to 66 percent canopy cover. Savanna, another NatureServe habitat associated with tree cover, is defined as having between 10 and 40 percent cover by trees and shrubs. Savanna is a rare ecosystem in northern forests and should not be confused with early successional stages of woodland or forest habitats, which also exhibit canopy cover of 10 to 40 percent. Therefore, we coded canopy of 10 to 40 percent as woodland. Canopy cover thresholds also are used to separate habitat composition within both forest and woodland classes. Areas are labeled as hardwood or conifer when >66 percent of the forest or woodland canopy consists of hardwood or conifer tree species, respectively. Habitats are labeled as mixed when neither hardwood nor conifer tree cover exceeds 66 percent of the total canopy cover.

We used NFFP projections to assess potential climate and land use driven changes in the areas of the six habitat classes from 2010 to 2060. NFFP's projections of future forest conditions were based on current data and historical trends from the U.S. Forest Service's Forest Inventory and Analysis (FIA) Program. FIA does not provide estimates of canopy cover, so we used a computer algorithm to derive estimates of canopy cover from FIA data, enabling us to crosswalk NFFP area projections to forest and woodland habitat classes. Details of the methods used to derive canopy cover estimates are provided by Toney et al. 2009 and Nelson et al. (in this proceedings).

NFFP projected future forest conditions under climate and land use change scenarios consistent with the Intergovernmental Panel on Climate Change's (IPCC) A1B, A2, and B2 storylines. A1B assumes rapid economic growth, a global population that peaks in the middle of the 21st century and then declines, and mixed energy use from fossil and non-fossil fuel resources; A2 assumes that the global population continues to grow throughout the century and that economic development will be regionally oriented; and B2 assumes regional and local economic growth with per capita income similar to A2 but assumes projected population growth that is lower than the other scenarios (USDA Forest Service 2012). For each storyline, climate conditions were projected using multiple General Circulation Models (GCMs) to examine model-based uncertainty.

RESULTS

Across the Northeastern and Midwestern U.S., the current total area of all forest and woodland habitat classes (as defined above) is 173.4 million acres (Table 1). The region is dominated by the forest-hardwood (41% of forest habitat) and woodland-hardwood (34%) habitat classes with no other class exceeding 10 percent of forest habitat. Forest land is about evenly split between the groups of forest and woodland habitat classes (49% and 51%, respectively).

Projected changes in habitat for IPCC storylines did not differ across GCMs, possibly because NFFP projected habitat conditions over a relatively short 50-year time period. For this reason, we did not stratify assessments results by GCMs.

Loss of total forest and woodland habitat area was projected under all three IPCC storylines although the magnitude ranged from 5.9 million acres under B2 to a loss of 11 million acres under A1B (Table 1). Patterns of change for habitat classes were consistent across all three IPCC storylines (Table 1). All three forest habitat classes gained area; percent gains were greatest

Table 1.—Area (millions of acres) and percent change of six forest and woodland habitat classes across the Northeast and Midwest.[a]

IPCC Storyline	Total Habitat	Forest-Hardwood	Forest-Conifer	Forest-Mixed	Woodland-Hardwood	Woodland-Conifer	Woodland-Mixed
Baseline	173.4	70.4	4.3	10.8	59.5	16.7	11.7
A1B	162.4 (-6.4%)	73.1 (3.8%)	5.2 (20.9%)	11.4 (5.6%)	48.5 (-18.5%)	14.3 (-14.4%)	9.9 (-15.4%)
A2	164.1 (-5.4%)	74.3 (5.5%)	5.0 (16.3%)	11.6 (7.4%)	48.7 (-18.2%)	14.5 (-13.2%)	10.1 (-13.7%)
B2	167.5 (-3.4%)	74.9 (6.4%)	5.0 (16.3%)	12.1 (12.0%)	50.6 (-15.0%)	14.6 (-12.6%)	10.2 (-12.8%)

[a] Estimates are provided for 2010 baseline conditions and for 2060 based on the A1B, A2, and B2 storylines from the Intergovernmental Panel on Climate Change (IPCC). Changes in habitat classes between 2010 and 2060 were driven by projected land use changes, forest succession, and forest harvest. See text for explicit definitions of forest habitat classes.

for forest-conifer and least for forest-hardwood. Conversely, all three woodland habitat classes lost area; percent losses were greatest for woodland-hardwood and least for woodland-conifer. Forest habitat classes were projected to increase relative to woodland habitat classes as a percent of total habitat (55% versus 45%, respectively).

DISCUSSION AND CONCLUSION

Our assessments suggest that the total area of forest and woodland habitat classes will decrease across the Northeast and Midwest by 2060. This loss in total forest and woodland habitat acreage has the potential to negatively affect wildlife populations. Although we did not directly assess spatial patterns of habitat loss, reduced habitat area can lead to smaller and more isolated forest patches. These patches support fewer individuals and are less likely to receive immigrants from other areas, increasing the likelihood of local extinctions and decreasing the likelihood of recolonization or population rescue. Smaller forest patches in this region of North America are also more exposed to negative ecological influences (e.g., nest predators) from surrounding nonforest land uses, contributing to local population declines. If habitat loss is widespread, regional declines and extinctions may result. These effects may be of more immediate concern for woodland habitat classes than forest habitat classes, which are projected to increase in area. Nevertheless, land conversion to nonforest land use types ultimately constrains the area and spatial distribution of all forest and woodland habitat classes. Our assessments suggest that uncertainty about future demographic, economic, and technological conditions (as represented by different IPCC storylines) contributes to uncertainty about the extent of habitat loss. Policy (e.g., promoting growth near existing urban centers) and financial mechanisms (e.g., tax deductions resulting from conservation easements) might be used to limit the negative effects of land use change on forest wildlife.

Researchers have reported decades-long declines in the area of early successional forest habitat across the Northeast and Midwest (Trani et al. 2001). These declines have been attributed to a number of different causes including forest maturation of abandoned farmland, altered forest management practices, forest ownership patterns that discourage harvest, disrupted natural disturbance regimes (e.g., fire suppression), and land use conversion (Trani et al. 2001). Assuming that early successional forests can be characterized as having more open canopies, projections of woodland habitat classes in our assessment suggested that declines of this habitat type may continue into the near future. We found that all woodland habitat classes declined and that regional habitat became dominated

by forest habitat classes. These projected declines may negatively affect not only woodland-associated species but also species typically associated with forest habitats that are dependent on woodland areas during certain times of the year (e.g., Streby et al. 2011, Vitz and Rodewald 2006). Ultimately, the future status of wildlife species dependent on young forests or woodland habitat will depend on the scale, type, and frequency of anthropogenic and natural disturbances occurring in landscapes across the Northeast and Midwest. These disturbance patterns will be affected by future management decisions (e.g., type of forest harvest) as well as changing socioeconomic (e.g., changing ownership patterns) and ecological conditions (e.g., climate change).

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