Small-Scale Investigations with Large Scale Implications: Ecological Impacts in Archaeologically Disturbed Areas

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ABSTRACT

As Archaeologists, we must constantly evaluate the short and long-term implications of our research, including the impacts of subsurface sampling. Certain methodological issues must be addressed, researched, and interpreted to facilitate the future of archaeological survey. Over the past years, a multi-scale "nested" sampling technique, developed by plant ecologists at Colorado State University to record species diversity and richness, has led to valuable insights for other fields. By modifying this sampling technique for archaeological sampling, we can participate in detailed survey and subsurface testing in specific areas. Various researchers and field school students at the Colorado State University Archaeological Field School in NW Nebraska, over the past 3 years, have put this technique to work and have sampled in a variety of ecological conditions. Also, this technique has been employed during the GRIZ (Greybull River Impacts Zone) project in the 2002 and 2003 field season in NW Wyoming. The disturbed areas (excavation plots) within the Modified-Whittaker subplots in Nebraska will be assessed for negative ecological impacts, focusing on vegetation regrowth issues as result of ground disturbance. Specifically vegetation diversity and percentage ground cover will be evaluated. Variables such as climate, surrounding vegetation, geologic strata, degree of slope, aspect, and human and livestock impacts will all interplay within an ecological model of vegetative recovery in a disturbed area. Using this model, one might begin to assess the ecological impacts of their actions long before the ground is even broken.

The research presented in this paper is the result of a pilot study conducted in the summer of 2003 in NW Nebraska. Four Modified-Whittaker sampling plots were relocated. The four plots relocated include NRTP (north of round top) first recorded summer 1999, WHO1 (Whitehead #1) first recorded summer 2000, PNO1 (Pine-ridge escarpment) first recorded summer 2002, and WRIN02 (West ridge-inside exclosure #2) first recorded summer 2002. In the 2003 survey of these Modified-Whittaker plots, the areas of ground disturbance in the plots were relocated and plant species, diversity and percent ground cover were recorded and evaluated. The results and comparisons of the primary and secondary survey will be discussed further in this paper.

When survey of these four Modified-Whittaker plots within this pilot study were initially conducted, a total of 40 subplot areas were archaeologically excavated. This resulted in the disturbance of the sediment within the subplots up to 10 cm in depth, and the surface vegetation effectively destroyed. Below is a step-by-step procedure regarding how to conduct vegetative sampling in the context of a Modified-Whittaker sampling plot.

Badlands and sodtables in Northwestern Nebraska **S. Heiner 2003**

How to Sample Vegetation using the Modified-Whittaker Sampling Plot
(Figure 1.1; Stohlgren, et al 2003)

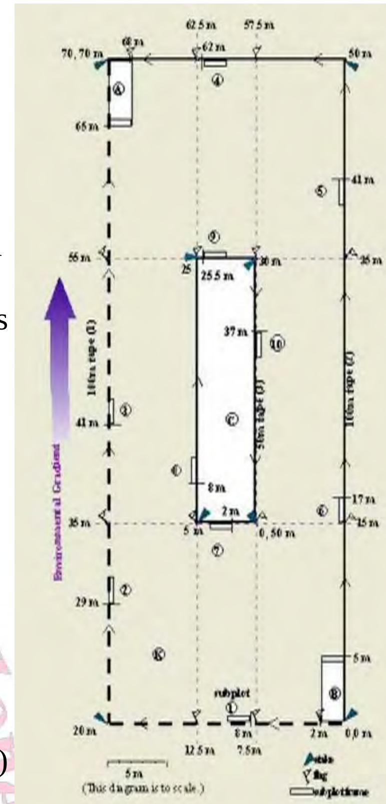
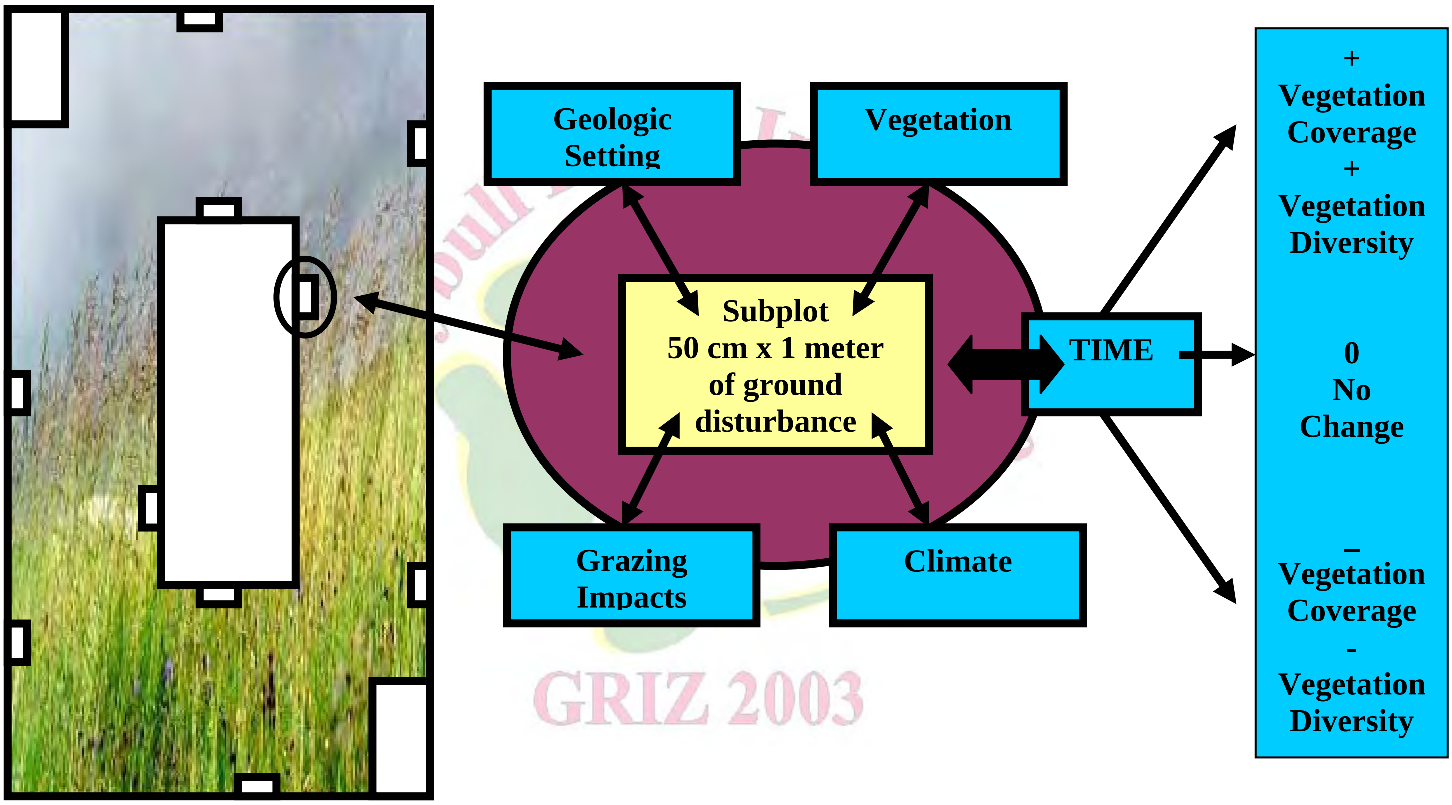


Figure 1.1

1. Look around the area and determine the environmental gradient in order to position the long side (50 m) of the 1000 m2 plot (K) parallel to the gradient. (The goal is to cover the most variation possible.)
2. Using two 100 m tapes (1&2), lay out the main plot (K) 20 x 50 m rectangle. Anchor tape ends at the starting point (right bottom corner, label 0,0). Using a compass to shoot a 90o angle, run tapes out following the arrows. Anchor the 20 m and 50 m corners.
3. Flag 7.5, 12.5, 35, and 55 m marks of tape (1), and 15, 35, 57.5, and 62.5 m marks of tape (2).
4. Using a 50 m tape (3) and the flags marked at 7.5 m and 35 m of tape (1) and 15 m of tape (2), determine and anchor the starting point (0, 50 m) of subplot C (inner rectangle). Moving clockwise, lay out this subplot.
5. Take a magnetic azimuth (bearing) of tape (1) and tape (2) at the (0,0) corner. Write it down on your field notebook with the plot name, site description and UTM coordinates from the GPS unit. (Or use the site description sheet.)
6. Starting from the (0,0) point of K, walk to the 8 m mark of tape (1) and place the 0.5 x 2 m subplot frame along the inside boundary of the K plot. Record all the species present within the subplot. Measure their average heights and determine (estimate) their percent cover. Flag unknown species as you encounter them, and make their labels (numbers) even if you aren't collecting them right away.
7. When finished at this location, pick up the subplot frame and moving clockwise, repeat step 6 until all ten 1m2 subplots are completed. There are six subplots around the inside of K plot, and four subplots around the outside of the C subplot.
8. Using flags and the subplot frame, set up subplot A and B. (Subplot A and B can be sampled in sequence with the 1m2 subplots) Record the species present in the A, B, and C subplots.
9. Walk through the entire K (1000m2) plot and record any species new to the plot. Label and collect unknowns.

Now that the methodology employed within this pilot study has been presented, the next focus of this paper will fall onto explaining the Ecological Model of Vegetative Recovery in a Disturbed Area. The model below, which was created for this study, demonstrates what variables will be evaluated in the summer of 2004. A further explanation of this model is included as follows.

Ecological Model of Vegetative Recovery in an Archaeologically Disturbed Area

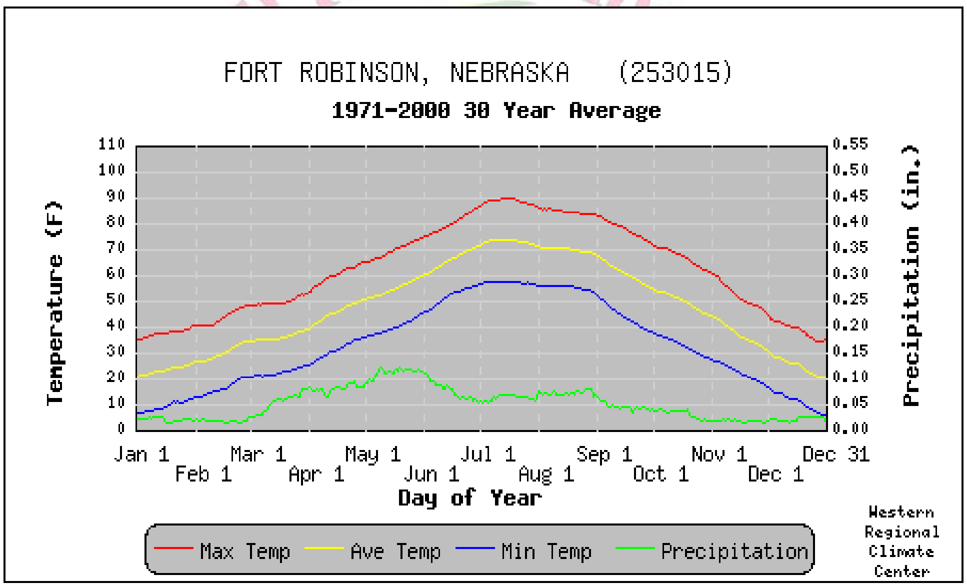


Modified-Whittaker Plot (Subplots, A, B, and C plots shown)
Note: diagram not to scale

The Ecological Model of Vegetative Recovery in a Disturbed Area is important, as it illustrates some of the possible variables influencing the short and long term impacts of archaeological excavations on landscape ecology, i.e. vegetation recovery and diversity. Further research in the Summer of 2004, will focus on evaluating how the variables within this model, such as climate, slope degree, grazing, geological strata, and current vegetation in the surrounding area, play into the relative success or failure of vegetative recovery and diversity within the archaeologically disturbed areas.

CLIMATE

Climatic variables such as wind, precipitation, sunlight intensity, and seasonal variables, have a dramatic influence on not only the vegetation but also the topography surrounding the area. Fluctuations in these climatic variables may result in differential rates of recovery and species diversity. Only through continued research, can one draw truthful conclusions about the impacts of climate on vegetative recovery. Most of the plots I relocated were on hilltops where the underlying geologic strata consisted of nutrient poor bedrock. Even though the spring of 2003 was high in precipitation, maybe the drought from the previous year had an impact on the vegetation diversity I observed.



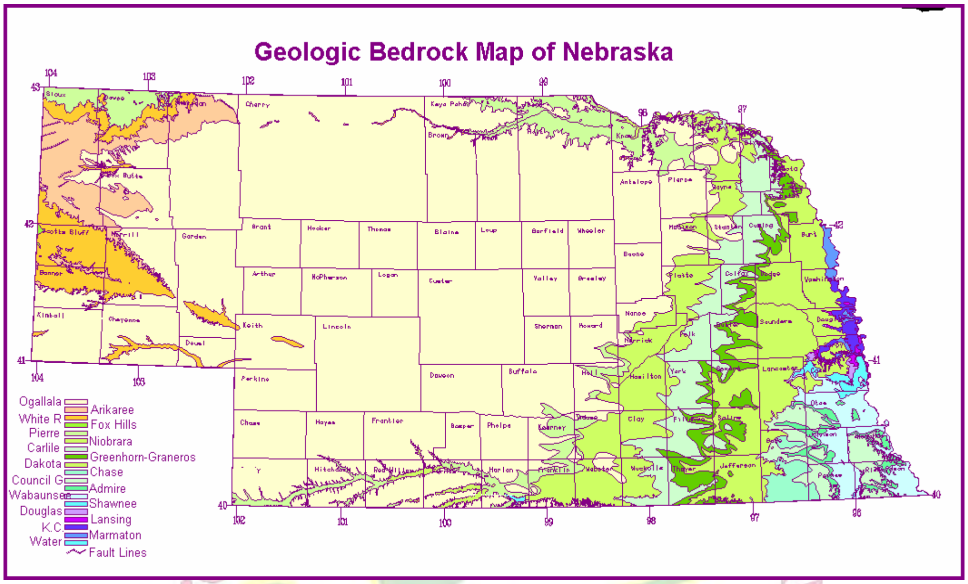
Example of Possible Climatic Variables to Evaluate

CATTLE GRAZING

Grazing of cattle and other large ungulates may also have a massive impact on vegetative recovery. The intensity of grazing in such research areas must be assessed. It may be possible if the cows are eating a couple certain species of grass, then a plant species population might fluctuate because of the impact. Also, trampling could cause ground disturbance making way for the hardy invasive plants and leaving the native species with a decreased chance of propagation and reproduction.

GEOLOGIC SETTING

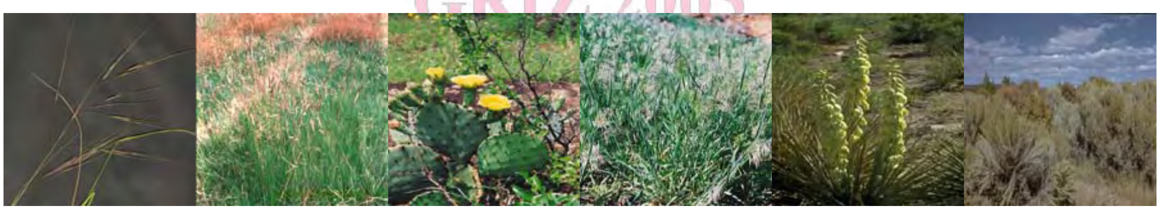
Geological strata underlying and around the subplot area might also have an impact on what plants can or will grow. Factors such as pH of the sediment, relative position, sand, gravel, loess concentrations present and other variables may play a role in vegetative recovery in archaeologically disturbed areas.



Example Geologic Bedrock Map of Nebraska

VEGETATION

Existing vegetation in the surrounding areas also contributes to the diversity and then statistics say that the bare area might have a greater likelihood of fostering the growth of a yucca community. There are problems with this though, as some species, as we know, are invader species i.e. Cheat grass, and will thrive on disturbed areas. The complexities of a plant community and its cycles are integral to understanding the possibilities of outcomes.



Examples of Dominant Vegetation Observed in Survey Areas; left to right; needle-and-thread grass, cheat grass, prickly pear, blue gramma grass, yucca, and sagebrush.

When all these variables surrounding and including the disturbed subplot area are incorporated, one might be able to make valid conclusions about the rate and density of growth, and the diversity of species. Time is a crucial factor to this model. As the old saying goes, "time heals all wounds," but does it really? In some areas I looked at I noticed almost no vegetative recovery in the subplots in areas that were **excavated 5** years ago. So time is a very interesting factor. The under-lying theme of this model is that all these variables, such as climate, existing vegetation, grazing etc. may result in differential rates of recovery of vegetation in the disturbed sub plot area. As a result of all these processes there are 5 general outcomes possible. There could be increased vegetation coverage and diversity of species, an area of no change in relation to surrounding areas, or an area of decreased vegetation coverage and species diversity. Overall, maybe then we can target certain areas as fragile because of the rate of recovery, and thus avoid them because of the potential for negative impact.

DATA TABLES AND DISCUSSION OF RESULTS

The next portion of this paper will focus on the data retrieved from the initial survey and the data acquired in 2003. One may compare and contrast these data sets to possibly evaluate patterns in vegetative recovery as a result of the variables expressed within the model discussed previously. Even though only 4 plots were relocated, an interesting pattern emerged as shown. In the areas where the ground disturbance had taken place, decreased vegetative coverage and diversity was observed. This may be attributed to the drought of 2002, the poor soil in the area, cattle grazing, and human impacts. As this is a pilot study, next summer all 15 Modified Whittaker sampling plots will be relocated in Nebraska. **Note: PLT=plot, SBPLT=subplot, SPCT=species count, COV= %coverage**

WRIN02

WRIN in on a hilltop and when surveyed in the K plot the vegetation in the undisturbed areas almost had a percentage ground cover of 100%. WRIN02 was not subject to grazing in 2002 and 2003, as it is within an area protected from grazing by fences. Increased deposition and topsoil accumulation appeared to occur in the south and northwesterly portion of the plot. Subplots 1-3, 7, and 9 where in areas where bedrock was very shallowly buried, therefore limited topsoil deposition. If one compares the SPCT (species count) from only 1 year, it is quite a dramatic difference. This could be attributed to different times of the year sampled, climatic conditions, topographic position, underlying geologic strata, etc, but also may be influenced by sampling error. Although I sampled both the 2002 and 2003 plot, my knowledge of plant species present, especially grasses increased dramatically over this year.

2002 Survey Results

PLT	SBPLT	SPCT
WRIN02	1	12
WRIN02	2	13
WRIN02	3	7
WRIN02	4	9
WRIN02	5	7
WRIN02	6	10
WRIN02	7	9
WRIN02	8	10
WRIN02	9	8
WRIN02	10	8
WRIN02	A	13
WRIN02	B	17
WRIN02	C	21
WRIN02	K	38

WRIN02 subplot 1 facing north

2003 Survey Results

PLT	SBPLT	SPCT	COV
WRIN02	1	3	2%
WRIN02	2	2	2%
WRIN02	3	4	5%
WRIN02	4	3	50%
WRIN02	5	4	35%
WRIN02	6	4	35%
WRIN02	7	7	5%
WRIN02	8	6	10%
WRIN02	9	5	5%
WRIN02	10	3	90%
WRIN02	A	7	90%
WRIN02	B	8	90%
WRIN02	C	12	90%
WRIN02	K	26	90%

NRTP

NRTP is located on a hilltop and as has been designated as an eligible site for the National Register of Historic Places (NRHP). The hill is slumping on the eastern side of the hill, with the densest vegetation coverage was observed. The southwestern side of the plot is the highest point, thus also has the least deposition and percent ground coverage. Findings associated with vegetation recovery in the plot were disturbing. After 5 years the subplots were strikingly bare of vegetation. Data for plots A-K were lost, as to account for the null value. Undisturbed areas around NRTP had a high percent ground cover, yet disturbed subplot areas had an average of less than 10% percent ground cover with only 2-5 species compared with 5-10 species in 1999.

1999 Survey Results

PLT	SBPLT	SPCT
NRTP	1	10
NRTP	2	11
NRTP	3	7
NRTP	4	10
NRTP	5	5
NRTP	6	7
NRTP	7	7
NRTP	8	5
NRTP	9	6
NRTP	10	8
NRTP	A(11)	10
NRTP	B(12)	9
NRTP	C(13)	16
NRTP	K	39

2003 Survey Results

PLT	SBPLT	SPCT	COV
NRTP	1	2	2%
NRTP	2	2	5%
NRTP	3	6	50%
NRTP	4	2	2%
NRTP	5	3	5%
NRTP	6	3	5%
NRTP	7	2	5%
NRTP	8	2	75%
NRTP	9	4	5%
NRTP	10	3	5%
NRTP	A	999	100%
NRTP	B	999	50%
NRTP	C	999	90%
NRTP	K	999	90%

NRTP northwest corner facing south

NRTP subplot 1 facing north

WHO1

WHO1 is in a grazed area in a gently rolling plain east of an eroding badlands/sod table margin. Vegetation diversity decreased with the years, yet percent ground cover even in disturbed areas was quite dramatic. Most the subplots had at least 60% + ground coverage. Some of the subplots were quite difficult to relocate, as they were so densely overgrown. These results may be evaluated through the variables influencing vegetation regrowth, as stated before.

2000 Survey Results

PLT	SBPLT	SPCT
WHO1	1	7
WHO1	2	7
WHO1	3	5
WHO1	4	7
WHO1	5	3
WHO1	6	7
WHO1	7	4
WHO1	8	6
WHO1	9	3
WHO1	10	9
WHO1	A	11
WHO1	B	11
WHO1	C	20
WHO1	K	48

2003 Survey Results

PLT	SBPLT	SPCT	COV
WHO1	1	4	100%
WHO1	2	3	25%
WHO1	3	3	90%
WHO1	4	4	100%
WHO1	5	3	45%
WHO1	6	4	100%
WHO1	7	3	25%
WHO1	8	2	10%
WHO1	9	3	35%
WHO1	10	5	100%
WHO1	A	5	95%
WHO1	B	3	50%
WHO1	C	6	85%
WHO1	K	15	90%

WHO1 northeastern corner facing south

PNO1

PN01 is located in an area grazed in both 2003 and 2003. It is located on hilltop sheltered by pine trees from the north, south and western sides. The topography is of a gently sloping nature to the south and with a steep drop-off on the west. A-K plot data was also lost, as to account for the null value. SPCT also decreased over the year, as with all the subplots sampled within the four Modified-Whittakers relocated.

2002 Survey Results

PLT	SBPLT	SPCT
PN01	1	8
PN01	2	10
PN01	3	7
PN01	4	11
PN01	5	7
PN01	6	7
PN01	7	6
PN01	8	6
PN01	9	6
PN01	10	7
PN01	A	12
PN01	B	13
PN01	C	13
PN01	K	25

2003 Survey Results

PLT	SBPLT	SPCT	COV
PN01	1	1	20%
PN01	2	2	2%
PN01	3	3	5%
PN01	4	7	20%
PN01	5	2	5%
PN01	6	4	2%
PN01	7	2	5%
PN01	8	3	2%
PN01	9	4	10%
PN01	10	5	2%
PN01	A	999	95%
PN01	B	999	95%
PN01	C	999	95%
PN01	K	999	95%

PN01 subplot 10 facing south

PN01 northeast corner facing south

CONLUSIONS

This study in Nebraska can be applied to the GRIZ project, as Modified Whittaker sampling has been conducted there as well. By correctly recording vegetation and diversity in the initial survey, maybe the sampling plots could be relocated at least yearly to monitor the ecological impacts of archaeological ground disturbance. Only by understanding the long and short term impacts of our actions, can we act accordingly to be aware of fragile areas, and avoid large or small scale ground disturbance.

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