Hemlock Resources at Risk in the Great Smoky Mountains National Park

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Introduction

Eastern hemlock (*Tsuga canadensis* (L.) Carr) is the dominant species in a variety of sites in Great Smoky Mountains National Park. Hemlock covers approximately 3820 acres (1528 hectares) or one percent of the Park, which at 524,856 acres is the largest area managed as wilderness in the eastern United States. Since timber was never harvested in about 20% of the Park, many of the hemlock areas are virgin forests containing trees exceeding 400 years of age. From 1992-1995, Park resource managers began to identify, map, and gather baseline information on hemlock forests. Approaching infestations of hemlock woolly adelgid provided some urgency for this inventory. In addition, the fauna of hemlock forests are virtually unknown. In 1996, the Park began a cooperative project with NC State University to develop survey methods for arthropods associated with hemlock. Knowledge of species present, seasonal abundance, natural variations in abundance and locations of rare species will be fundamental in decisions regarding the use of insecticides or biological controls against HWA. Baseline information gathered prior to infestation will assist Park managers in evaluating changes in the ecosystem and potential restoration efforts.

Objectives

1) Determine the location and size of hemlock - dominated forests throughout the Park
2) Determine the species composition, ages, and disturbance history of these forests before the arrival of hemlock woolly adelgid
3) Develop survey methods for hemlock fauna
4) Determine seasonal abundance and distribution of selected arthropod species associated with hemlock

Methods

Potential hemlock stands were located using Great Smoky Mountains National Park's Geographic Information Systems data (Pyle, 1985) and 1982 winter aerial photographs (scale 1:34000). Minimum stand size was 5 hectares. Winter photos gave the benefit of leaf-off condition for hardwoods and weather conditions may make one set of photos better than another for distinguishing hemlock from white pine (*Pinus strobus* L.). Once located on the aerial photos, the larger potential areas of hemlock were field checked to verify the forest cover type, to obtain species composition and age data, and to note visual signs of past disturbance. The two forest type classifications used for hemlock delineation were "hemlock/cove hardwood" and "hemlock/northern hardwood." These were determined by the species association with the highest representation of stems in the upper canopy layers. To verify overall forest type and species composition, a minimum of two canopy tree tallies were conducted in each stand, using approximated 1/10-ha circular "plots." For each of the tallies, a center point was arbitrarily selected, and within a visually estimated 20m radius, trees greater than 10 cm DBH were tallied by species, crown class, and presence/absence of regeneration. To determine tree ages and to gain an idea of tree sizes within the stand, increment cores and diameter were taken at breast height from a minimum of two trees per tally site. Any visual signs of disturbance such as (but not limited to) selective logging, fire, or chestnut blight (Cryphonectria parasitica (Murrill) Barr), were noted on the field data sheets.

For the arthropod monitoring component of the study, research plots were established in two old growth stands (Inadu Knob and Cataloochee) and two secondary growth stands (Elkmont and Cosby). Within each stand, 16 monitoring stations were located at sites representative of the plot. Each station was a 0.1-acre circular plot. Approximately 20 meters separated the stations. The study had a total of 64 monitoring stations (32 in old growth and 32 in secondary growth stands). The design allowed for sampling all 64 stations within one week. Several sampling techniques were used, with light traps and pit-falls producing the most specimens. On successive nights, one UV light trap was placed in each of the four hemlock stands to capture nocturnal aerial insects. For approximately one hour after sunset, insects attracted to the light trap were captured with an aerial net.; a white sheet hung near the light facilitated this operation. The light trap was powered by a portable battery pack and remained the entire night, with insects being captured in soapy water.

Ground dwelling arthropods were captured in pit-fall traps that were open 24 hours. The center of each sampling station had five traps placed in an X-pattern. Surveys were conducted in the weeks of June 5, 1995, July 17, 1995, September 4, 1995 and April 22, 1996.

Results

Hemlock forests are widely distributed in the Park with elevations ranging from 1,500 to 5,700 ft. At lower sites, stands are found along streams and north-facing slopes, while higher sites are along ridges. In addition to the contiguous stands delineated in this study, hemlock are a frequent component of cove hardwood and northern hardwood forests and are sometimes mixed with pine or spruce. The hemlock stands were heavily logged before the Park was established: Thirty three million board ft. were removed from the Smokemont drainages alone, and one billion board ft. from the Little River area (Stupka, 1964). While the Park has the current national champion tree (a

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specimen 165 ft tall) many of the oldest trees are growing on poorer sites inaccessible to loggers and may be rather small. For example, one 20-inch DBH tree cut for a trail footlog was 535 years old. Average ages were around 220 years. Forty-nine stands were delineated, with a total of 87 ha (2,169 acres). Most of this was old growth, with some areas showing signs of selective logging and occasional fires. At present, 57% of the Park's photo-delineated stands have been ground checked, with the priority placed on the largest contiguous areas. A rough estimate of the Park's hemlock coverage stands at approximately 4,000 acres.

One of the reasons for delineating the hemlock stands was to facilitate research in inventory and monitoring of species associated with these ecosystems. Specimens from one of the first studies, the NC State arthropod study, are still being processed and identified. The total number of specimens caught in light traps were numerous and considering that most were microlepidopterans and even smaller insects, these numbers are probably in the order of five to six thousand. Where aerial nets were used to selectively sample insects coming to the light traps, 668 quality specimens were collected. Approximately 50 percent of these have been identified to species. In the old growth stands, 260 were collected at Cataloochee and 57 at Inadu; for the secondary growth stands, 184 were collected at Cosby and 195 at Elkmont. In addition to the 668 specimens taken with aerial nets, light traps yielded 614 specimens from Cataloochee and 461 from Inadu; for Cosby the number was 793 and for Elkmont, 579. All these specimens are pinned and identified to family. The results of the pitfall traps clearly show distinctive differences in insect diversity between the old growth and secondary growth forests. The old sites yielded only 172 insects (Cataloochee 116 and Inadu 56), but the secondary growth sites totaled 1133 (Cosby 259 and Elkmont 874). The diversity in these terrestrial insects is striking when expressed in terms of family. The old growth had 27 families while the secondary growth had 63 families. There were 13 families that were common to each of the different forest sites.

In 1998 the Park began an "All Taxa Biodiversity Inventory" with the goals of completing a comprehensive checklist of all life forms in the Park, along with range maps, habitat and natural history information, and relative abundance. Priority is placed on ecosystems at risk, and hemlock is certainly among these. The Park invites researchers to assist in this project.

References

Johnson, K. S. 1995. **Eastern hemlock forest delineation in Great Smoky Mountains National Park (1993-1995).** Great Smoky Mountains National Park, Resource Management files. 21 p.

Pyle, C. 1985. **Vegetation disturbance of the Great Smoky Mountains National Park: An analysis of archival maps and records.** USDI, National Park Service, Southeast Region, Research/Resource Management Report SER-77, Atlanta, GA. 69p.

Stupka, Arthur. 1964. **Trees, shrubs and woody vines of the Great Smoky Mountains National Park.** University of TN Press, Knoxville, TN. 186 p.

Yost, E. C.; Johnson, K. S.; Blozan, W. F. 1994. **Old growth project: stand delineation and disturbance rating.** National Park Service, Great Smoky Mountains National Park, Technical Report NPS/SERGSM/NATR.