1976

Report of Progress to the National Science Foundation for Grant

James A. MacMahon

Report of Progress to the National Science Foundation

for Grant BMS 75-13966

January 1, 1976

"Odum's Ecosystem Attributes: testing an hypothesis"

James A. MacMahon
Principal Investigator
Social Security No. 288-34-8484
Department of Biology
Telephone: (801) 752-4100 Ext. 7841

Preamble

The study of spruce-fir succession with a view to testing Odum's hypotheses about seral changes in ecosystem attributes was financed in the spring of 1975.

Late snow cover in the mountains delayed establishment of permanent plots. The fencing of the plots, due to the massive man-hour effort required, took longer than anticipated.

As was obvious in our supplementary proposal, our soil invertebrate collaborator went to another University and we were required to conduct a postdoctoral search. Funds to cover a full-time position had to be secured to supplement the one-half time equivalent obtained through the National Science Foundation.

This accumulation of fiscal, natural and stochastic events created some initial, unanticipated delays in the functioning of a highly polished research effort. Currently all parts are functioning and we are in the process of adding the "rouge" of one season's experience to polish the parts.

The following material is a capsular presentation of work accomplished and plans for the next field season. The data are provided by the various collaborators, both senior and junior associates. Comments on the 1976-1977 budget are appended.

Soil Biochemistry and Microbiology

Two of the three replicate seres were used for soil sampling. Each sere contained meadow, aspen, subalpine fir and Englemann spruce plots. Surface samples for biological and biochemical examination (two per plot) were collected twice during 1975 (July and October), the pit or depth samples to ca. 80 cm depth (one for each sere) were collected in July. In addition eight subsamples (one for each surface sample location) were collected for carbon-14 dating procedures.

The samples were analyzed for the following (several analyses are still in progress):

(A) Chemical Analyses

(1) Pit Samples

pH

Salinity, E Ce

Texture (estimated)

Cation Exchange Capacity

Lime, $CaCO_3$ equiv.

Total N, exchangeable NH_4^+, fixed NH_4^+

Organic C

NO_3^-

Moisture - 1/3 atm, 15 atm, saturated

Phosphorus

Exchangeable Na^+, K^+, Mg^{++}

Extractable Na^+, K^+, Mg^{++}

(2) Surface Samples

pH

Total N

Organic C

NO_3^-

Exchangeable NH_4^+

Fixed NH_4^+

(B) Biological Analyses

(1) Pit and Surface Samples

Microbial Numbers:

Anaerobes

Aerobes

Streptomycetes

Fungi

Proteolytic Organisms

Cellulolytic Organisms (aerobic and anaerobic)

Lipolytic Organisms

Chitinolytic Organisms

Hemicellulolytic Organisms

Dehydrogenase Activity

(2) Surface Samples Only

N-fixation

Denitrification

Nitrification potential

ATP

The soil samples for carbon-14 dating were shipped to Radioisotopes and Radiations Laboratory, Washington State University, Pullman, Washington for analysis, December, 1975.

Data suggest that soil biological activity is greatest in the spruce and fir plots and lowest in the meadows. Higher dehydrogenase and microbial activity figures in litter layers indicate a high degree of decomposition activity in the spruce and fir stands.

The C:N ratio rose at both sites from July to October but never exceeded 25. C:N values were lower (13 to 16) in the aspen and meadow areas as would be expected from the lower carbon input sources such as litter and other plant material. Values at the spruce and fir stands ranged from 14 to 25.

Projected Changes for 1976

Due to its secondary scientific importance and limitations in the budget, the study of the nutritional grouping of heterotrophic aerobes [Proposal, p. 17, item (a)] will be omitted.

Litter Invertebrates

A preliminary survey of the study site was undertaken to determine which invertebrate groups were present in the litter and to determine the appropriate sample size, number and extraction technique. The following invertebrate groups were found: Araneae, Acarina (Oribatei and Mesostigmata), Coleoptera, Collembola, Chilopoda, Diplopoda, Tardigrada, Nematoda, Rotifera, Protozoa. Suitable extraction techniques for most major groups have been devised.

Dr. Bennett arrived in Logan September 1, 1975. His activities were obviously limited. However, extensive sampling during the fall and winter suggests that the litter and soil invertebrates are active under the snow.

The phylogenetic composition of the fauna is like that of a temporary pond. Since the soils are seasonally waterlogged, we are pursuing this interesting analogy.

It is expected that substantial progress will be made in elucidating the trophic relationships, feeding rates, and nutrient standing crop of the invertebrate litter fauna. Attempts will be made to visualize gut contents by phase contrast microscopy and various staining techniques. In addition, radioisotope tracers and preference studies will be used to determine feeding rates and efficiency.

Plants--Herbaceous

After snowmelt permitted access to the study area with vehicles and equipment, all personnel were assigned the tasks of 1) locating suitable plots for vegetation

and herbivory studies and 2) constructing suitable exclosures around these plots (Fig. 1).

Four stages were identified in the sere: 1) meadow, 2) aspen, 3) fir and 4) spruce. Four levels of restriction on herbivory were selected for study: 1) unrestricted, 2) no ungulates (cattle, sheep, elk), 3) no mammals (ungulates, rodents, hares, etc.) and 4) no animals (mammals and invertebrates).

Three replicates of the four stages with their various restrictions on herbivory were required for the study. Attempts were made to keep the plots within a replicate in close proximity but considerations of aspect, soil and species composition as well as adequate area of contiguous coverage of a successional stage required the resultant dispersion of plots as shown on the study area map (Fig. 2).

Each plot encloses a sampling grid of 20 by 25 m with a buffer zone of at least 5 m at the edge of the enclosure. The exclosures (Fig. 1) are designed to restrict herbivory in the four categories as follows: 1) unrestricted requires no fence; 2) no-ungulate plots are bounded by three strands of barbed wire; 3) no-mammal plots are enclosed by 1/4 in mesh hardware cloth, 36 in wide, buried approximately 10 in with the top 4 in folded out forming approximately a 45° angle. Small mammals will be removed from these enclosures at the beginning of each field season. Periodic trapping to check and maintain the plot will be done during the field season. 4) No-animal plots are additionally bounded by 20 in wide galvanized steel flashing buried with the hardware cloth and folded in the same fashion. These plots will also be trapped and poisoned with "Temik." "Temik" is an aldicarb pesticide produced by Union Carbide Corp., Salinas, California. It is a cholinesterase inhibitor commercially available for agricultural use to control insects, mites, and nematodes. "Temik" is a systemic and it is rapidly degraded to non-toxic end

products which are not translocated through ground water (Union Carbide, 1971). An additional unused exclosure of type 2 (no ungulates) was established for future comparisons.

Throughout the first field season, taxonomic voucher specimens were collected for all plant species observed. A preliminary sample of the herbaceous component was taken from aspen plot A-D (Fig. 2) between August 20 and September 15, 1975. The sample was used to statistically determine adequate sample size and number for the sampling regime of 1976. Aspen plot A-D was selected because it contained the highest spatial, life form, phenological and species diversities. This is due in part to the fact that the aspen stands are generally little wider than the plot width so that vegetation more characteristic of the adjacent meadow and fir stands is included under the aspen canopy. This plot was also bisected by a vernal strear

The preliminary sample consisted of 38 randomly chosen 1 m^2 plots in the 20 by 26 m grid. Each 1 m^2 plot was clipped in three nested subsamples of 1/10 m^2 (31.6 x 31.6 cm), 1/2 m^2 (70.7 x 70.7 cm) and 1 m^2. Species in each sample were separated and identified in the field and returned to the lab for processing.

Of the 38 clipped plots 11 were chosen at random for root biomass sampling. Soil and surface litter were taken from a 10 cm diameter core, separated into 10 cm depth increments and returned to the lab.

Roots and other organic matter were separated from the soil by floatation and sieve washing in a saturated NaCl solution. All biomass samples were dried for 48 hrs at 40 C and weighed. The data were then analyzed after the manner described by Kelley, Van Dyne and Harris (1974).

The total above ground biomass was most accurately estimated by the 1 m^2 plots. To obtain an estimation of total biomass within 80% of the true mean with 80% confidence, 41 such plots will be required at each sampling date.

It is expected that similar analyses of samples collected from other grids in other successional stages will indicate that those stages will be as accuratel

represented by smaller samples.

Root biomass samples did not reveal a good correlation between above ground (AGB) and below ground (BGB) biomass. Coefficients of correlation were calculated between 1/2 m^2 or 1 m^2 AGB and 9-50 cm or 0-10 cm BGB and ranged between $r = 0.14$ and $r = 0.47$.

The samples indicate that, to obtain the root biomass estimator, 50 cores of 10 cm diameter by 40 cm deep are required.

Winter test plots were established to examine the effectiveness of Temik in reducing or eliminating the populations of soil invertebrates. Available data on the effectiveness of this pesticide are all from agricultural contexts of higher moisture and temperature than at the spruce-fir site and of cultivation. Paired 3 x 3 m plots in each successional stage were established with Temik applied to one at the maximum recommended agricultural rate of 20 lbs/acre on October 10, 1975. Samples of soil were taken on December 7, 1975, and January 17, 1976, and sampling will continue periodically until snowmelt. Examination of invertebrate fauna in the litter/A horizon should indicate the effectiveness of Temik against the various organisms present and the duration of this effect at low temperatures.

Preliminary results from the first sample (December 7) indicate a marked reduction but not an elimination of mites. Soil surface temperatures were 1.5 C with 68 to 82 cm snow cover.

Temik will be applied to the selected study plots in spring just before snowmelt is complete. This will take advantage of maximum moisture availability to insure good dispersal in litter and humus and good uptake by the plants. Thus, control of invertebrate herbivory will begin with the 1976 growing season.

The expected sampling schedule for the field season is to sample the entire array of 48 plots (3 replicates of 4 successional stages with 4 levels of herbivory control) at least 3 times. This implies sampling at least eight plots per week

Table 1. Avian species list and status

Species	Status
Turkey Vulture	V,R
Cooper's Hawk	P,U
Red-tailed Hawk	S,R
Blue Grouse	P,U
Ruffed Grouse	P,R
Broad-tailed Hummingbird	S,C
Common Flicker	S,R
Yellow-bellied Sapsucker	S,R
*Hairy Woodpecker	P,C
*Downy Woodpecker	P,C
*Say's Phoebe	S,U
Olive-sided Flycatcher	S,R
*Hammond's Flycatcher	S,U
*Dusky Flycatcher	S,U
*Western Flycatcher	S,U
*Western Wood Pewee	S,C
Violet-green Swallow	V,U
Steller's Jay	P,U
Common Raven	W,R
*Black-capped Chickadee	S,(W?),C
*Mountain Chickadee	P,C
*Red-breasted Nuthatch	W,U
*Robin	S,A
*Hermit Thrush	S,C
Mountain Bluebird	S,C
Ruby-crowned Kinglet	S,R
*Warbling Vireo	S,U
*Yellow-rumped Warbler	S,C
*Western Tanager	S,C
*Cassin's Finch	S,C
Pine Grosbeak	S,(W?),C
*Pine Siskin	S,(W?),U
Green-tailed Towhee	S,(W?),A
*Gray-headed Junco	S,U
*White-crowned Sparrow	S,A
	S,A

P=permanent resident
S=summer breeder
V=summer visitor
W=winter visitor

A=abundant
C=common
U=uncommon
R=rare

* indicates species that will be studied more intensively

allowing no time between completion of one sample cycle and beginning the next. The preliminary sample of one plot required approximately 15 man days to collect. With elimination of the nested subsampling and other efficiency increasing procedures, that time could be cut by 2/3 at best. At this rate the desired sampling regime will require eight workers full-time throughout the field season.

Although this estimate does not include expectations of smaller sample requirements for non-aspen plots it is still far above the available manpower resources. An alternative is to use a herbage capacitance meter and double-sample so that only a portion of the samples actually need be clipped for calibration of the meter and species determinations. Such an instrument has been used with considerable success by the Forest Service for biomass determinations of similar vegetation, particularly aspen understory. Their procedure uses a 20% plot clipping ratio. Such an instrument would markedly increase sampling efficiency.

An additional manpower requirement will be completion of the enclosure for the last fir replicate and repair of winter damage to the existing enclosures. Also type 2 enclosures (no ungulates) will require at least an additional strand of barbed wire, but preferably netting, to more effectively exclude domestic sheep.

Plants--Trees

Detailed information on the above ground biomass of 40 Englemann spruce trees for dimension analysis predictions of biomass of spruce on the study plots was collected. We are examining the data to determine the level of statistical reliability of our estimates. Supplemental spruce trees will be sampled next summer if these analyses suggest a need for more data. Most of the work for the upcoming summer will be to determine dimension equations for subalpine fir and quaking aspen. Trees are sampled for new foliage, new twigs, twig bark, twig wood, stem wood, stem bark and growth increments of these components.

Excavation of stumps and spot sampling by soil pits or cores will be used to estimate below ground biomass.

Litter traps were placed in two of the replicates with three 1 m^2 traps per 20 x 25 m plot. Analysis of similar data indicates that this is a gross under sample. An additional 54 traps in these 2 replicates are needed.

Litter collections on the meter-square plots where the traps were placed indicate that such samples suffer from a large variance and thus probably a different sampling scheme for tree litter is necessary. The downed woody litter should be 100% sampled at the same time as the stem map is made for structural analysis and biomass determination. At least 100 measurements of leaf litter accumulations per 20 x 25 m plot is a minimum if $\pm$ 80% of mean with 80% probability is desired. We feel that 200 depth measurements to convert to area quantities would be necessary.

The first litter collection from the traps will be made as soon as the snow melts in spring. At least two subsequent collections will be made before winter. Tree foliage and leaf litter will be analyzed for common nutrients.

The stand tables and stem maps scheduled to be made in 1975 should have high priority for early completion in 1976.

Animals--Birds

Data were collected to document the avifauna of the spruce-fir seral stages in order to choose suitable species for further study (Table 1). Of the 36 species observed, 18 are present in sufficient numbers for research purposes.

Four 10 hectare plots were selected for study during the breeding season, one in each of the seral stages (meadow, aspen, subalpine fir, and Engelmann spruce). An intensive colorbanding program will begin this spring with the arrival of breeding birds. A banding permit with permission to use color bands was obtained from the Banding Laboratory, Laurel, Maryland. Also, federal and state scientific

collecting permits were obtained so that food habits of selected species can be assessed.

Preliminary research this past summer and fall indicates that meadows are rarely utilized by the avian component. Only juncos nest in the meadows, utilizing pocket gopher (Thomomys) burrows. This unusual commensal relationship will be investigated in the next few breeding seasons.

The aspen and subalpine fir stages are the most highly utilized of the four seral stages and will constitute an exception to Odum's hypothesis that the climax stage has the highest species diversity.

The spruce stands are not utilized by many species. One hypothesis is that most hole-nesting birds are dependent on woodpeckers to create suitable holes. Since spruce is an extremely hard wood, woodpeckers prefer other tree species. Thus the number of holes may be limiting to the hole-nesting species. There is also some evidence that there are fewer insects associated with spruce trees.

Winter research in the 1975-76 season has been hampered by the extremely low abundance of finches. Only the mountain chickadee has been abundant. Since the winter birds tend to wander great distances, plotless sampling techniques are being employed. However, summer research plots will be censused periodically during the winter to compare summer densities with winter densities.

Preliminary data suggest that birds do not utilize the meadow and the aspen stages in the winter. Mountain chickadees and red-breasted nuthatches seek out subalpine fir trees. Analysis of two chickadee stomachs shows that the birds are able to remain partially insectivorous during the winter. Attempts to capture insects on branches of subalpine fir trees are now underway, with the emphasis on determining whether the birds are gleaning live insects, scavenging dead material, or using stores accumulated during the summer. A comparable study from Norway suggests that congeners cache insects in the breeding season for use as food in the winter.

One observation of a flock of grosbeaks suggests that finches can utilize the seeds of the Engelmann spruce in winter, and in fact the winter presence of finches is probably dependent on the spruce seed crop. In conjunction with another component of the project, this hypothesis will be tested over the next few years.

Animals--Large Mammals

Live-trapping for snowshoe hares (Lepus americanus) was initiated on the primary study site in December 1975. Two 4 x 4 trap grids with individual traps spaced at 150 m intervals were established adjacent to one another in coniferous cover. The total area encompassed by the two grids was approximately 40 ha (100 acres). The trap spacing employed and the discontinuity of vegetation types precluded confining all the traps to a single coniferous type (i.e., spruce or fir). Tomahawk double-door (23 x 23 x 81 cm) folding live traps, baited with apple slices, were employed. The trapping period spanned nine days and involved a total of 176 trap nights. In addition "live snares" were set at several locations within the grids.

These trapping efforts met with limited success. The overall trapping success was 17.6 percent, but only six animals were tagged, five of which were recaptured. Two additional hares were killed due to malfunctioning of live snares. Finally, one hare died in the trap when harassed by a weasel. A provisional density estimate was calculated by the Schnabel method, incorporating known mortality. This estimate (9.2 hares/ha or 43/mi^2 of contiguous coniferous cover) is undoubtedly conservative, since the estimated number of hares on the trapping grid (6) is less than the known number of captures. It does appear from field observations that the density of hares on the primary study site is low. Additional trapping efforts will be conducted at monthly intervals throughout the winter and we hope to improve the validity of our density estimates.

Stomach samples for later food-habits analysis were collected from the hares that died. These are being supplemented by collections from areas of similar vegetative cover, away from the study area.

The limited and discontinuous areal extent of the major vegetation types on the primary study site has necessitated some modifications of the original research design for the larger mammal species such as snowshoe hares, deer (Odocoileus hemionus) and elk (Cervus canadensis). Due to the larger cruising radius and home ranges of these animals, it will not be possible to estimate differences in density between different vegetative communities of the sere.

In the case of snowshoe hares we will determine the population density of hares on the study area and then ascertain relative affinities for various vegetation types and changes in use patterns between seasons by indirect methods, such as track counts and pellet counts. An analogous approach will be employed to document the utilization of different vegetative communities in the sere by deer and elk.

To further cope with this problem, we have established an additional study site in southeastern Idaho approximately 25 km northwest from the School Forest. The vegetation types are the same as those on the primary study site but are much larger and more continuous. Density estimates for mammal populations will be obtained on this site, by the same data collection processes as employed on the primary study site. The results from the two areas will be compared. This approach should permit separation of the possible "edge effect" caused by the patchy nature of the vegetation and those that are directly attributable to the successional stage.

Animals--Small Mammals

The objectives of the small mammal group are to determine, for primary and secondary mammalian consumers, differences, if any, in species diversity, numbers,

biomass, and food and habitat utilization between the successional stages under consideration.

Efforts during the first field season were directed toward locating and establishing permanent sampling grids and conducting an intensive trapping program.

Because of the disturbance that live-trapping would impose on the vegetation, it was impractical to work in the exclosures constructed to study the effects of herbivory. Therefore, trapping sites were chosen which closely approximated the slope, aspect, vegetational structure and floristic composition of the exclosures.

Trapping efforts during this field season were directed primarily toward sciurids and other rodents. The following species were collected: deer mouse (Peromyscus maniculatus), red-backed vole (Clethrionomys gapperi), sagebrush vole (Lagurus curtatus), Uinta chipmunk (Eutamias umbrinus), least chipmunk (Eutamias minimus), Northern flying squirrel (Glaucomys sabrinus), red squirrel (Tamiasciurus hudsonicus), long-tailed weasel (Mustela frenata), and masked shrew (Sorex cinereus) Although at least one species of Microtus and one to two species of Spermophilus are present in nearby localities (in slightly different habitats) no signs of their presence were found on the study site.

Methods

Due to the patchiness of the habitat it was decided that a small sampling grid would be used and as many of these grids as was feasible would be used at each site. Each grid contained 16 traps and encompassed an area of 21 m^2. There were a total of ten grids (160 traps) in each vegetation type. The number of grids at each site varied from three to five depending on the amount of suitable habitat at that site.

A seven day preliminary trapping was carried out in mid-July to determine activity periods of the animals present. Based on information gathered during this time, it was decided that traps would be set in the late afternoon and checked each morning, beginning about 0830 hrs. Each sample period contained five days.

The first regular trapping period began on August 20, 1975, and 1 1/2 replicates (two samples each in meadow and subalpine fir, one each in aspen and spruce vegetation types) were completed before operations were shut down for the winter. Sherman live-traps were used for all animals smaller than red squirrels and Tomahawk mesh live-traps for squirrels.

All animals captured were weighed and sexed. Most were toe-clipped for future identification; a few flying squirrels were marked with ear tags. The data collected during this field season are presented below.

Because of their greater mobility, red squirrels were sampled using a 7 x 8 trap grid with traps situated 15 m apart. Although there was considerable squirrel activity on all parts of the study site, only one animal was captured during a six day trapping period. Chipmunks were caught in several of the traps. Many traps were found still open with the bait removed, possibly due to improper trigger adjustment.

No quantitative vegetation sampling was carried out by this group during the first year. Vegetational data collected by other groups will be correlated to our sites. Predominant plants (above and below ground parts) on the site were collected for use in preparing a reference collection of plant cell types. This collection will be used to analyze stomach contents of selected animals collected during periods of snap-trapping in the fenced exclosures. The intent of this trapping is to render selected exclosures mammal free, but will serve the dual purpose of providing reference animal skins and stomachs. Some stomachs were collected this summer but have not been analyzed. Modifications of the technique described by Sparks and Malachek will be used to determine percent dry weight of various foods in the diet.

Vegetational data will be utilized in this portion of the study as an indicator of selectivity of habitat and diet for the animals present. Data on density and frequency of plants at each capture site of a given animal species will be

compared to density and frequency of those plants on the entire site. If a particular plant is recorded at a higher density and frequency at capture sites than on the site as a whole it may indicate that the animal is selectively choosing this/these plants over others available.

Data will also be collected which describe structural characteristics of the four seres. Although all trapping sites within a vegetation type are floristically similar there are, in some cases, structural differences between them (e.g., young vs. mature stands, providing differences in cover). By choosing stands in this way, it will be possible to observe any differences in the animal community that may be attributable to vegetation structure.

Discussion

Analysis of live-trapping data from the first field season is incomplete but preliminary results are summarized in Table 2. Recaptures are not included in total number of individuals captured, but are included in the computation of capture frequency. Biomass data are available but are not included in this report.

Although the data presentation is straightforward, a few points require explanation. Although chipmunks were captured in meadows, nearly all were taken near small "islands" of conifers or at the meadow-aspen interface. The large increase in the number of Peromyscus during the second meadow sample is due to a preponderance of juveniles, indicating that a new cohort had entered the population between the first and second sample. Also of interest is the large number of flying squirrels captured during the second fir sample. Although the second sample immediately followed the first, more than three times the number of squirrels were trapped. Attempts to account for this difference are speculative; however, it is possible that:

1) the animals reached a pre-winter activity peak during the second sample and were therefore more readily trapped, or
2) these animals may require a longer period to adjust to human presence in

Table 2. Mammal capture data (numbers of individuals) by vegetation type.

Species	Meadow		Aspen	Fir		Spruce
	Aug. 25-29	Sept. 17-21	Sept. 25-29	Sept. 11-15	Sept. 17-21	Sept. 3-7
Peromyscus maniculatus	28	66	16	6	10	17
Clethrionomys gapperi			2	4	3	6
Lagurus curtatus		3				
Glaucomys sabrinus		1	7	7	23	7
Mustela frenata		2				
Eutamias umbrinus	6	9	17	31	11	42
Eutamias minimus		1	4			
Total No Ind. Caught	34	82	46	48	47	76
Capture Frequency**	.14		.09	.15		.13

**Includes captures and recaptures

their habitat.

A program developed by the I.B.P./Desert Biome will be used to calculate population densities and home ranges for all species sampled. This program provides estimates based on the Schnabel, Schumacher-Eschmeyer and Jolly methods and fits the data to the negative binomial, geometric and Poisson distributions. A program (SPECDIV) which computes 15 species diversity indices will also be utilized.

The major limitation encountered this year was the restricted size of the sampling sites, particularly in the aspen type. Because of this size limitation it is possible that "edge effect' may be a significant factor and we may be merely sampling interfaces between two vegetation types in some cases. To alleviate this problem additional study areas will be established in southeastern Idaho, approximately 25 km northwest of the U.S.U. School Forest. The vegetation types are similar to those on the primary study site, but are much larger in extent. Other proposed changes in the research design include:

1) winter sampling for red squirrels, and

2) installation of pit traps for shrews.

Animals--Gophers

Pocket gophers (Thomomys) are a conspicuous component of the spruce-fir sere. Their secretive habits require special trapping effort and techniques. We therefore treat them separately from the other "small mammals."

The pocket gopher data required to accomplish the goals set down in the NSF proposal are 1) numbers, 2) biomass, 3) food preferences, and 4) consumption rates of gophers within each of the four seral stages being examined.

An extensive literature review indicates that variation in both physical and demographic characteristics of northern pocket gophers (Thomomys talpoides) pre-

cludes broad use of published data. Methods appropriate to gather the needed data have been critically examined, principal techniques selected and some of the field procedures tested.

The numbers and total biomass of pocket gophers (per unit area) within each seral stage will be estimated through coordinated programs involving capture-recapture and radiotelemetry techniques. Radiotelemetry, not heretofore attempted on any strictly fossorial species, will allow monitoring of animal movements and spatial distribution during winter and other periods when trapping is inefficient or prohibitively destructive to the soil within sampling areas. Together these techniques will result in accurate estimates of age, sex, and season-specific variations in weight and dispersion patterns.

Intensive effort related to the pocket gopher study began in September. Nine of the necessary twelve 30 x 30 m census plots (3 replicates per seral stage) have been delimited. Initial trapping effort resulted in 13 gophers captured and released within 2 meadow and 2 aspen plots. Data are insufficient to allow any meaningful estimate of population densities within these plots. However, no gopher activity was noted within the climax spruce plots. Numbers and biomass data will be collected from the extensive Franklin Basin, Idaho, study areas as well as the School Forest. No work was attempted in the former area.

Five gophers (1 male, 4 female) were removed from sites near the census plots and housed in a laboratory colony. These and additional animals to be collected will be used to determine consumption rates under controlled conditions, and hopefully, to establish a breeding colony (the first?) from which growth rates and reproductive parameters can be obtained. A current study of appropriate methods to determine consumption rates suggests our values may be considerably below those reported in the single published study. Captive individuals will also be used to insure maximum efficiency of telemetry techniques prior to field implementation.

Because of the competitive relationship between commercial range stock and pocket gophers, food preferences and disturbance effects have received considerable attention in the literature. Compilation of data to allow correlation of (qualitative) preference to morphological and nutritive (caloric, protein content and cell-wall constituents) characteristics of the important species of angiosperms and three conifers found within the study area was initiated. Techniques were selected and equipment is currently being assembled for laboratory analyses of gut contents, allowing quantitative estimation of food preferences. Nutrition data not found in the literature will be determined in the laboratory. Equipment is either available or has been ordered for the techniques selected. Plant parts available to gophers will be categorized into above and below ground, and three phenological stages for these analyses.

An examination of the relationship between soil-disturbing pocket gopher activities and vegetation was initiated through selection and preliminary monitoring of several study plots and the marking and photographing of approximately 20 mounds and casts of various ages. Additional marking and subsequent quantitative monitoring of vegetative changes associated with the disturbance sites are planned, as is determination of rates at which disturbances are created.

Animals--Reptiles and Amphibians

The montane herpetological species list is small. That the populations are also sparse is indicated by the finding of a single garter snake (Thamnophis elegans) DOR near one of our sites. This animal constitutes the spruce-fir herps.

Animals--Foliage Arthropods

Shrubs of each seral stage were sampled with a D-Vac. Calibration curves are

being established by removing shrubs after vacuum sampling and sorting by hand to determine what proportion of the arthropods are missed.

Trees are being sampled by clap trapping throughout the canopy. Access is permitted by ladders.

Preliminary data suggest that meadow stages have surprisingly low species densities for all arthropods. Tree canopies have high population and species densities. Coniferous foliage harbors the greatest number of spider species.

To date it appears that the arthropod fauna of the entire sere will contain about 500 insect and 40 spider species.

Because of the paucity of insectivorous vertebrates, spiders and some insects are the dominant community secondary consumers.

Some insects and spiders are active throughout the winter in the canopy and at the snow-soil interface.

Budget Comments

The budget as originally proposed (see appended copy) seems reasonable if we may use some of the first year surplus from computer costs and travel to underwrite certain equipment items not originally noted.

These include an herbage meter ($2500) for herbaceous vegetation measurement, radiotelemetry equipment for bird and mammal studies ($1500) and additional meteorological equipment.

Summary

Summer work was slow getting started. Winter work is well underway at a high level of accomplishment.

It is difficult to report scientific progress of a study initiated July 1, 1975, since this summary essentially covers the period only to January 1, 1976.

The summer field season approaching is well planned and all logistic and sampling problems are either solved or at least seem tractable.

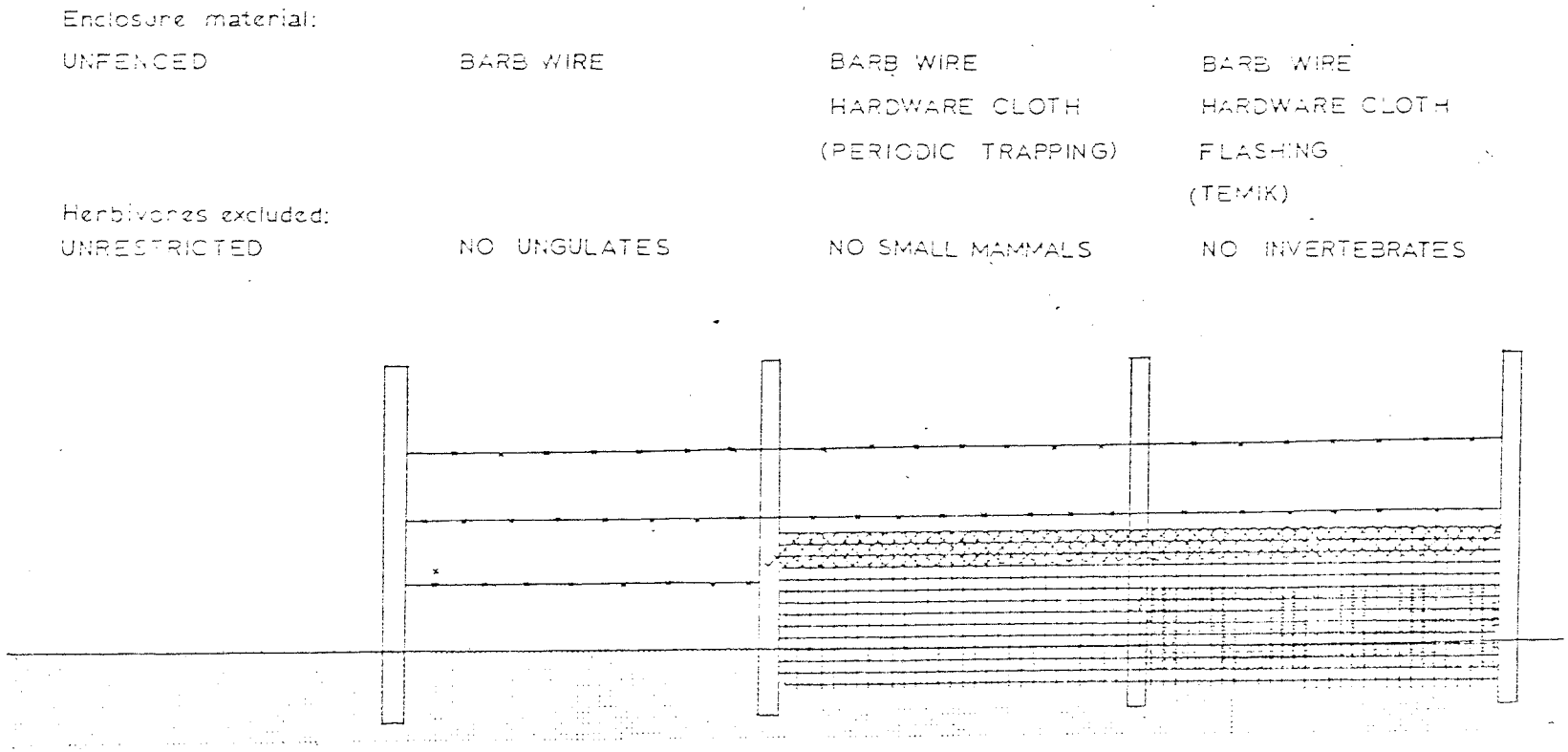

Fig. 1. Diagram of herbivore exclusion plot fencing.

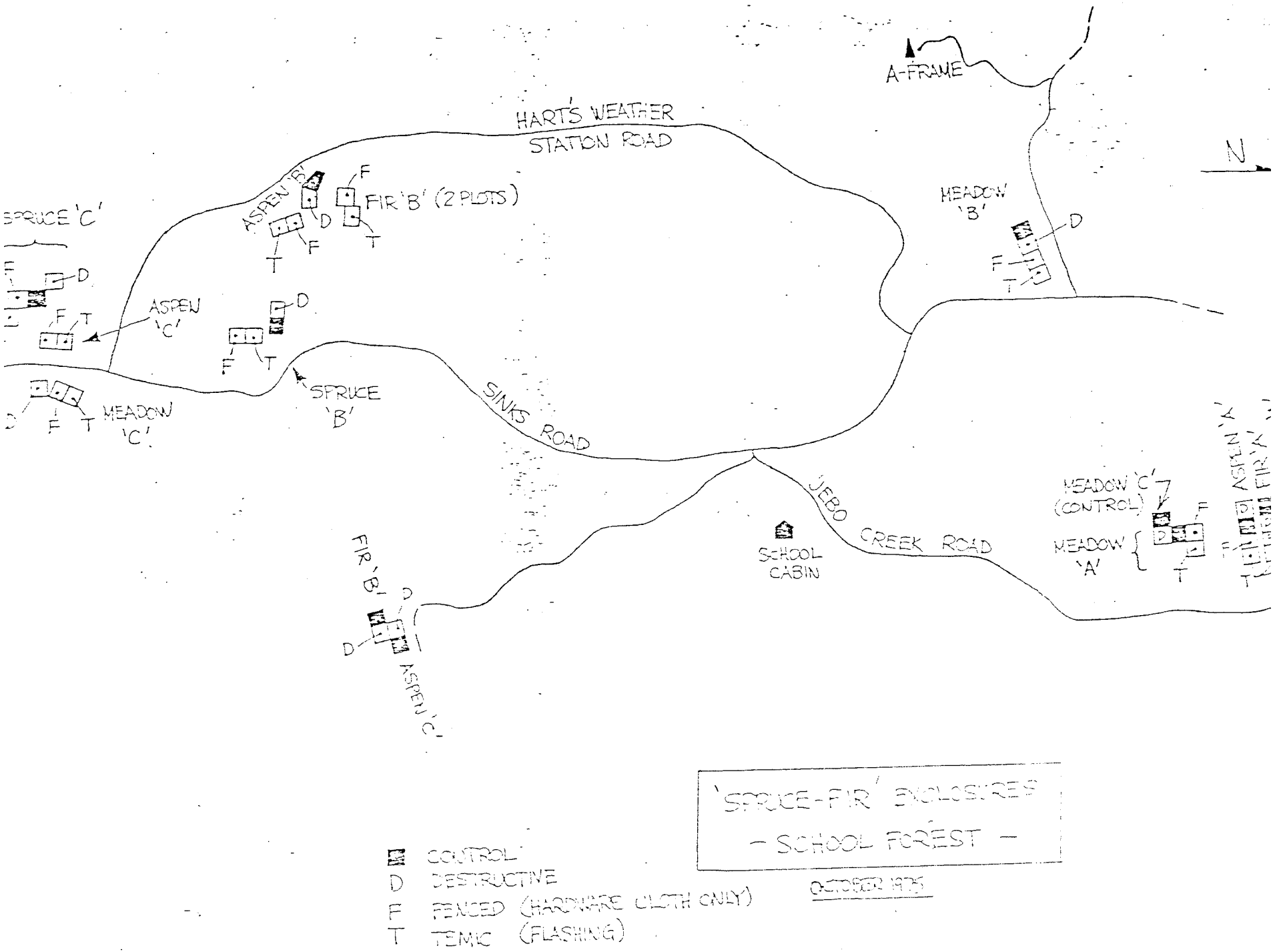

Fig. 2. Plot placement within Utah State University School Forest.