

Appendix D - UNIVERSITY HONORS PROGRAM  
SENIOR PROJECT - APPROVAL

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I have reviewed this completed senior honors thesis with this student and certify that it is a project commensurate with honors level undergraduate research in this field.

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Comments (Optional):

**Small mammalian populations in anthropogenic and natural disturbed forests  
in Oak Ridge, Tennessee**

A Senior Thesis

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## **SMALL MAMMALIAN POPULATIONS IN ANTHROPOGENIC AND NATURAL DISTURBED FORESTS IN OAK RIDGE, TENNESSEE**

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*Abstract:* The purpose of this mark-recapture study was to determine if wildlife response to anthropogenic disturbances (such as clearcutting) mimic natural disturbances (such as tornadoes). To investigate this question, the following population parameters were compared: abundance, sex ratio, age structure, and species diversity between the anthropogenically-disturbed study sites (clearcuts) and naturally-disturbed study sites (tornadoes). The following null hypotheses were tested: Abundance does not differ between clearcut study sites and tornado study sites, sex ratios do not differ between clearcut study sites and tornado study sites, age structure does not differ between clearcut study sites and tornado study sites, and species diversity does not differ between clearcut study sites and tornado study sites. If these null hypotheses are rejected, support will be given to the idea that anthropogenic disturbances (such as clearcutting) do mimic natural disturbances (such as tornadoes).

Research was conducted at the University of Tennessee Forestry Experiment Station in Oak Ridge, TN. The experimental design involved 3 habitat types: clearcut (an experimental variable), tornado (another experimental variable), and mature, undisturbed forest (the control), 2 study sites per habitat types for a total of 6 study sites. Twenty Sherman live traps were placed in a grid covering each study site, for a total of 40 traps per habitat type, and a grand total of 120 in the study. The study period consisted of 10 trap nights—February 4-6, 11-13, 18-20, March 3-5, and 10-12. Two types of comparisons are made: comparisons of population parameters within the study sites and then comparisons of population parameters among the habitat types.

Clearcuts had slightly more individuals than the tornado (31 vs. 25). The forest areas had the least number of individuals (7). The clearcuts' sex ratio was skewed towards males more than the tornado areas (65% vs. 52%), whereas the forest areas' sex ratio was skewed to the females (57%). The clearcuts' age structure was skewed towards juveniles (65%) whereas it was balanced in the tornado areas (52%). The forest areas' age structure was skewed towards the adults (57%). Species diversity was greatest in tornado areas (4 species), next greatest in the forest areas (3), and lowest in the clearcut area (2). However, the sample size was not large enough (i.e., not enough small mammals were captured) for statistical analyses to draw strong inferences, and further study is needed to answer this question.

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**Key words:** clearcut, disturbance, mark-recapture, small mammals, species diversity, tornado

A long-held assumption is that anthropogenic disturbances mimic natural disturbances, even though this assumption has received little empirical testing of its validity (Andreadis 1995). A tornado that swept through a forestry experiment station in Oak Ridge, Tennessee, on 21 February 1993, thereby damaging approximately 100 ha of forest, provided a unique opportunity to test this assumption because tornado-disturbed forest was the same size, forest type, and age as the adjacent clearcut areas (Andreadis 1995). Since these disturbances approximate each other in terms of space and time, comparisons can be made between the disturbed areas. The surrounding mature forest was used as a control. The purpose of the present study was to evaluate the response to these disturbances on small mammal populations. The following null

hypotheses were tested: Abundance does not differ between clearcut study sites and tornado study sites, sex ratios do not differ between clearcut study sites and tornado study sites, age structure does not differ between clearcut study sites and tornado study sites, and species diversity does not differ between clearcut study sites and tornado study sites. If these null hypotheses are rejected, support will be given to the idea that anthropogenic disturbances (such as clearcutting) do indeed mimic natural disturbances (such as tornadoes).

#### STUDY AREA

The Oak Ridge Unit of the University of Tennessee Forestry Experiment Station is a 900-ha research forest in eastern Tennessee (Figure 1). The Oak Ridge Unit is comprised of three management areas: Chestnut Ridge, Pine Ridge, and a public Arboretum. The present study was conducted exclusively on Chestnut Ridge. The soil on Chestnut Ridge is primarily a Fullerton cherty silt loam with dolomite rock below (Andreadis 1995).

A single tornado struck a continuous 4.2 km stretch of the Unit and heavily damaged the Chestnut Ridge forest. Approximately 100 ha were severely impacted by the tornado. A research disturbance area was established on 28 ha of the severely impacted area where the downed timber was not salvaged (Andreadis 1995).

In 1990 clearcutting occurred. Two distinct plots totaling 10 ha were clearcut. Three replicates of four treatments (0.4 ha each) within these plots were established to determine the effects of various site preparations on the re-establishment of a mixed deciduous-coniferous forest. The four treatments were: 1) commercial clearcut, 2) commercial clearcut and fell all remaining stems, 3) commercial clearcut, brown with herbicides, and burn, and 4) commercial

clearcut, fell all remaining stems, and burn. Then all treatments were replanted in white pine on a 6 m by 6 m spacing (Andreadis 1995).

A predominantly two-aged, oak-hickory forest with 50-60 year-old and 100-120 year-old age classes was the intact forest used in this study. Until 1942 when the United States Atomic Energy Commission bought the land this area was under private control and subjected to grazing, fire, and high-grading. In 1962 the University of Tennessee acquired the land from United States Atomic Energy Commission. From 1942 to the present, the land has been protected from fires and grazing animals. Timber harvest has been limited: salvages of a small amount of windblown timber and southern pine beetle infested stands and small clearcuts for research purposes (Andreadis 1995).

Trapping plots were stratified across the forest, clearcut, and tornado areas, with two replicates per habitat, resulting in six study sites. Following is a brief description of each study site.

Tornado site 1 was steeply sloped  $25.25^{\circ}$  ( $SEM = 2.93^{\circ}$ ) (Andreadis 1995). Residual trees were mainly oaks with sourwoods (*Oxydendrum arboreum*), tulip poplars (*Liriodendron tulipifera*), maples (*Acer* spp.), and hickories present (Andreadis 1995).

The second tornado study site was steeply sloped, averaging  $30.63^{\circ}$  ( $SEM = 2.00^{\circ}$ ) (Andreadis 1995). The most abundant canopy trees were oaks with tulip poplars, maples, and hickories present (Andreadis 1995).

The first clearcut study site was moderately sloped ( $6.88^{\circ} \pm 1.19^{\circ}$ ) (Andreadis 1995). Sourwoods were dominant with tulip poplar, cherry, dogwood, and maple present .

The second clearcut study site was moderately sloped ( $7.69^{\circ} \pm 1.08^{\circ}$ ). Maple, sourwood, and cherry were the most abundant. Tulip poplar and maple were also present.

The first mature forest study site was moderately sloped ( $7.81^{\circ} \pm 1.31^{\circ}$ ). The dominant trees were oaks with tulip poplar, pine, sourwood, maple, hickory, black gum, and dogwood also present.

The second mature forest study site was moderately sloped ( $8.44^{\circ} \pm 1.82^{\circ}$ ) (Andreadis 1995). The most abundant trees were oaks and tulip poplar with maple and sourwood also present.

## METHODS

The experimental design for the present mark-recapture study involved 3 habitat types: clearcut (an experimental variable), tornado (another experimental variable), and mature, undisturbed forest (the control). There were 2 study sites per habitat type: C1, C2, T1, T2, F1, and F2 for a total of 6 study sites. Twenty Sherman live traps were placed in a systematic grid in each study site at a spacing of five traps per 0.4 ha, for a total of 40 traps per habitat type, and a grand total of 120 in the study (Figure ). Within the clearcut study sites, the design was overlaid on the four site preparation treatments, so that each set of five traps sampled a different site preparation treatment. A dirt road traversed one of the watersheds. Traps were placed on each side of the road (Figure ). Two trapping grids were established in the mature forest study sites—one adjacent to a clearcut area and one near the tornado-damaged area.

The study period consisted of 10 trapping sessions. Trapping sessions consisted of 2 nights per week for a period of 5 weeks. Traps were set and baited in the afternoon of the first trapping night of each week; checked, rebaited, and reset the next morning; and checked and

closed the following morning. Trapping dates were as follows: February 4-6, 11-13, 18-20, March 3-5, and 10-12. Traps were baited with a mixture of oats and peanut butter (approximately 4:1 ratio of oats:peanut butter). Data recorded on captured individuals included: species, sex, age (juvenile or adult), and weight. Age was determined using a combination of pelage characteristics and body mass (Tim Pruitt, pers. comm.). Captured individuals were marked with aluminum ear tags (#1, National Band and Tag Co., Newport, KY), and the tag number recorded. Recaptured individuals' tag numbers were also recorded. To reduce trap disturbance, large mammal box traps were set in the sites receiving heavy disturbance and baited with a mixture of oats and peanut butter and sliced apple. A total of 4 animals were caught and released at a significant distance away from the study sites. Three opossums (*Didelphis virginiana*) and a striped skunk (*Mephitis mephitis*) were caught and released. One opossum was captured in one of the forest study sites, another captured in one of the tornado study sites, and the third captured in one of the clearcut study sites. The striped skunk was captured in one of the clearcut study sites. Research was conducted at the University of Tennessee Forestry Experiment Station in Oak Ridge, TN.

Two types of comparisons were made: comparisons of population parameters within the study sites and then comparisons of population parameters among the habitat types. The following population parameters were compared among the anthropogenically-disturbed study sites (clearcuts), naturally-disturbed study sites (tornadoes), and undisturbed control sites (mature forest): abundance, sex ratio, age structure, and species diversity. Abundance was defined as the number of captures independent of recapture status. Species diversity was defined as the unique number of species, and trap success was defined the number of times a trap

contained an individual during the entire study and can be used as a relative measure of abundance.

## RESULTS

T1 had a greater abundance of individuals than T2, 15 vs. 10 (Fig. 1). For T1, the sex ratio was slightly skewed towards the females at 53%, while for T2 it was skewed more towards the males at 60% (Fig. 1). For T1, the age structure was skewed more towards the adults at 60%, while for T2 it was skewed more towards the juveniles at 60% (Fig. 1). Species diversity was the same for both tornado sites, with each area having 3 different species (Fig. 1). T1 had golden mice (*Oshrotomys nuttalli*), white-footed mice (*Peromyscus leucopus*), and a least shrew (*Cryptotis parva*) (Fig. 1). T2 had golden mice, white-footed mice, and a star-nosed mole (*Condylura cristata*) (Fig. 1). With a capture rate of 280, T1 had a higher capture rate than T2's 210 (Fig. 1). It should be noted that capture rates are given per 100 trap nights.

With 12 individuals, C1 had a greater abundance than C2's 10 individuals (Fig. 2). C1's sex ratio was 50/50 while C2's was skewed towards the males at 74% (Fig. 2). C1's age structure was skewed towards juveniles at 58%, while C2's was even more skewed towards the juveniles at 68% (Fig. 2). Species diversity was the same for both clearcut sites with each having 2 species (Fig. 2). The 2 species for both sites were golden mice and white-footed mice (Fig. 2). C1 had a much higher capture rate than C2; 320 vs. 180 (Fig. 2).

F1 had a greater abundance of individuals than F2; 7 vs. 3. F1 had a sex ratio skewed towards females at 57% and an age structure skewed towards the adults at 57% (Fig. 3). F1 had a species diversity of 2: golden mice and white-footed mice were captured there (Fig. 3). At F2

only northern flying squirrels (*Glaucomys sabrinus*) were captured, so sex ratio and age structure were not included (Fig. 3). F1 had a much higher capture rate than F2; 100 vs. 30 (Fig. 3).

For the comparisons among the habitat types, Clearcuts had the greatest abundance with 31 individuals (Fig. 4). Tornado areas had the second greatest abundance with 25, and forest areas had the lowest with 7 (Fig. 4). Clearcuts had the most skewed sex ratio with 65% males (Fig. 4). Tornado areas were also skewed towards males at 52%, whereas forest areas were skewed towards females at 57% (Fig. 4). Clearcuts had the most skewed age structure with 65% juveniles (Fig. 4). Tornado areas and forest areas were both skewed towards adults at 52% and 57%, respectively (Fig. 4). The tornado areas had the greatest species diversity with 4 different species: golden mice, white-footed mice, a least shrew, and a star-nosed mole (Fig. 4). The forest area had the second highest species diversity with 3 different species: golden mice, white-footed mice, and northern flying squirrels (Fig. 4). Clearcuts had the lowest species diversity with 2 different species: golden mice and white-footed mice (Fig. 4). Finally, the capture rate was highest in the clearcuts at a rate of 500, closely followed by the tornado areas at 490 (Fig. 4). The capture rate was lowest in the forest areas with a rate of 130 (Fig. 4).

## DISCUSSION

In order to answer the question "Do clearcuts mimic natural disturbances such as tornados?" the comparisons among habitat types were used even though the comparisons of population parameters within study sites did show considerable variation within study sites. Clearcuts did have more individuals than the tornado area, the clearcuts' sex ratio was skewed towards males more than the tornado area, and the clearcuts' age structure was skewed towards the juveniles whereas it was skewed towards the adults in the tornado area (Fig. 4). However,

the most striking finding is that species diversity was twice as high in the naturally-disturbed area, ie tornado area, as in the clearcut area (Fig. 4). However, the sample size was not great enough (ie, not enough small mammals were captured) to subject the data to statistical analyses in order to draw strong inferences, and further study is needed to answer this question. However, in the case of species diversity—one of the most important factors—clearcuts did not seem to mimic natural disturbances—a situation that definitely calls for more intense investigation.

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| <u>Site</u> | <u>Number of<br/>Individuals<br/>Captured</u> | <u>Trap Success<br/>(per 200 trap<br/>nights)</u> | <u>Sex Ratio</u> | <u>Age<br/>Struct.</u> | <u>Number of Species</u>              |
|-------------|-----------------------------------------------|---------------------------------------------------|------------------|------------------------|---------------------------------------|
| T1          | 15                                            | 28                                                | 47% M<br>53% F   | 40% J<br>60% A         | 3<br><br>GOMO<br>WFMO<br>LESH         |
| T2          | 10                                            | 21                                                | 60% M<br>40% F   | 60% J<br>40% A         | 3<br><br>GOMO<br>WFMO<br>STMO         |
| C1          | 12                                            | 32                                                | 50% M<br>50% F   | 58% J<br>42% A         | 2<br><br>GOMO<br>WFMO                 |
| C2          | 10                                            | 17                                                | 74% M<br>26% F   | 68% J<br>32% A         | 2<br><br>GOMO<br>WFMO                 |
| F1          | 7                                             | 10                                                | 43% M<br>57% F   | 43% J<br>57% A         | 2<br><br>GOMO<br>WFMO                 |
| F2          | 3                                             | 3                                                 |                  |                        | 1<br>FLSQ                             |
| Total T     | 25                                            | 49                                                | 52% M<br>48% F   | 48% J<br>52% A         | 4<br><br>GOMO<br>WFMO<br>LESH<br>STMO |
| Total C     | 31                                            | 49                                                | 65% M<br>35% F   | 65% J<br>35% A         | 2<br><br>GOMO<br>WFMO                 |
| Total F     | 7                                             | 13                                                | 43% M<br>57% F   | 43% J<br>57% A         | 3<br><br>GOMO<br>WFMO<br>FLSQ         |

**Table 1. Comparison of small mammal population parameters for tornado-disturbed, clearcut-disturbed, and undisturbed forest sites, Oak Ridge Forest, Oak Ridge, Tennessee, February-March, 2000.**