The Use of Computer Templates for Managing Ecological Data

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Abstract

The process of managing the volume of data collected on ecological studies on rangeland is time consuming and difficult. The Central Grasslands Research Extension Center has been conducting extensive studies of plant community dynamics on long term ecological studies since 1988. Data collected on these studies includes three production clips each season, soil water monitoring, frequency data on nearly 200 species, and basal cover and density on all forbs, shrubs and cespitose grasses. The goal set for this project is to have all the data processed within four months of the date it is collected. Data sheets from the field are entered into computers using Lotus 1-2-3™. Templates have been developed that enhance this process and prevent errors. This is accomplished by data input templates that allow error trapping and reduces repetitious keystrokes, prepare data for analysis in statistical packages such as SAS™, then analyze and summarize the resulting data from SAS into concise reports.

Introduction

At CGREC changes in the plant communities are monitored by sampling the percent frequency of occurrence, density per unit area, and percent basal cover of all plant species. Frequency of occurrence is sampled by placing a frame on the ground fifty times along a transect at each sampling site. Every time it is placed on the ground all the plant species which occur in the frame are recorded. Figure 1 shows a facsimile of the form used in the field to collect frequency and density data. A similar form is used to collect basal cover data. The number of frames in which a species occurs divided by the total number of frames, multiplied by 100, is the percent frequency of that species. For this study, a 25 x 25 cm frame with 5 x 5 cm and 10 x 10 cm frames nested within it, is used. Overflow and silty range sites are sampled each year on thirty sites.

Density is determined by counting all the individual plants of each species in each of the frames. Density data were only collected on shrubs and forbs from 1988 to 1991. In 1992 we began collecting density data on cespitose (bunch) grasses and sedges. Density data are not collected on rhizomatous grasses and grass-like plants because of the difficulty of counting individual plants.

Several templates were developed to efficiently process large amounts of frequency, density, and basal cover data taken in the field. This poster will highlight three templates: basic data entry, preparation of data for analysis, and summarization of the analyzed results.

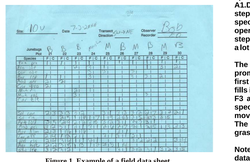
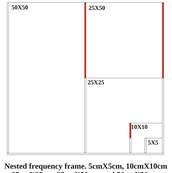


Figure 1. Example of a field data sheet.



Nested frequency frame, 5cmX5cm, 10cmX10cm 25cmX25cm, 25cmX50cm, and 50cmX50cm.

Phase I
Data Entry

Data entry is probably the most important and time-consuming step in correctly processing data. If data is not accurately punched embarrassing results can appear after the data has been analyzed. If a mistake is found at this time it takes a lot longer to correct than it would at the initial entry stage. At CGREC a lot of time is spent on this step. The data entry macro attempts to reduce error and tedium as much as possible.

Using layered spreadsheets, a separate sheet is used for each site and is assigned a range name which identifies the site, e.g. all data collected on pasture 1 on the overflow range site will have a range name of OV01, and is used as a permanent database for that site. A list of species and their plant form (forb, grass or shrub) is completed and updated each year and is used as a lookup table to assist with data entry. Table 1 shows a portion of that list. Another lookup table references the treatment which is allocated to each site (table 2). Both tables are used in the data entry process.

Table 1. List of some plants found on the grazing intensity overflow site.

Species	Form	Latin Name
Achmil	F	Achillea millefolium
Agrsmi	G	Agrostis gigantea
Agrpal	G	Agropyron smithii
Ambcon	S	Amorpha canescens

Table 2. Site and Treatment List.

Site	TRT
Ov01	Light
Ov02	Moderate

A B C D E F G H I K
1 F 2000 OV01 sokoan
2 type Date Site Species Plot Frame Density Frame_1 Frame_2 Frame_3 Error_chk
3 # 2000 OV01 sokoan 1 1 1 0 0 0
4 # 2000 OV01 sokoan 2 3 1 0 0 1
5 F 2000 OV01 sokoan 3 1 1 1 1 1 Density Missing
6 F 2000 OV01 sokoan 4 1 0 0 0 1
7 F 2000 OV01 sokoan 5 3 5 0 0 1
8 F 2000 OV01 sokoan 6 1 1 0 0 1
9 F 2000 OV01 sokoan 7 2 5 0 1 1
10 F 2000 OV01 sokoan 8 2 9 0 1 1
11 F 2000 OV01 sokoan 9 5 1 0 0 1 Frame No. ??
12 F 2000 OV01 sokoan 10 1 10 1 1 1

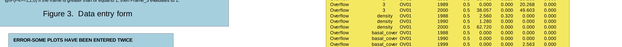
FORMULAS

Column H4: @IF(I4=1,1,0) if the species appears in the 5cm x 5cm frame (frame 1), frame_1 to frame_3 evaluates to 1 if the frame number is greater than one, then Frame_1 will evaluate to 0.

Column I4: @IF(I4=0AND(I4=1),1,0) if the species appears in the 10cm x10cm (frame 2), frames 2 and 3 evaluate to 1. If the frame is >0 then Frame_2 will evaluate to 0.

Column J4: @IF(I4=1,1,0) if the frame is greater than or equalto 1, then Frame_3 evaluates to 1.

Figure 3. Data entry form



ERROR-SOME PLOTS HAVE BEEN ENTERED TWICE

Site	Plot	Species	Plot. Count	Err. Check
OV01	1	sokoan	2	Error
OV01	2	sokoan	2	Error
OV01	3	sokoan	2	Error
OV01	4	sokoan	2	Error
OV01	5	sokoan	2	Error
OV01	6	sokoan	2	Error
OV01	7	sokoan	2	Error
OV01	8	sokoan	2	Error
OV01	9	sokoan	2	Error
OV01	10	sokoan	2	Error
OV01	1	achmil	1	
OV01	1	ambpsa	1	
OV01	1	ambpsa	1	
OV01	1	artabs	1	
OV01	1	artfri	1	
OV01	1	astern	1	
OV01	1	astern	1	

Figure 4. Results of the [COUNT_PLOT] command reveal this a set of plots have been entered twice for the same species.

Figure 2 shows the data entry macro [CTRL-G].

VG	{MENUBRANCH MENU1}{ESC}{QIT}			
MENU1	ENTER DATA	COUNT	TABULATE	QUIT
	Enter Data (IV)	Plots/spp (V1)	Table All Data (V2)	Return to 123 (QIT)

Figure 2. Data entry and tabulation macro.

When all sites have been entered and checked for error, the next step is to summarize and tabulate the data. Select [TABULATE] from the menu. Figure 5 shows the results of the tabulation and includes a percent frequency value for each frame. The arcsine transformation is applied to the frequency data to convert it from a binomial distribution to a nearly normal distribution. The data is now ready for the next step in the process.

Year 2000 Grazing Intensity Frequency and Density Summary on Overflow Sites

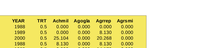
Year	TRT Site	Species	Frame 1	Frame 2	Frame 3	Square Root	Density/ Frame_1	% freq Frame_1	% freq Frame_2	% freq Frame_3	Transformed Data Frame_1	Frame_2	Frame_3	Relative Freq
2000	0.5 OV01	achmil	0	0	1	0.64	0	0	0	2	0.000	0.000	11.537	0.3a
2000	0.5 OV01	agrpse	6	10	15	17.92	12	20	30	20.268	26.565	33.211	2.56	
2000	0.5 OV01	agrsmi	14	14	29	20.00	12	28	28	58	20.268	33.690	49.863	4.96
2000	0.5 OV01	allsto	0	1	1	0.96	0	2	2	2	0.000	8.130	8.130	0.17
2000	0.5 OV01	ambpsl	2	13	37	32.32	4	26	74	74	11.537	30.957	59.343	5.92
2000	0.5 OV01	andger	5	12	17	0.00	10	24	34	18.435	29.334	35.669	2.91	
2000	0.5 OV01	antdis	0	1	1	0.96	0	2	2	2	0.000	8.130	8.130	0.17
2000	0.5 OV01	artabs	3	7	7	14.40	2	6	14	8.130	14.179	21.973	1.28	
2000	0.5 OV01	artfri	5	13	21	25.92	10	26	42	18.435	30.957	40.397	3.59	
2000	0.5 OV01	astern	1	5	18	18.56	2	10	36	8.130	25.104	36.870	2.38	
2000	0.5 OV01	astsim	6	11	19	30.72	12	22	38	20.268	27.972	38.057	3.25	
2000	0.5 OV01	bouhir	5	10	28	0.00	10	20	56	18.435	26.565	48.446	4.79	
2000	0.5 OV01	camrot	1	2	3	2.88	2	4	6	8.130	11.537	14.179	0.51	
2000	0.5 OV01	chrdol	2	10	17	13.44	4	20	34	11.537	26.565	35.669	2.91	
2000	0.5 OV01	agrsar	4	9	19	4.16	0	18	38	0.000	24.498	35.104	1.97	
2000	1.0 OV02	agrhyw	2	5	13	9.28	4	10	26	11.537	18.435	30.657	2.84	
2000	1.0 OV02	agrsmi	8	10	17	0.00	12	20	34	20.268	26.565	35.669	3.71	
2000	1.0 OV02	agrsmi	2	3	5	0.00	4	6	10	11.537	14.179	18.435	1.09	
2000	1.0 OV02	ambpsl	2	9	24	14.96	4	18	48	11.537	25.104	43.654	5.24	
2000	1.0 OV02	andger	12	23	36	22.08	24	46	72	29.334	42.706	58.052	7.86	
2000	1.0 OV02	andsco	0	0	1	0.32	0	0	2	0.000	0.000	14.179	0.86	
2000	1.0 OV02	andsco	0	0	1	0.32	0	0	2	0.000	0.000	8.130	0.22	
2000	1.0 OV02	anecan	1	1	5	2.88	2	2	10	8.130	8.130	18.435	1.09	
2000	1.0 OV02	artmeq	0	0	1	0.32	0	0	2	0.000	0.000	8.130	0.22	
2000	1.0 OV02	artpri	0	0	1	0.32	0	0	2	0.000	0.000	8.130	0.22	
2000	1.0 OV02	artsul	2	6	20	19.84	4	12	40	11.537	20.268	39.232	4.37	
2000	1.0 OV02	astern	3	5	16	11.20	6	10	32	14.179	18.435	34.450	3.49	
2000	1.0 OV02	bouhir	2	4	8	0.00	4	8	16	11.537	16.430	23.578	1.75	

Figure 5. Compiled results of the tabulate command from ALT-G

Phase II
Preparation of Data for Analysis in SAS

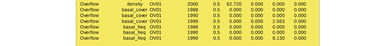
This step relies heavily on functions and formulas in both Lotus-Approach™ and Lotus 1-2-3.™ The data which is shown in Figure 5 is appended to a permanent database which contains data for all years of the study. Figure 6 shows how the data has been rearranged with species organized in columns rather than in rows. A template of a SAS program file is then modified each year to accomplish a number of tasks: create the data set in SAS, analyze the data sets using analysis of variance, and then compile results that are significant at P<0.05. Figure 7 is a facsimile of the compiled results of the analysis of variance indicating differences in frequency, density and basal cover due to the year x treatment interaction. Similar reports are generated indicating differences due to treatment and due to year.

A major advantage of the SAS results shown in Figure 7 is that it greatly reduces the amount of paper used to show the results. The SAS report compiled over 200 pages for each species analyzed and this template efficiently organizes results which may be viewed very quickly and conserves paper.



SITETYPE	FRAME	SITE	YEAR	TRT	Achmil	Agropk	Agrsmi	Agrsmi
Overflow	1	OV01	1989	0.5	0.000	0.000	8.130	0.000
Overflow	1	OV01	1989	0.5	0.000	0.000	8.130	0.000
Overflow	1	OV01	1989	0.5	0.000	0.000	8.130	0.000
Overflow	2	OV01	1989	0.5	8.130	0.000	8.130	0.000
Overflow	2	OV01	1989	0.5	0.000	0.000	14.179	0.000
Overflow	2	OV01	2000	0.5	29.334	0.000	31.948	0.000
Overflow	3	OV01	1988	0.5	18.435	8.130	20.268	0.000
Overflow	3	OV01	1989	0.5	0.000	0.000	14.179	0.000
Overflow	3	OV01	2000	0.5	38.057	0.000	49.463	0.000
Overflow	density	OV01	1988	0.5	2.560	0.320	0.000	0.000
Overflow	density	OV01	1990	0.5	1.280	0.000	0.000	0.000
Overflow	density	OV01	2000	0.5	82.720	0.000	0.000	0.000
Overflow	basal_cover	OV01	1989	0.5	0.000	0.000	0.000	0.000
Overflow	basal_cover	OV01	1990	0.5	0.000	0.000	0.000	0.000
Overflow	basal_cover	OV01	1999	0.5	0.000	0.000	2.563	0.000
Overflow	basal_feq	OV01	1988	0.5	0.000	0.000	0.000	0.000
Overflow	basal_feq	OV01	1990	0.5	0.000	0.000	0.000	0.000
Overflow	basal_feq	OV01	1999	0.5	0.000	0.000	8.130	0.000

Figure 6. Data after it has been rearranged with species spread in columns across the top.

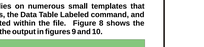


STYPE	FRAME	NAME	DF	SS	PROB	Wilk's	TRTSS	TRT_SS	YEAR_SS	TOTAL_SS	MODEL_R²	Year x TRT R²	Year RF	TRT RF	LSD
OV	1	Achmil	130	3468.61	0.00	8093.69	5624.61	1533.85	5640.97		0.80	0.27	1.45	0.18	8.37
OV	2	Achmil	130	5218.28	0.00	12960.86	9826.23	23990.92	53988.26		0.90	0.25	0.46	0.19	10.23
OV	3	Achmil	130	6000.00	0.00	20566.07	15445.47	102200.43	129797.56		0.79	0.15	0.24	0.35	12.72
OV	Density	Achmil	120	95764.64	0.00	20566.07	23401.47	102200.43	629797.56		0.93	0.16	0.24	0.35	32.70
Sr	1	Achmil	130	4640.47	0.03	2633.32	3298.51	8136.70	18709.01		0.75	0.14	0.43	0.18	9.65
Sr	2	Achmil	130	7976.79	0.04	4421.64	5623.20	15794.50	33816.13		0.76	0.13	0.47	0.17	12.65
Sr	3	Achmil	130	13296.20	0.04	7363.71	11637.75	29946.38	62264.05		0.79	0.12	0.48	0.19	16.33
Sr	Density	Achmil	120	1245.00	0.00	1245.00	1245.00	1245.00	1245.00		1.00	0.00	0.00	0.00	0.00
Sr	1	artfri	130	3740.45	0.01	2465.86	2624.21	2774.66	10610.19		0.61	0.25	0.26	0.10	8.67
Sr	Density	Agreg2	120	0.14	0.00	0.10	0.01	0.06	0.36		0.56	0.33	0.19	0.03	0.05

Figure 7. Compiled results of ANOVA showing differences in frequency and density due To Year x Trt interaction On Overflow & Silty Sites In 2000.

Phase III
Summarization of the Analyzed Results

This phase of the process relies on numerous small templates that include the use of lookup tables, the Data Table Labeled command, and macros which have been created within the file. Figure 8 shows the menu [ALT-M] used to generate the output in figures 9 and 10.



MENU1	TABULATE_DATA	MEANS_SEPARATION	GRAPH_DATA	QUIT
	Summarize The Data (XI)	Run Lod (VA)	Graph species data (VG)	Return to 123 (QIT)

Figure 8. Macro which compiles summaries for each species using the results of the SAS analysis.

Summarizing the SAS Results and Identification of Changes in Species Abundance

Table3. Lookup table using unique data extracted from SAS.

Loop count	Name	Frame
1	Achmil	1
2	Achmil	2
3	Achmil	3
4	Achmil	Density
5	Achmil	Basal_cover

The [TABULATE_DATA] routine uses a lookup table that is created by extracting the unique values for the site type, frame and species from the three SAS reports indicating differences due to treatment, year, and the year x treatment interaction (table 3). A looping macro then uses this information to create the criteria in figure 9 which is referenced by the Data Table Labeled command. The following steps describe the generation of the summary for each species and frame.

1. Two tables are created simultaneously for each species: one with the arcsine transformed frequency values for each frame, or density or basal cover data (figure 9). The other table contains the untransformed data for each frame, etc. (figure 10). Figure 9 is abbreviated for this poster so that pertinent information can be illustrated but a complete summary of data for *Achillea millefolia* is shown in figure 10.

2. Data in figure 7 are used as a lookup table to reference the LSD value, the probability value (P<0.05), and the R^2 values for each species on the list. These values are then placed to the right of each table and are used by another menu selection [MEANS_SEPARATION] to identify specific differences between means.

3. The macro identifies species that are significant due to treatment by referencing a lookup table similar to the one in figure 7 but which do not show a significant interaction by placing a "T" in the far left column of the table.

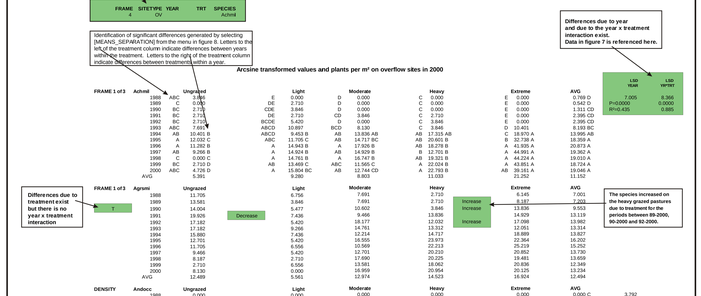


Figure 9. Means separation, least significant differences, and change in species abundance generated by the menu selections in figure 8.

Identification of Specific Differences Between Treatment Means

The [MEANS_SEPARATION] selection from the menu in figure 8 uses an extensive macro to produce the following results:

1.Identifies specific differences in means due to year and due to the interaction of year x treatment. The LSD values for both are listed to the right for each species and corresponding frame. These are used to compare means. Figure 9 shows that *Achillea millefolia* (Achmil) had a significant interaction between year x treatment in frame 1. When this occurs, the differences between treatments in a given year are identified as well as the between years differences in each treatment. If the data is significant due to year only, specific differences between years are identified.

2.The results are copied to the tables in figure 10.

By selecting [GRAPH_DATA] from the menu, the untransformed data for each species is charted (figure 10).

These templates help to process data in an efficient and timely manner, and produce reports that are comprehensive and concise.

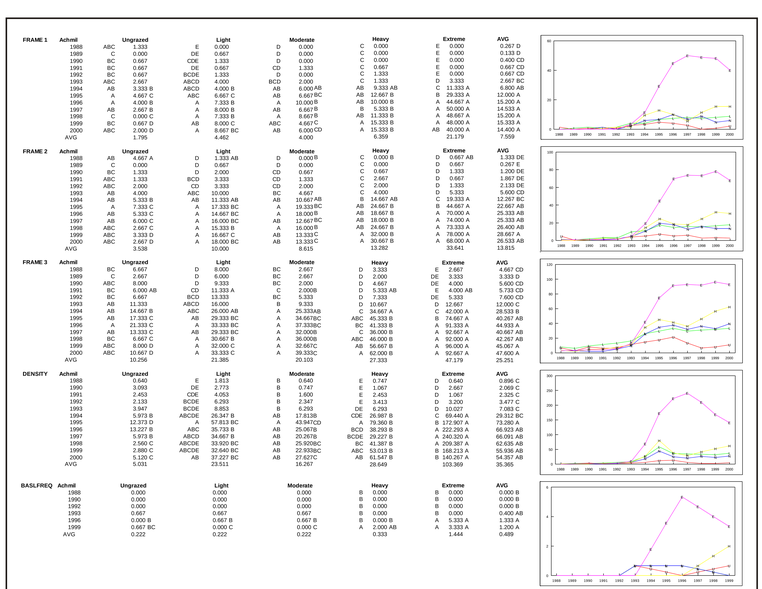


Figure 10. Percent Frequency Values And Plants Per M² On Gi Overflow Sites In 2000