Acadian Flycatcher Habitat Loss in Great Smoky Mountains National Park due to Hemlock Woolly Adelgid

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Hierarchical species-habitat analysis and conservation, Spring 2007

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Introduction

The hemlock woolly adelgid (*Adelges tsugae* Annand) is an exotic pest that infects and kills carolina hemlocks (*T. caroliniana* Carriere) and eastern hemlocks (*Tsuga Canadensis* Carriere). It is expected to spread throughout the Great Smoky Mountains National Park (GSMNP), significantly altering plant communities in the park (Koch et al. 2006). Shriner and Simons (2001) found that presence for eight species of songbirds, including the Acadian Flycatcher (*Empidonax virescens*) were positively associated with hemlock presence. It is therefore important to understand the relationship between adelgid infestation and songbirds in order to effectively manage songbirds in the park.

Objective

To estimate the amount of habitat that will be lost in the near future to hemlock woolly adelgid (HWA) for a hemlock-associated songbird.

Hypothesis

The loss of currently infested hemlocks will result in a significant loss of Acadian Flycatcher habitat.

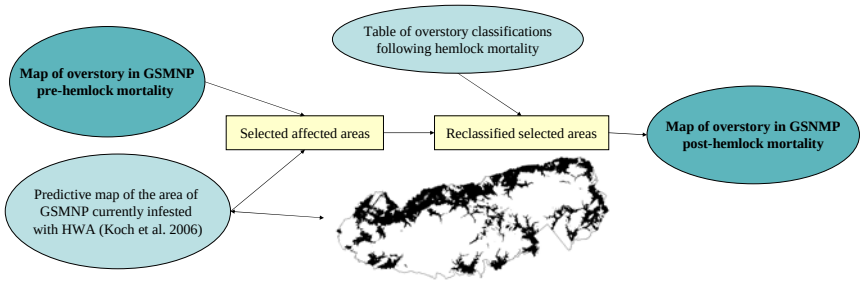
Methods

I created a deductive model in ArcMap of Acadian Flycatcher (ACFL) habitat in GSMNP and ran it using maps of canopy composition from before and after hemlock death due to HWA. I used Koch et al.'s (2006) predictive map of current HWA infestation in GSMNP to create a post-HWA overstory classification map. I identified canopy type, patch size, distance to edge, percent canopy cover, and distance to stream as environmental variables that are associated with ACFL presence by reviewing habitat associations described in published literature, Natureserve Explore, and the Birds of North America. I used these variables as criteria for selecting forest patches that are suitable for breeding ACFL's.

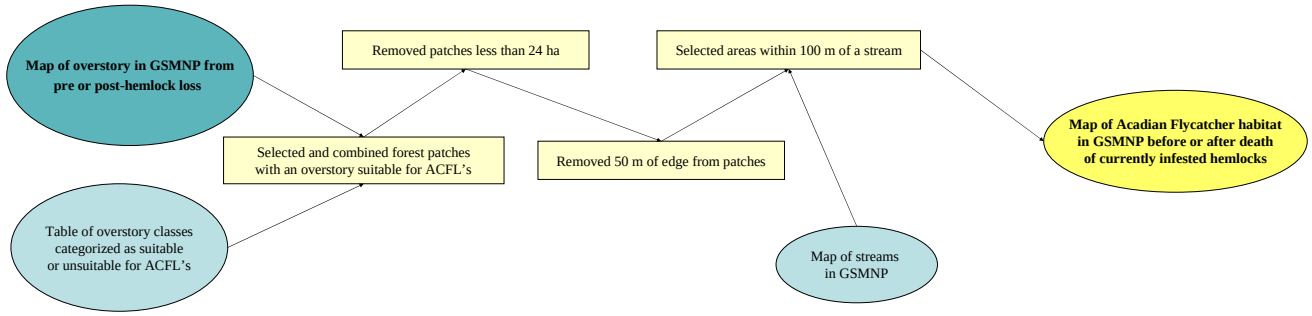
Ecologically significant assumptions

•Habitat selection criteria for ACFL's will not change with the removal of hemlocks.
•HWA infestation results in the complete mortality of hemlocks in the area.
•Following hemlock mortality, forests transition to a state where the remaining tree species dominate and pure hemlock stands become non-forested areas following hemlock death.
•Canopy classes that fall in the "forest" or "woodland" categories have a canopy cover of over 50%.

Creating a post-hemlock mortality overstory map



Modeling Acadian Flycatcher habitat in GRSMNP before and after the death of hemlocks currently infested with HWA



Infested and non-infested Acadian Flycatcher habitat in GSMNP

Acadian Flycatcher

Results

•22% of GSMNP is suitable habitat for ACFL.
•1.01km2 (0.0002%) of ACFL habitat is currently infested with HWA.
•Average patch area will decrease by 0.0001% when currently infested trees die.
•The number of habitat patches will increase by 220 after hemlock death.

Model assessment

Under the assumption that ACFL's occupy all suitable habitat, I assessed my model with observations in GSMNP made by Ted Simons and colleagues by comparing observed presences and absences of ACFL's with my model's results. My predictions agree with observations slightly better than random predictions would (Kappa = 0.21), and the proportion of my predictions that were correct was high (sensitivity = 0.76, specificity = 0.89, correct classification rate = 0.89).

Conclusions

A very small proportion of ACFL habitat in GSMNP is currently infested with HWA. My results indicate that the death of infested hemlocks will result in habitat fragmentation but not a substantial decrease in average patch size. However, HWA is spreading throughout the park and will have greater effects on ACFL in the future. My estimates are specific to the period of 1997-1999, when my data sets were created. A more accurate model may produce more conservative designation of habitat and increase the estimate of the proportion of habitat that is infested. My model could be improved by introducing elevation and distance to river and by refining the criteria for defining a patch of ACFL habitat. Future work on this subject would benefit from the integration of results from field studies that specifically address the relationship between ACFL and hemlocks in the understory as well as the overstory and further explore ACFL's tolerance of forest edges.

Koch, F. H., H. M. Cheshire, and H. A. Devine. 2006. Landscape-scale prediction of Hemlock Woolly Adelgid, Adelges tsugae (Homoptera: Adelgidae), infestation in the southern Appalachian mountains. Community and Ecosystem Ecology 35:1313-1323.
Shriner, S. A., and T. R. Simons. 2001. Potential effects of hemlock loss on forest and bird communities of Great Smoky Mountains National Park. PhD dissertation, North Carolina State University, Raleigh, NC.