"PRELIMINARY" FINAL REPORT
Forest Service Grant No. NA-95-0302

Period covered by this report: August 16, 1995 through December 31, 2001

Issued to: Arbor Resources Group

Address: 405 W. Mosley Street, #4, Ann Arbor MI 48103

Project Name: A Study for the Effect of Vegetation on Microclimate and Residential Energy Use in Ann Arbor, MI

Contact Person/Principal Investigator:

Name:	Geoffrey Lewis
Mailing Address:	same as above
Phone Number:	734.665.6665
Fax Number	734.647.5841
E-Mail Address:	glewis©umich.edu

Date of Award: September 28, 1998

Grant Modifications: N/A

Date of Expiration: December 1, 2001

Funding: Federal Share: $55,000 plus **Grantee Share:** $60,250 = **Total Project:** $115,250

FS Grant Manager: Phil Rodbell
Address: Forest Service, 100 Matsonford Rd. 5 Radnor Corporate Center, Ste. 200, Radnor, PA, 19087-4585
Phone Number: 610.975.4133
Fax Number: 610.975.4136

Project Abstract (as defined by initial proposal and contract):

Energy conservation attributable to trees through direct shading, evapotranspiration, and wind shielding is experienced locally in lower utility bills and reduced peak energy demand. On the larger scale, a reduction in energy use implies lower emissions of greenhouse gases (including carbon dioxide) from the burning of fossil fuels. Building on previous work in Ann Arbor, Michigan funded by NUCFAC, this study seeks to quantify the effect of vegetation on microclimate and residential energy use. The first phase of the study monitors air temperature, wind direction and speed, and solar radiation in three neighborhoods with distinctly different tree canopies. Differences in microclimate variables attributable to vegetation would imply differences in energy used for heating and cooling. The second phase studies changes in energy use related to the removal of large healthy trees. Electricity and gas use for one year before tree removal will be compared with data for one year after removal, with any significant weather-corrected difference signaling an effect due to the presence of the tree.

Project Objectives:

The primary objective of both phases of the study is to increase our understanding of how trees affect energy use in residential buildings through modification of microclimate. In the first phase, a major objective is the measurement of microclimate variables (temperature, wind direction and speed, and insolation) for at least one complete heating and cooling season (i.e., one year) in areas of different canopy closure. Once these data are gathered, statistical analysis to determine the presence and magnitude of any difference due to vegetation is the next objective. Comparison of the data with utility use information may also be of interest.

The second phase of the project looks at changes in energy use over time in a group of houses that are having large adjacent trees removed. This instantaneous change in vegetation is much easier to analyze than planting trees and waiting for them to mature to provide shade and wind shielding. We will identify candidates for the study through cooperation with tree care companies and will then obtain electricity and gas use for the subject houses for one year prior to and for one year after tree removal. After correcting for differences in weather, analysis of energy use will provide a measure of the tree's role in affecting the space conditioning needs of the house.

Objectives met successfully to date:

For phase one, we procured six sets of instruments and data loggers from NRG, Inc. and erected them together in a large field as a beginning calibration. The instruments were deployed in the study area in April 1996, two each in three contiguous neighborhoods in Ann Arbor, Michigan. One neighborhood had very heavy tree cover, one had very few trees, and the third was an area of intermediate tree stocking. The loggers record hourly averages of temperature, wind direction, wind speed, and insolation. Data were downloaded from the loggers approximately once a month. The instruments were moved back to the large field in July 1997 for an ending calibration.

Data analysis began in September 1998 after a delay described in the no-cost extension paragraph of this report. The analysis of the pre- and post-experiment instrument calibration data is complete and has resulted in a determination that the instruments performed without measurable difference when placed in the same location. Any differences detected in the data from the study period will then be attributable only to differences in meteorological conditions. The analysis of study period data has been completed and a report is in preparation and will be submitted shortly.

In reference to the second phase, participation of the utility companies has been secured and identification of candidate houses is complete. Approximately 30 of the 50 houses identified to date are appropriate participants, as determined by screening criteria applied to every tree removal we are informed of. These criteria include: no change in the adjacent structure; removed trees must have been previously healthy, removed trees must be within a certain distance of the house. Although the original goal of 50 to 100 participants was not reached, we believe that our approach will still provide a meaningful analysis of the direct effect of trees on energy use. Since it has now been 1 full year since the last tree removal, analysis is underway on all cases included in the study.

Objectives not yet met:

The identification of at least 50 houses for phase two was not achieved. In the interest of completing this phase of the project in a timely manner and due to the 1-year time lag that must occur before analysis can begin, we elected to end the search for new participants at the current number (--30). The analysis of the energy use data for the participating houses will be completed and reports on both phases of the project will be written and submitted to the U.S. Forest Service no later than March 1, 2002. This date is later than anticipated due to the necessity of one of the principals undergoing and recovering from a surgical procedure.

How will this project increase knowledge about urban forestry?
How will the public benefit?

The potential for energy conservation through vegetation management is certainly real. While preliminary studies have shown the potential to be considerable, a challenge exists in quantifying the combined effect of trees on both heating and cooling using occupied houses as the subject of study. Comparison of residential microclimate conditions under various levels of canopy closure will allow researchers to directly measure the impact of trees and estimate savings and costs for space conditioning.

Peak energy demand is a major concern for most electric utility companies. The ability to limit the occurrence and moderate the severity of peak demand, for many companies, determines the construction of new generating capacity or the need to purchase, at high cost, electricity from other generators. Indeed, a successful demand side management program (including, for example, tree planting) may delay or prevent the need to construct additional power plants. Moderating peak energy demand is thus beneficial economically and ecologically.

This study will increase our understanding of one of the quantifiable benefits of urban trees, their effect on energy use. Benefits to the public include:

- advice on the optimal placement of trees around houses to maximize energy conservation in a particular climate
- direct reduction of energy use and expenses for utility bills
- reduction of carbon emissions from combustion of fossil fuels
- guidance for electric utility companies interested in managing their peak energy demand and lowering the cost of supplying power.

What specific quantifiable results will be produced?

The first phase of the project will result in a statistical analysis of microclimate focused on identifying differences in temperature, wind speed and direction, and insolation attributable to differences in vegetation. Any differences found can be used to inform a methodology for estimating the energy savings or cost of trees around a house.

Phase two will also result in a statistical analysis, this time of the difference in energy used for heating and cooling in houses that are having large trees removed.

How will the results be disseminated to the public?

A press release on the large tree removal phase of the project was distributed in northeast Ohio. As a result, a story was published in a local newspaper and WEWS television in Cleveland broadcast a story describing the research. Additional press releases will be sent out as both phases of the project are completed.

In addition to sharing information with the general public, we will also present papers at national and regional conferences and publish at least one paper on each phase of the project in a peer-reviewed journal. A presentation on the microclimate phase of the project is being presented at the ISA conference in August 1999. We feel that the results of this study should be of interest to the arboricultural community as well as those in the utility industry and we will strive to present them in the appropriate publications.

If a no-cost time extension has been requested, why is (was) it needed?

A no—cost extension was requested and granted to accommodate administrative and political difficulties in transferring the grant from the original issuee (ACRT, Inc.) to the Arbor Resources Group following the departure of one of the investigators (Mr. Laverne) from ACRT, Inc.

A second no-cost time extension was requested to accommodate the data analysis and report writing necessary for phase two. This extension resulted directly from the difficulty in identifying the desired number of candidate houses with adjacent large tree removals.

List the active partners (key individuals or organizations) involved to date:

R.J. Laverne (Davey Resource Group) and Geoff Lewis (Arbor Resources Group) have been solely responsible for the design and implementation of both phases of this research project. We have received cooperation from Gordon Heisler and Dave Nowak of the U.S. Forest Service. Utility companies that have agreed to supply energy use data are Detroit Edison, Michigan Consolidated Gas Company, Ohio Edison, and East Ohio Gas Company. We have also received advice and guidance on statistical analysis from Dr. Gary Fowler, Dr. Edward Rothman, and Dr. Emily Silverman at the University of Michigan.

Comments considered of importance but not covered above:

This report was prepared by:
Name: Geoffrey Lewis
Title: President, Arbor Resources Group
Phone: 734.665.6665
Date: 1/11/02