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Jarvinen + Schmid

Introduction of Miss Jarvinen

Julie A. Jarvinen, Research Fellow, in the Department of Zoology at the University of Minnesota, Minneapolis received her B.A. degree at the University of Minnesota in 1966 and her M.A. in zoology in 1968. She has received an NDEA IV fellowship, teaching assistantship and research assistantships. Her specific interests are parasitology, ecology and immunology. Miss Jarvinen expects to complete her Ph.D. in zoology in 1972.

SNOWMOBILE USE AND WINTER MORTALITY OF SMALL MAMMALS

by

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Snow cover is considered to be important to the survival of many animals that live beneath it (subnivean) because of the protection it affords from stresses of direct exposure to severe winter climate and predation; e.g., Mail (1930), Formozov (1946), Pruitt (1957,1970) and Fuller (1969). The recent explosion in popularity of snowmobiles for winter recreation has raised questions about ecological effects because in addition to their noise and exhaust fumes, snowmobiles compact the snow. It is the last factor, mechanical compaction of snowfields, that can produce a stress upon subnivean organisms and thereby increase winter mortality rates.

Both the reduction in snow depth and the increase in snow density due to snowmobile packing operate to reduce the insulative value of snow and to increase the mechanical barrier to animal movements beneath the snow. Schmid (1971) reported on increased snow density, destruction of subnivean air spaces, and increased temperature fluctuation beneath snowmobile trails. These effects were most severe in areas that had been packed continuously since the first snowfall where the observed densities were very close to the "critical density" of snow as reported by Anderson and Benson (1963) and indicated the maximum of mechanical compaction had occurred. Densities of trails formed after accumulation depths of around 36 centimeters of snow were more typical of the compaction profiles described by Wuori (1963) wherein the highest values occurred at the compaction-mixing surface. These observations were important in the design of our study during the winter of 1970-71 when we examined the effects of snowmobile packing on small mammal activity and survival. This paper is a preliminary summary of the results of that study.

Methods

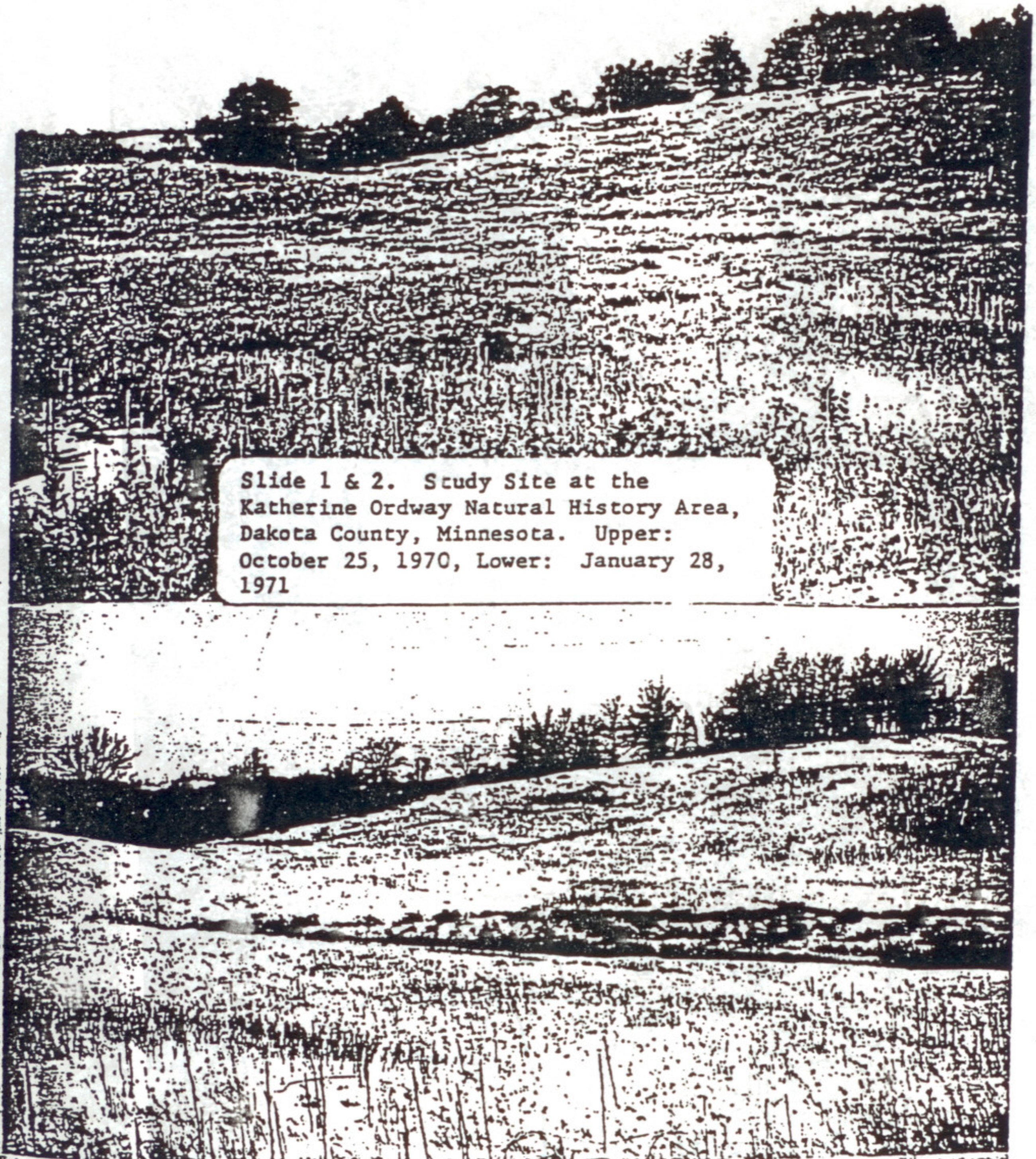
The field work was conducted at the Katherine Ordway Natural History Study Area in Dakota County (T27N, R22W, S22,23), Minnesota. This site was chosen because of its nearness to the metropolitan area of St. Paul and Minneapolis, and because its access to public use is controlled by Macalester College, St. Paul, Minnesota. The Biology Department of Macalester College gave us access to its winterized laboratory which greatly facilitated our marking and measuring of specimens.

The specific site for the small mammal trapping was chosen to be the center of an open field that had not been plowed, mowed, grazed or burned for several years (Slides 1 and 2) in order to avoid compounding habitat variation with snowmobile treatment; ie., this site was of the most homogeneous habitat that we could find within the reserve. It was also the kind of habitat that receives a great deal of use by the snowmobiling public near St. Paul and Minneapolis.

A 24-station grid, 50 meters by 60 meters, was established in this field on October 25, 1970. There were four parallel lines of traps with six traps per line. The trap lines were 20 meters apart and the traps within each line were 10 meters apart, so that the inter-trap distances were 10 meters and 20 meters along the shorter and longer axes of the grid, respectively. We used both modified Sheffer traps (Davis, 1956) constructed from one-pound coffee cans and Longworth traps (Chitty and Kempson, 1949). We filled the open chambers of these traps with either fresh cedar shavings or packed alfalfa hay that trapped specimens used as nesting material. The traps were baited with a mixture of peanut butter, rolled oats and sunflower seeds.

When trapping in snow, it is necessary to provide a shelter for the traps in order to prevent snow from inactivating the trap mechanism and to provide easy access to the traps for both the trapper and trapee: e.g., Pruitt (1959), Fay (1960) and Iverson and Turner (1969). We used inverted plastic wastebaskets, pinned to the ground at four corners by 20-penny nails, to shelter our traps (Slides 3 and 4). Easy access to traps was obtained by cutting off the bottoms of the wastebaskets (now the top of the trap shelter chimney). The shelters were closed by inverting the cut-off bottoms to friction-fit tightness into the top of each chimney. Small mammals tended to burrow beneath the bottom edges although we had punched holes through the plastic at the ground surface of each chimney. We used these shelters at all twenty-four trap stations throughout the study period, from October 25, 1970, to April 10, 1971.

On January 17, 1971, after twelve weeks of trapping, the capture data were inspected in order to subdivide the grid into two sections: one to be packed by snowmobile and the other to serve as a control plot. The grid was halved between the two center lines of traps into two plots, each 50 meters by 30 meters and with twelve trap stations. That plot with a slightly greater number of small mammal captures was designated as the experimental section and packed by running a snowmobile over its entire area except that immediately adjacent to the traps. The packing treatment of the experimental plot was planned to be relatively conservative since it was done after 26 to 39 centimeters of snow had accumulated, rather than by continuous packing from the time of the first snowfall. Although some drifting has occurred, there was no difference of average snow depth (measured near each trap site prior to packing) between the two plots. Repacking was done after snowfalls and/or drifting on January 22, 30 and February 4, 15, to minimize the accumulation of unpacked snow on the experimental plot. Trapping was continued for twelve weeks after the date of initial packing. Although no distinction was made between the grid halves until January 17, all of the results will be discussed in terms of the experimental and the control plots. For example, our trapping effort was 306 trap-days on both the experimental plot and the control



Slide 1 & 2. Study Site at the Katherine Ordway Natural History Area, Dakota County, Minnesota. Upper: October 25, 1970, Lower: January 28, 1971

Slide 3 & 4. Trap Shelter Constructed From Plastic Wastebasket. Upper: Shelter in Place on Grid, October 25, 1970. Lower: Top of Shelter Showing Above the Snow on January 28, 1971 plot during the first twelve weeks, and 534 trap-days on each plot during the second twelve weeks, after packing (Slide 5). One trap-day is equal to one trap set for 24 hours, or two traps set for 12 hours.

Results

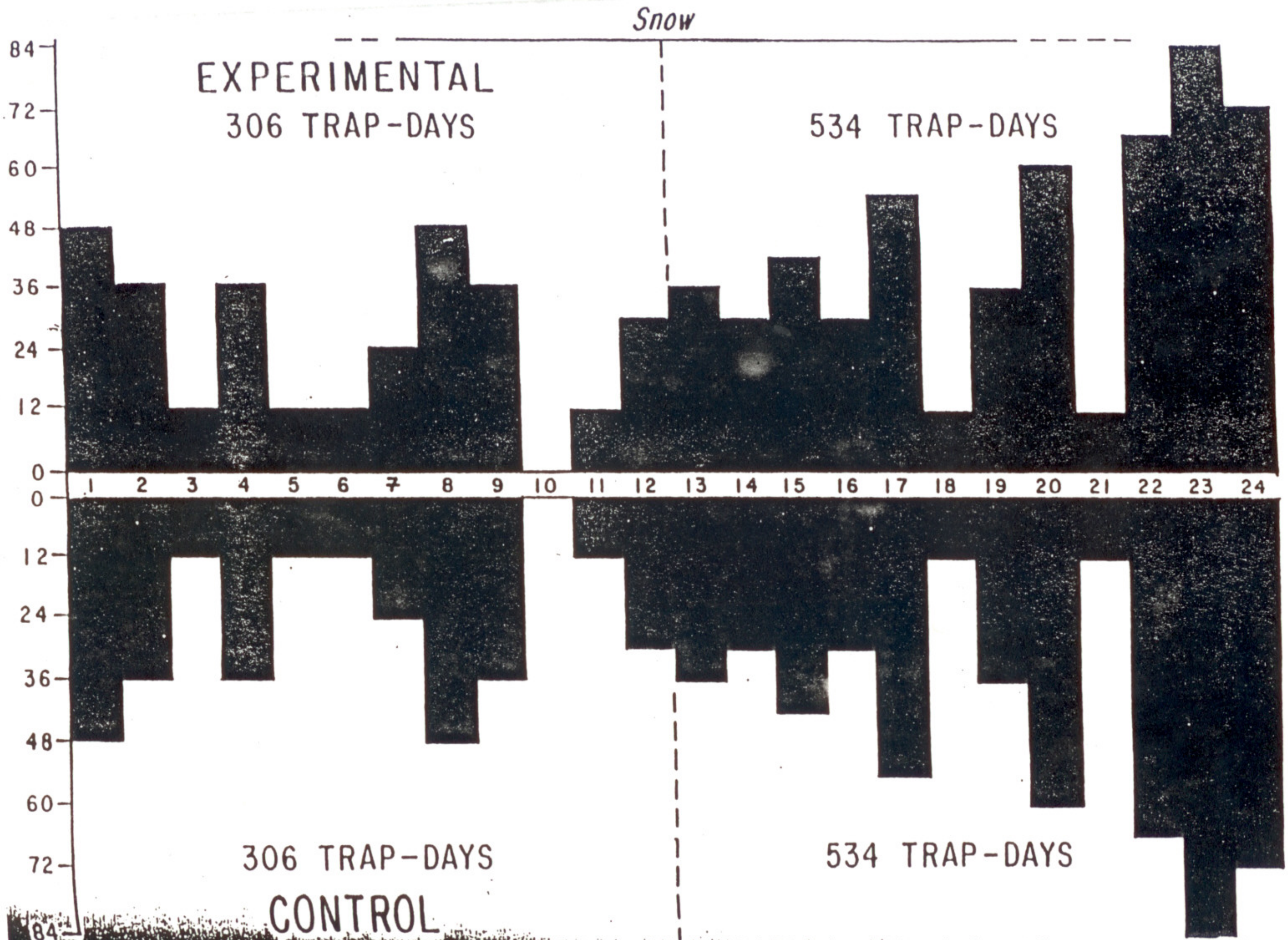
The only data we have begun to analyze are those pertaining to captures and recaptures so that the present results are somewhat preliminary. Nonetheless some conclusions can be drawn because of the extreme effect of our snowmobile compaction. The 612 trap-days resulted in 143 total captures over the entire grid before packing half of the area, while 1068 trap-days during the next twelve weeks yielded 103 captures. It can easily be seen from (Slide 6), a frequency histogram of weekly captures for each plot, that both captures of new animals and recaptures were significantly reduced ($p<.01$, by Chi-square) on the experimental plot during the second twelve weeks. In fact, there were no captures on the packed area until after the snow cover had melted.

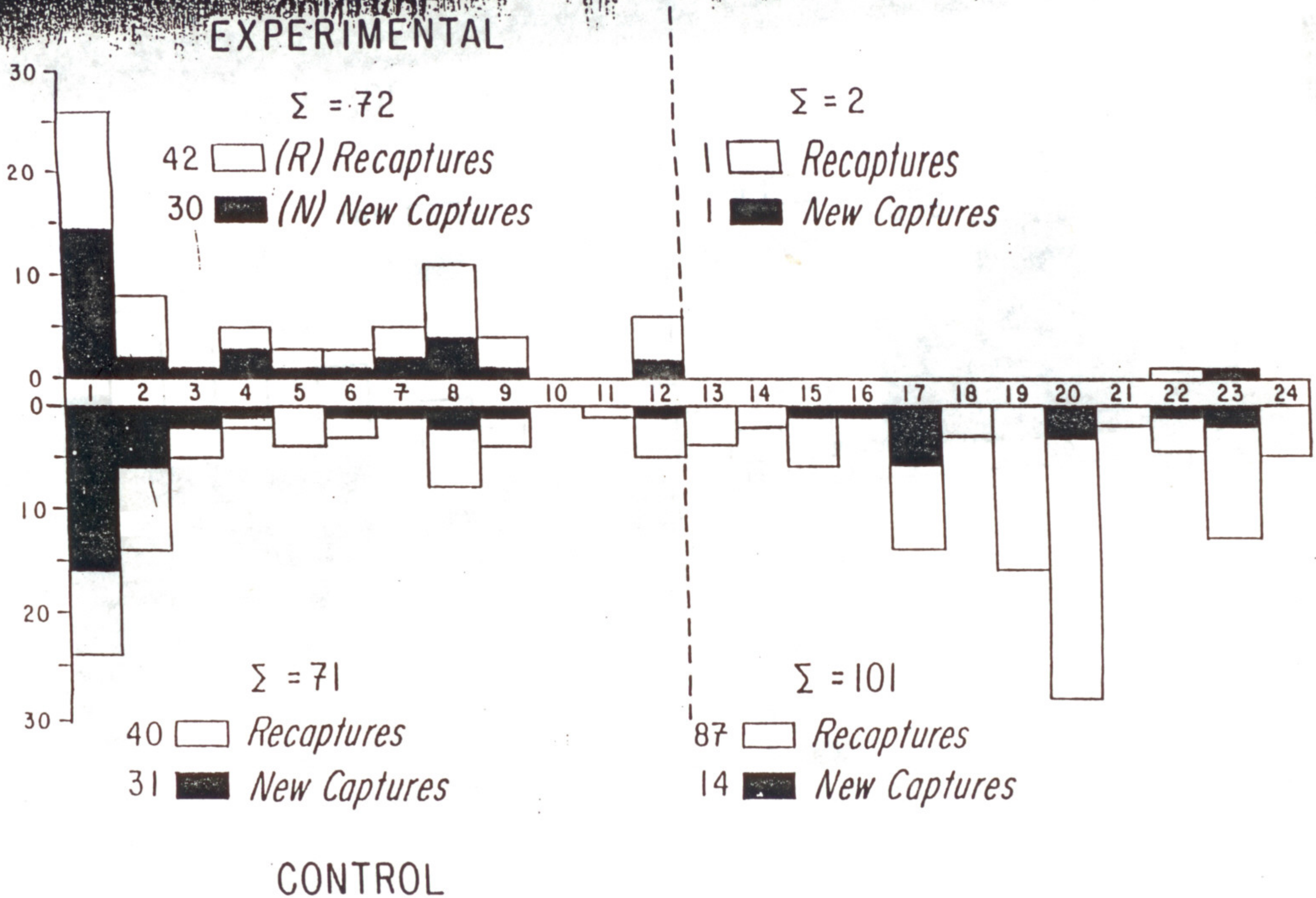
Captures were dominated by two species commonly found in this type of habitat wherever it occurs in Minnesota, the meadow vole (*Microtus pennsylvanicus*) and the short-tail shrew, (*Blarina brevicauda*). There were occasional captures of the white-footed mouse (*Peromyscus leucopus*) and a few of the thirteen-lined ground squirrel (*Spermophilus tridecimlineatus*), the masked shrew (*Sorex cinereus*) and the spotted skunk (*Spilogale putorius*). Next, the weekly data were normalized to the constant effort level of captures per 100 trap-days in order to obtain independence from the obvious variations in our trapping from week to week. After inspection of the normalized captures of each species we decided that only the date of *Microtus* were sufficient for us to infer something about seasonal trends in activity. The data of *Microtus* and the pooled, normalized data of all species are shown in Slide 7, where it can be seen that the mid-winter activity, as indicated by trap captures, was very low in comparison to that of early or late winter. High trap mortality precluded a similar analysis of activity for the short-tail shrew, *Blarina*.

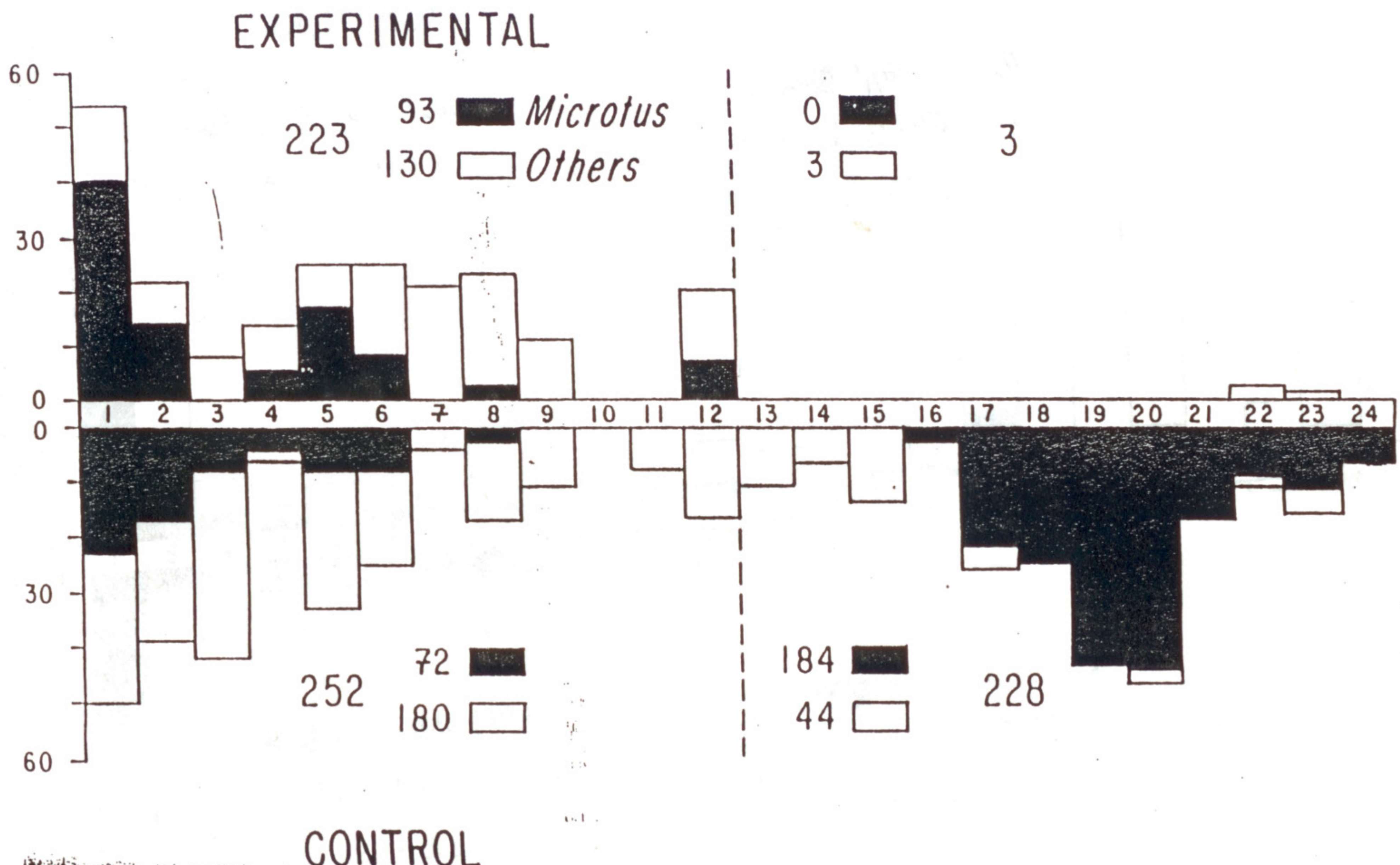
A final analysis of recapture data was performed to check emigration of specimens from the experimental to the control plot. Subtraction of "trap deaths" from the totals of animals marked before snowmobile packing left 21 and 18 specimens on the experimental and control plots, respectively. None of the 21 mammals that had been marked on the experimental plot were ever recaptured; whereas, 8 of 18 on the control plot were recaptured at least once during the second 12 weeks of trapping. These data indicate no emigration from packed to unpacked plots, and suggest very high (100%) mortality rates after snowmobile treatment.

Discussion

Our trapping results clearly showed a marked increase of winter mortality in small mammals beneath snowmobile-compacted snowfields. Hamilton (1942) suggested that the usual winter reduction in small mammal populations was simply the result of normal turnover; i.e., young replacing old. More recent studies; e.g., Gorecki (1968) and Gebczynska (1970), indicated that there may be an energetic based selection operating against larger specimens during the winter. The colder temperatures of winter seem to be stressful to small mammals, even if moderated by snow cover. For example, Mezhzherin (1964), Schwartz, et. al. (1964), Fuller (1969), Fuller, Stebbins and Dyke (1969) and Brown (1971) have found reduction or stoppage of growth for small mammals during the winter.


Snow
EXPERIMENTAL
306 TRAP-DAYS
534 TRAP-DAYS
84
72
60
48
36
24
12
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
306 TRAP-DAYS
534 TRAP-DAYS
CONTROL


EXPERIMENTAL
30
20
10
0
Σ = 72
42 (R) Recaptures
30 (N) New Captures
Σ = 2
1 Recaptures
1 New Captures
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
0
10
20
30
Σ = 71
40 Recaptures
31 New Captures
Σ = 101
87 Recaptures
14 New Captures
CONTROL



EXPERIMENTAL
60
30
0
0
30
60
223
93 Microtus
130 Others
0
3
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
138
252
72
180
184
44
228
CONTROL

Mortality of subnivean mammals in the area packed by snowmobiles was probably due to a combination of factors that increased winter stress to the point where survival was impossible. Mechanical compaction of snowfields will (1) destroy subnivean air spaces, (2) reduce snow depth, (3) increase density, thermal conductivity, thermal diffusivity and shear strength of snow. These effects would in turn be inhibitory to mammal movement beneath the snow and at the same time subject subnivean organisms to greater temperature stress. There is also the possibility that air beneath packed snow may become toxic because of abnormal carbon dioxide accumulation. The permeability of snow decreases as density increases. Bashenina (1956) reported carbon dioxide levels as high as four percent beneath deep snow that, according to Dejours (1966) are stressful to terrestrial mammals.

We stress the preliminary nature of this study with the hope that greater interest will be turned to winter ecology. Since dead carcasses were not removed, the results of our research only infer, by indirect evidence, that very high mortality occurred among winter active small mammals. Stronger evidence might have been obtained by intensive snap-trapping and pit-trapping over the entire grid after the snow had melted off. However, the circumstance of a wild fire at Ordway on April 9, 1971, prevented us from making this logical follow-through effort to recover as many marked specimens as possible. Nonetheless, if our live-trap data are truly representative of the population changes, we can conclude that even conservative snowmobile packing was destructive of wintering small mammals.

Acknowledgments

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Figure Legends

Slides 1 and 2.--Study site at the Katherine Ordway Natural History Area, Dakota County, Minnesota. UPPER: October 25, 1970, LOWER: January 28, 1971.

Slides 3 and 4.--Trap shelter constructed from plastic wastebasket. UPPER: Shelter in place on grid, October 25, 1970. Vegetation (grasses and composites dominant) here was typical of that at the other trap sites. LOWER: Top of shelter showing above the snow on January 28, 1971.

Slide 5.--Frequency histograms of weekly trapping effort for the experimental plot (upper histogram) and the control plot (lower). The perfect symmetry of the histograms is due to equal effort (trap-days) on both plots throughout the entire 24 weeks of study.

Slide 6.--Frequency histograms of total captures of all small, winter-active mammals (*Microtus pennsylvanicus*, *Blarina brevicauda*, *Peromyscus leucopus* and *Sorex cinereus*). N = new captures, R = recaptures. Upper histogram is for the experimental plot, lower is for the control plot.

Slide 7.--Frequency histograms of weekly captures on the experimental (upper) plot and on the control (lower) plot that have been normalized to captures per 100 trap-days per week. *Microtus pennsylvanicus* showed less activity during mid-winter than in either fall or spring.

Question Period Following Miss Jarvinen's Presentation

Q. (Unidentified):

Did you follow through at all to see what happened to the population after the reproduction season?

A. Miss Jarvinen:

That would have been a logical follow through to our study, however, we were prevented from doing this by a series of circumstances including Easter vacation, some small children and a little wildfire that burned over two-thirds of our study area!