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## Early Warning and Crop Condition Assessment

October 1981

### AN EMPIRICAL, GRAPHICAL, AND ANALYTICAL STUDY OF THE RELATIONSHIP BETWEEN VEGETATION INDICES

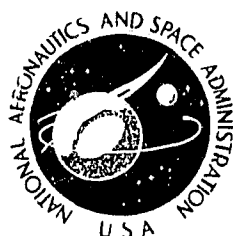
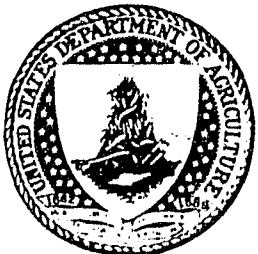
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U.S. Department of Agriculture  
Statistical Reporting Service

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AN EMPIRICAL, GRAPHICAL, AND ANALYTICAL STUDY OF THE  
RELATIONSHIPS BETWEEN VEGETATION INDICES

Lyle F. Lautenschlager and Charles R. Perry, Jr.  
U.S. Department of Agriculture, Statistical Reporting Service

The aim of science is to seek the simplest explanation of complex facts. We are apt to fall into the error of thinking that the facts are simple because simplicity is the goal of our quest. The guiding motto in the life of every natural philosopher should be, "Seek simplicity and distrust it".

Alfred North Whitehead

ABSTRACT

Since the launching of Landsat I in 1972, investigators have derived numerous formulae for the reduction of multispectral scanner (MSS) measurements to a single value (vegetation index) for predicting and assessing vegetative characteristics such as plant leaf area, total biomass and general plant stress and vigor. This report summarizes the origin, motivation, and derivation of some four dozen vegetation indices. Empirical, graphical, and analytical techniques are used to investigate the relationships among the various indices. It is concluded that many vegetative indices are very similar, some being simple algebraic transforms of others.

## 1. INTRODUCTION

Current and accurate information on a global basis regarding the extent and condition of the world's major food and fiber crops is important in today's complex world. Traditional sampling techniques for estimating crop conditions, based on field collection of data, are time consuming, costly, and not generally applicable to foreign regions. An alternate approach is remote sensing - the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation [Lillesand and Kiefer (1979)].

A series of earth resources technology satellites (Landsats) have provided a way to monitor worldwide crop conditions since 1972. The sensor system onboard the Landsats, the multispectral scanner (MSS), measures the reflectance of the scene in four wavelength intervals (bands or channels) in the visible and near-infrared portions of the spectrum. The spectral measurements are influenced by the vegetation canopy, soil type, and atmospheric condition.

Investigators have developed techniques for qualitatively and quantitatively assessing the vegetative canopy from spectral measurements. The objective has been to reduce the four bands of Landsat spectral data to a single number for predicting or assessing such canopy characteristics as leaf area, biomass, percent ground cover, and plant population.

This report summarizes and references the origin, derivation, and motivation for some four dozen of these formulae which are referred to as vegetation indices (VIs). The VIs are categorized on the basis of statistical correlations and algebraic similarities. This analysis reveals the similarities of many vegetation indices.

## 2. LANDSAT DATA CHARACTERISTICS

Three Landsats have been launched since the summer of 1972, with Landsats 2 and 3 still operational. Each satellite is capable of providing 18-day repetitive coverage of the earth's surface. Each Landsat's onboard four-channel MSS system measures reflectance in four bands (fig. 1). The measurements are converted to digital counts and transmitted to receiving stations. Landsat MSS images cover an area of 185 by 185 kilometers and are composed of 7,581,600 picture elements (pixels). [Watkins and Freedon (1979)].

Typical reflectance patterns for herbaceous vegetation and soil are compared in figure 1. Dead or dormant vegetation has higher reflectance than living vegetation in the visible spectrum and lower reflectance in the near-infrared. Soil has higher reflectance than green vegetation and lower reflectance than dead vegetation in the visible, whereas in the near-infrared, soil has lower reflectance than green and dead vegetation [Tappan (1980)]. Jackson et al. (1980), Tucker and Miller (1977), and Deering et al. (1975) provide an extensive discussion of reflectance properties. Three papers of historical interest are Jordan (1969), Knipling (1970), and Pearson and Miller (1972).

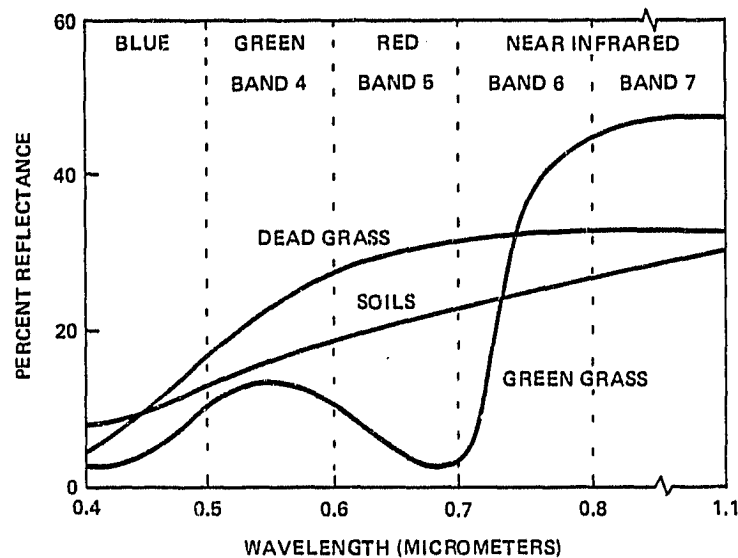


Figure 1. Typical Reflectance of herbaceous vegetation and soil from 0.4 to 1.1 micrometers.



### 3. DEVELOPMENT OF VEGETATION INDEX FORMULAE

Numerous vegetation indices have been used to make quantitative estimates of leaf area index, percent ground cover, plant height, biomass, plant population, and other parameters [Pearson and Miller (1972) and Wiegand et al. (1974)]. The formulae are based on ratios and linear combinations of the MSS bands.

The individual Landsat bands (CH4, CH5, CH6, CH7) have been used to estimate percent ground cover and vegetative biomass [Wiegand et al. (1974) and Seevers et al. (1973)]. The correlation coefficients reported ranged from 0.295 for CH7 with crop cover to 0.877 for CH6 with leaf area index. Similar correlations were reported by Tucker (1979).

Ratios of the Landsat bands have been used to estimate and monitor green biomass, etc. [Rouse et al. (1973, 1974), Carneggie et al. (1974), Johnson (1976), and Maxwell (1976)]. The obtained coefficients of determinations were slightly higher than those for the corresponding band differences. The twelve pairwise ratios (six of which are inverses of the other six) will be denoted by  $R45 = CH4/CH5$ ,  $R46 = CH4/CH6$ , etc.

Rouse et al. (1973, 1974) proposed using the normalized difference of Landsat channels 7 and 5 for monitoring vegetation, which will be referred to as ND7. Deering et al. (1975) added 0.5 to ND7 to avoid negative values and took the square root of the result in hopes of stabilizing the variance. This index is referred to as the transformed vegetation index and will be denoted by TVI7. Similar formulae using channels 6 and 5 were proposed.

$$ND6 = (CH6 - CH5)/(CH6 + CH5)$$

$$ND7 = (CH7 - CH5)/(CH7 + CH5)$$

$$TVI6 = (ND6 + 0.5)^{1/2}$$

$$TVI7 = (ND7 + 0.5)^{1/2}$$

Our experience has been that the addition of 0.5 does not eliminate all negative values. We suggest the following computationally correct formulae:

$$\begin{aligned} \text{TVI6} &= (\text{ND6} + .5) / \text{ABS}(\text{ND6} + .5) [\text{ABS}(\text{ND6} + .5)]^{1/2} \\ \text{TVI7} &= (\text{ND7} + .5) / \text{ABS}(\text{ND7} + .5) [\text{ABS}(\text{ND7} + .5)]^{1/2} \end{aligned}$$

where ABS denotes absolute value, and 0/0 is set equal 1. In section 6, it is shown that these formulae are equivalent for decision making to the basic ratios R65 and R75. Therefore, their use can only be justified if either they improve the regression fit or they normalize the regression errors [Draper and Smith (1966)].

Kauth and Thomas (1976) proposed an orthogonal transformation of the original Landsat data space to a new four-dimensional space. They christened this transformation the tassal cap transformation and named the four new axes soil brightness (SBI), green vegetation (GVI), yellow stuff (YVI), and non-such (NSI). The names attached to the new axes indicate the characteristics the indices were intended to measure.

$$\begin{aligned} \text{SBI} &= .332 \text{ CH4} + .603 \text{ CH5} + .675 \text{ CH6} + .262 \text{ CH7} \\ \text{GVI} &= -.283 \text{ CH4} - .660 \text{ CH5} + .577 \text{ CH6} + .388 \text{ CH7} \\ \text{YVI} &= -.899 \text{ CH4} + .428 \text{ CH5} + .076 \text{ CH6} - .041 \text{ CH7} \\ \text{NSI} &= -.016 \text{ CH4} + .131 \text{ CH5} - .452 \text{ CH6} + .882 \text{ CH7} \end{aligned}$$

Wheeler et al. (1976) and Misra et al. (1977) applied principal component analysis to Landsat data. The structure of the resulting transformation and the interpretation of the principal components are similar to those for the Kauth-Thomas transformation.

$$\begin{aligned} \text{NSBI} &= .406 \text{ CH4} + .600 \text{ CH5} + .645 \text{ CH6} + .243 \text{ CH7} \\ \text{MGVI} &= -.386 \text{ CH4} - .530 \text{ CH5} + .535 \text{ CH6} + .532 \text{ CH7} \\ \text{MYVI} &= .723 \text{ CH4} - .597 \text{ CH5} + .206 \text{ CH6} - .278 \text{ CH7} \\ \text{MNSI} &= .404 \text{ CH4} - .039 \text{ CH5} - .505 \text{ CH6} + .762 \text{ CH7} \end{aligned}$$

Misra et al. (1977) proposed another linear transform, based on the idea of spectral brightness and contrast. Generalizations of spectral brightness and contrast were defined in spectral density space, then transformed back to count space. The first two components of the resulting transformation are similar to the first two components of the two preceding transformations.

$$\begin{aligned} \text{SSBI} &= .437 \text{ CH4} + .564 \text{ CH5} + .661 \text{ CH6} + .233 \text{ CH7} \\ \text{SGVI} &= -.437 \text{ CH4} - .564 \text{ CH5} + .661 \text{ CH6} + .233 \text{ CH7} \\ \text{SYVI} &= -.437 \text{ CH4} + .564 \text{ CH5} - .661 \text{ CH6} + .233 \text{ CH7} \\ \text{SNSI} &= -.437 \text{ CH4} + .564 \text{ CH5} + .661 \text{ CH6} - .233 \text{ CH7} \end{aligned}$$

Richardson and Wiegand (1977) used the perpendicular distance to the "soil line" as an indicator of plant development. The "soil line", a two-dimensional analogue of the Kauth-Thomas SBI, was estimated by linear regression. Two perpendicular vegetation indices were proposed.

$$\begin{aligned} \text{PVI7} &= [(.355 \text{ CH7} - .149 \text{ CH5})^2 + (.355 \text{ CH5} - .852 \text{ CH7})^2]^{1/2} \\ \text{PVI6} &= [(-.498 - .457 \text{ CH5} + .498 \text{ CH6})^2 + (2.734 + .498 \text{ CH5} - .543 \text{ CH6})^2]^{1/2} \end{aligned}$$

Evidently a minor error was made in the derivation of PVI6. The formula for PVI6 should be:

$$\text{PVI6} = [(-2.507 - .457 \text{ CH5} + .498 \text{ CH6})^2 + (2.734 + .498 \text{ CH5} - .543 \text{ CH6})^2]^{1/2}$$

These formulae are computationally inefficient and do not distinguish right from left of the "soil line" (water from green stuff). The standard formula from analytic geometry for the perpendicular distance from a point to a line solves this difficulty [Salas and Hille (1978)].

$$\begin{aligned} \text{PVI6} &= (1.091 \text{ CH6} - \text{CH5} - 5.49)/(1.091^2 + 1^2)^{1/2} \\ \text{PVI7} &= (2.4 \text{ CH7} - \text{CH5} - .01)/(2.4^2 + 1^2)^{1/2} \end{aligned}$$

The difference vegetation index (DVI), suggested by Richardson and Wiegand (1977) as computationally easier than PVI7, is essentially a rescaling of PVI7.

$$DVI = 2.4 CH7 - CH5$$

The Ashburn vegetation index [Ashburn (1979)] was suggested as a measure of green growing vegetation. The doubling of CH7 is to make the scale compatible; CH7 is 6-bit data and has one-half the range of the other three bands which are 8-bit data.

$$AVI = 2.0 CH7 - CH5$$

Colwell et al. (1979) proposed a vegetation indicator called greenness above bare soil (GRABS). This was another attempt to develop an indicator for which a threshold value could be specified for detecting green vegetation. The calculations were made using the Kauth-Thomas tassell cap transformation applied to sun-angle and haze-corrected data. The resulting index is quite similar to the GVI, since the contribution of SBI is less than 10 percent of GVI.

$$GRABS = GVI - .09178 SBI + 5.58959$$

Kanemasu et al. (1977) regressed winter wheat leaf area measurements on MSS band ratios and produced the following regression equation.

$$ELAI = 2.68 - 3.69 R45 - 2.31 R46 + 2.88 R47 + 0.43 R56 - 1.35 R57 \\ + 3.07[R45 - (.5 R47)(R45)]$$

Pollack and Kanemasu (1979) later used a larger data set plus stepwise regression and obtained another regression equation.

$$CLAI = .366 - 2.265 R46 - .431(R45 - R47)(R45) + 1.745 R45 + .057 PVI7$$

Separate regression equations were also obtained for CLAI values above and below 0.5.

$$\text{LAI} = 1.903 - 1.138 \text{ R56} - .071(\text{R45} - \text{R47})\text{R45} - .016 \text{ PVI6},$$

if CLAI is less than 0.5

$$\text{LAI} = -5.33 + .036 \text{ PVI7} + 6.54 \text{ TVI6},$$

if CLAI is greater than 0.5

The Foreign Crop Condition Assessment Division (FCCAD) of the Foreign Agricultural Service (FAS), Houston, Texas uses another leaf area model. We have been unable to find any reference to the development of this model.

$$\text{OLAI} = 41.325 \text{ R45} - 42.45 \text{ R46}$$

Badhwar (1981) proposed a ratio of GVI to SBI as an indicator of crop discrimination. It will be shown in section 6 that this index is a generalization of a normalized difference.

$$\text{GVSB} = \text{GVI/SBI}$$

Craig Wiegand (personal communication) suggested converting reflectance values to radiances. Linear transformations were used to change from reflectance to radiance values. Ratio and normalized difference formulae were also created using the radiance values.

$$\text{RAD5} = 0.0157 \text{ CH5} \quad \text{for Landsat 1}$$

$$= 0.0134 \text{ CH5} + 0.06 \quad \text{for Landsat 2}$$

$$= 0.0139 \text{ CH5} + 0.03 \quad \text{for Landsat 3}$$

$$\text{RAD7} = 0.0730 \text{ CH7} \quad \text{for Landsat 1}$$

$$= 0.0603 \text{ CH7} + 0.11 \quad \text{for Landsat 2}$$

$$= 0.0603 \text{ CH7} + 0.03 \quad \text{for Landsat 3}$$

$$\text{RADR75} = \text{RAD7/RAD5}$$

$$\text{NDRAD} = (\text{RAD7} - \text{RAD5}) / (\text{RAD7} + \text{RAD5})$$

Thompson and Wehmanen (1978) proposed a technique utilizing transformed Landsat digital data to indicate when agricultural vegetation is undergoing moisture stress. The screening number or green number (GIN) was proposed to estimate the percentage of land in an area with a "healthy" cover of vegetation. A "soil line" is determined by inspecting the channel data and discarding data not considered reasonable for agricultural data. The "soil line" is then evaluated as the minimum value remaining in CH5 and subtracted from GVI to obtain GIN.

$$\text{GIN} = \text{SVI} - \text{soil line}$$

The data sets included in this study did not permit the computation of GIN. However, GIN is a linear transformation of GVI.

## 4. EVALUATION OF VEGETATION INDICES

### 4.1 BACKGROUND

Richardson and Wiegand (1977) correlated eight VIs (GVI, DVI, SBI, PVI6, PVI7, TVI6, TVI7, and R57) with four plant component variables (crop cover, shadow cover, plant height, and leaf area index). The correlation coefficients obtained by plant component with the VIs (excluding SBI) were very similar. Later, Wiegand et al. (1979) correlated leaf area indices for winter wheat fields to five VIs (TVI7, TVI6, PVI7, PVI6, and GVI). The correlation coefficients by field and even between fields were similar.

Aaronson et al. (1979) studied the similarities and differences among seven VIs (AVI, DVI, GVI, OLAI, PVI7, TVI7, and KVI). The obtained correlation coefficients ranged from 0.8 to 1.0 and were stable from spring greenup to harvest. Aaronson and Davis (1979) later used a large data set, which included vegetation measurements and several VIs, to study interrelationships. The VIs (AVI, DVI, GVI, OLAI, KVI, PVI6, PVI7, TVI6, and TVI7) were correlated against each other and against vegetation measures such as plant height from tillering through harvest. The correlation coefficients between the VIs ranged from 0.81 to 1.00, and those between VIs and vegetation measures were similar.

### 4.2 CLUSTER ANALYSIS OF VI

The similarity between the VIs was first studied using the BMDP program P1M, cluster analysis of variables (Dixon and Brown, 1979) and the data set described in appendix A. The absolute value of the bivariate correlations was used as the measure of distance between VIs, and the average distance between elements was used as the between cluster distance. Similar results were obtained using other standard distance measures.

This procedure separated the VIs into two large clusters plus a number of small clusters. One large cluster contained VIs based on MSS bands 5 and 7, which included AVI, PVI7, R75, TVI7, and ND7. The other large cluster contained VIs, based on MSS bands 5 and 6, and a few VIs involving three or all four bands, which included GRABS, CLAI, OLAI, R65, TVI6, ND6, GVI, MGVI, PVI6, and SGVI. The VIs within these two clusters had absolute

simple linear correlations greater than 0.90, with most greater than 0.95. The elements of these two large clusters are correlated at 0.8 or higher. Three smaller clusters readily apparent were: (NSI, R76), (R64, R74), and (SBI, MSBI, SSBI, SNSI). This clustering is applicable to the period from spring greenup to harvest. There are some clusters, however, which have high correlations for the whole season, especially those involving bands 5 and 7. The cluster trees on which this discussion is based are attached as appendix B.

Some VIs were not used in the cluster analysis because of their known relationships to others. The inverse ratios R54, R46, R47, R56, R67, and R57 were not used. DVI was discarded because of its relationship to PVI7, as were RAD5, RAD7, RADR75, and NDRAD because of the linear relationships to CH5, CH7, R75, and ND7.



## 5. VEGETATION INDICES EQUIVALENCE

In this section, a definition of VI equivalence will be developed. This permits a natural categorization of the VIs. VIs are functions which associate a real value to the four-dimensional Landsat reflectance measurement vector, (MSS4, MSS5, MSS6, MSS7). Thus, it will be convenient to employ standard function notation:  $f:S_1 \rightarrow S_2$  denotes a function from the set  $S_1$  into the set  $S_2$ ;  $f(X)$ , the value of  $f$  at the point  $(X)$  of  $S_1$ ;  $\text{Dom}(f)$ , the domain of  $f$ ;  $\text{Ran}(f)$ , the range of  $f$ ; and  $f^{-1}:S_2 \rightarrow S_1$ , the inverse of  $f$  when it exists. The inverse exists if, and only if,  $f$  is one-to-one and onto. The composition of two functions has an inverse if, and only if, both functions have inverses; in which case

$$(f \circ g)^{-1} = g^{-1} \circ f^{-1}.$$

It might seem that VI equivalence should correspond to function equality; i.e.,  $V_1 = V_2$  if, and only if,  $V_1(X) = V_2(X)$  for each Landsat reflectance value  $X$ . However, this requirement is too restrictive because it involves only the VIs output and ignores the decisions made on the basis of this output. Since vegetation indices are formulae used in making decisions about crop characteristics and conditions, it seems appropriate to say that two VIs are equivalent if the same decision results regardless of the VI employed. This means that two VIs,  $V_1$  and  $V_2$ , are equivalent for making the set of decisions  $D$  if, and only if for every decision rule  $d_1:\text{Ran}(V_1) \rightarrow D$ , there corresponds a decision rule  $d_2:\text{Ran}(V_2) \rightarrow D$  such that the decision, based on  $d_2$  and  $V_2$ , is the same as the decision based on  $d_1$  and  $V_1$  for all Landsat reflectance measurements  $X$ ; that is,  $d_1(V_1(X)) = d_2(V_2(X))$  for each  $X$ . It is easy to see that the two vegetation indices,  $V_1$  and  $V_2$ , are equivalent if, and only if, there exists a one-to-one onto function

$T:\text{Ran}(V_1) \rightarrow \text{Ran}(V_2)$  such that  $T \circ V_1 = V_2$ . This implies that a decision  $d$  results from the same set of Landsat reflectance regardless of which VI is used; that is

$$V_1^{-1}[T^{-1}(d)] = (T \circ V_1)^{-1}(d) = V_2^{-1}(d) \quad (\text{Equation 1})$$

for each decision  $d$  in  $D$ , where the superscript  $-1$  indicates the inverse image of  $d$  under the given function. The relationship defined is an equivalence relation on the set of vegetation indices; that is,

- i. Each VI is equivalent to itself: Reflexive property.
- ii. If  $V_1$  is equivalent to  $V_2$ , then  $V_2$  is equivalent to  $V_1$ : Symmetric property.
- iii. If  $V_1$  is equivalent to  $V_2$ , and  $V_2$  is equivalent to  $V_3$ , then  $V_1$  is equivalent to  $V_3$ : Transitive property.

These properties are important because they permit one to avoid many tedious computations.

A number of studies have investigated the transformed vegetation indices TVI6 and TVI7 and the corresponding ratios R65 and R75 as predictors of biomass, leaf area index, plant height, and percent ground cover. The predictive ability of TVI6 and R65 or TVI7 and R75 are similar as evidenced by the estimated correlation coefficient. We now show that the transformed vegetation index and its generalizations are equivalent to the corresponding ratios. This example makes clear not only the algebraic and geometric meaning of VI equivalence but also demonstrates the utility and appropriateness of this definition.

Let  $a$  and  $b$  be positive constants, and define the functions  $f$ ,  $g$ , and  $T$  by

$$\begin{aligned}f(X_5, X_7) &= (aX_7 - bX_5)/(aX_7 + bX_5) \\g(X_5, X_7) &= X_7/X_5 \\T(y) &= (b/a)[(1 + y)/(1 - y)]\end{aligned}$$

for  $X_5$  and  $X_7$  positive and  $ABS(y)$  less than one. Observe that  $T$  is invertible; in fact

$$T^{-1}(z) = (az - b)/(az + b) \text{ for } z \text{ positive}$$

Thus, f and g are equivalent and the values of f can be computed from the values of g and vice versa.

$$\begin{aligned} (T \circ f)(X_5, X_7) &= g(X_5, X_7) \\ (T^{-1} \circ g)(X_5, X_7) &= f(X_5, X_7) \end{aligned}$$

Let k and p be real, and define the functions  $G:(-1,1) \rightarrow (k-1, k+1)$  and  $H:(k-1, k+1) \rightarrow (L, U)$  by

$$\begin{aligned} G(v) &= v + k \\ H(w) &= w[ABS(w)]^{p-1}, \text{ for} \end{aligned}$$

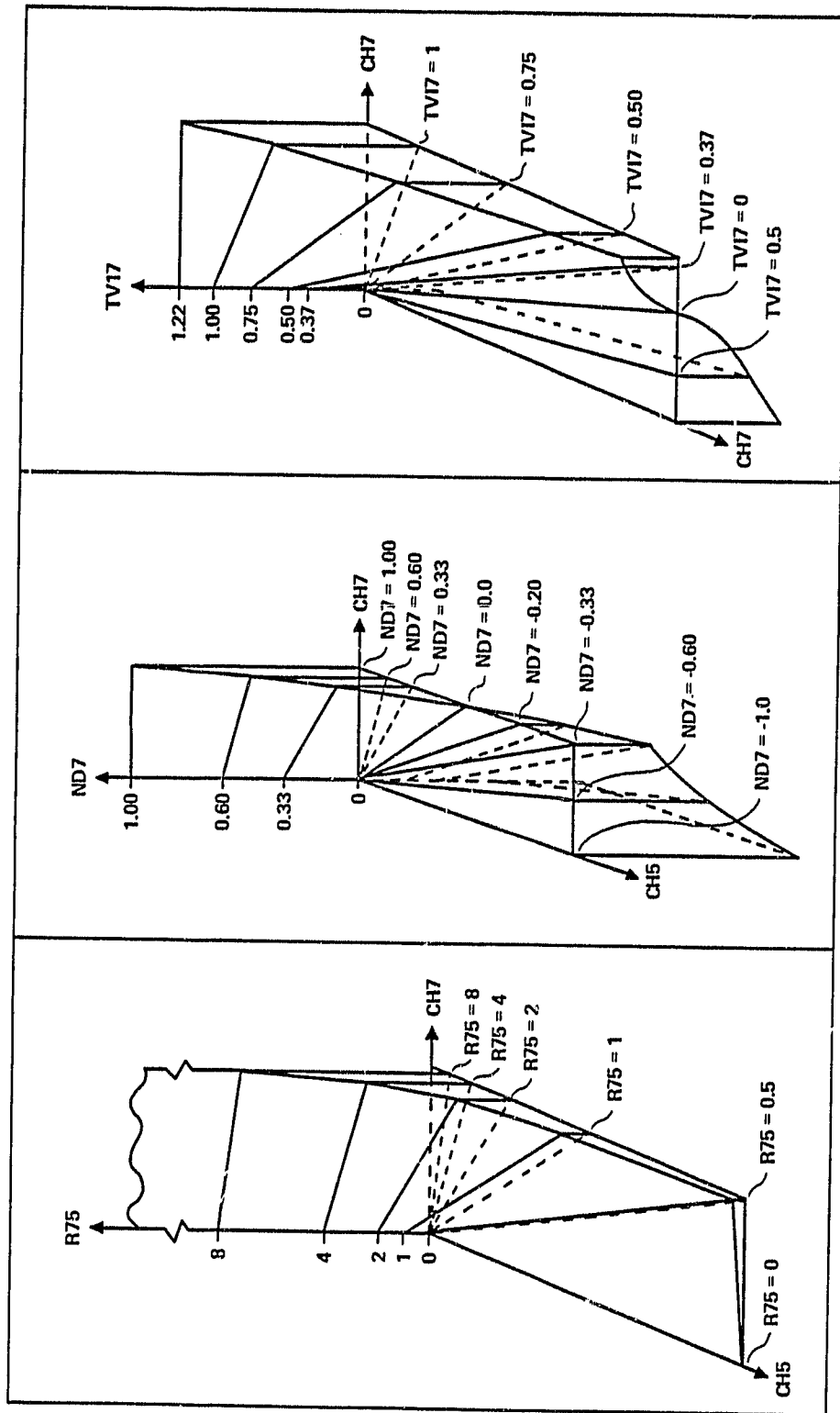
w between k-1 and k+1,  $L = (k-1)[ABS(k-1)]^{p-1}$ ,  $U = (k+1)[ABS(k+1)]^{p-1}$ , for  $ABS(v)$  less than one, and  $O/O$  defined as 1. It is easy to verify that G and H are one-to-one and onto and that

$$(H \circ G \circ T^{-1} \circ g)(X_5, X_7) = (f(X_5, X_7) + k)[ABS(f(X_5, X_7) + k)]^{p-1}.$$

Taking  $k = p = 1/2$  and  $a = b = 1$  shows that the transformed vegetation index, TVI7, is equivalent to the seven-five ratio, R75.

$$(H \circ G \circ T^{-1}) R75 = TVI7$$

Equivalence of VIs means their response surfaces determine precisely the same partition of the reflectance measurement space (equation 1). Elements of this partition are referred to as decision classes. Representative response surfaces and equivalence classes associated with R75, ND7, and TVI7 are illustrated in figures 2a, 2b, and 2c. Similar graphs for other popular indices are attached as appendix C. The nonlinear algebraic relationships exhibited among R75, ND7, and TVI7 are illustrated graphically in figure 3. Similar graphs for other indices are studied in appendix D.



(a) Associated with R75                      (b) Associated with ND7                      (c) Associated with TVI7

Figure 2. Response surface and equivalence classes.

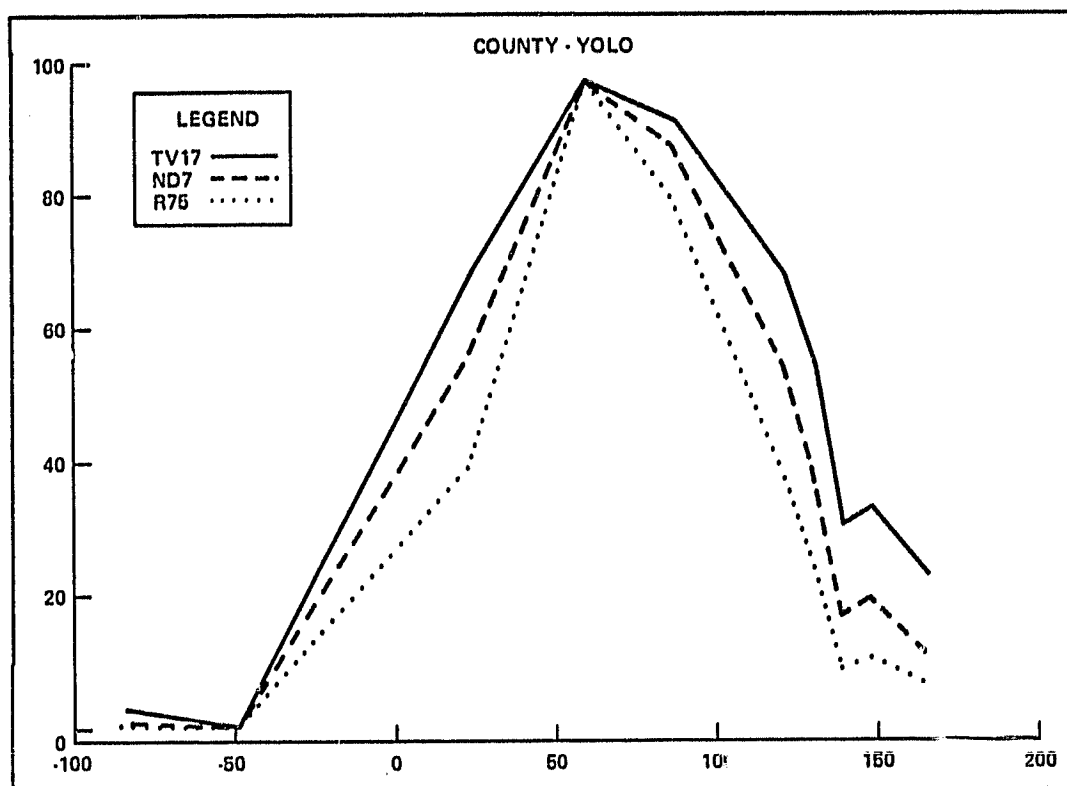


Figure 3. R75, ND7, and TVI7 versus time using data listed in Appendix A. All VI values have been rescaled 0 to 100.

As a further illustration of the utility of VI equivalence, GVSB is shown to be approximated by ND6. Thus, the more complicated GVSB can be expected to provide approximately the same information about crop condition as the simple ratio R65.

Using Landsat data described in appendix A, the following estimates were obtained.

GRANT AREA DATA / N = 6084

Variable	N	Mean	Std. Dev.
CH4	6084	23.2	7.2
CH5	6084	26.7	10.0
CH6	6084	41.4	15.9
CH7	6084	17.5	6.3

CORRELATION COEFFICIENTS

Variable	CH4	CH5	CH6	CH7
CH4	1.00			
CH5	0.86	1.00		
CH6	0.73	0.64	1.00	
CH7	0.67	0.50	0.96	1.00

From these estimates, one easily obtains the regression equations

$$CH7 = .4100 CH6 + .5100$$

$$CH4 = .6236 CH5 + 6.564$$

Naively substituting into the formulae for GVI and SBI gives the following formulae.

$$EGVI = .74 (CH6 - 1.14 CH5 + .03)$$

$$ESBI = .78 (CH6 + 1.03 CH5 + 2.96)$$

These approximations are illustrated in figures 4 and 5. Using the information in the above tables pertaining to the expected range of the data, it is easy to see that a rough approximation for GVS<sub>B</sub> is:

$$EGVS_B = (CH6 - 1.14 CH5)/(CH6 + 1.03 CH5)$$

which is approximately ND<sub>6</sub>. In fact, let

$$h(v) = (b + vd)/(a - vc)$$

$$k(x,y) = (ax - by)/(cx + dy)$$

$$r(x,y) = x/y,$$

$$\text{then } h(k(x,y)) = x/y = r(x,y)$$

Thus, the estimate, EGVS<sub>B</sub>, is equivalent to R<sub>65</sub> and ND<sub>6</sub>. These relationships are illustrated graphically in figure 6. Graphs similar to figures 4, 5 and 6 for other sites are contained in appendix E.

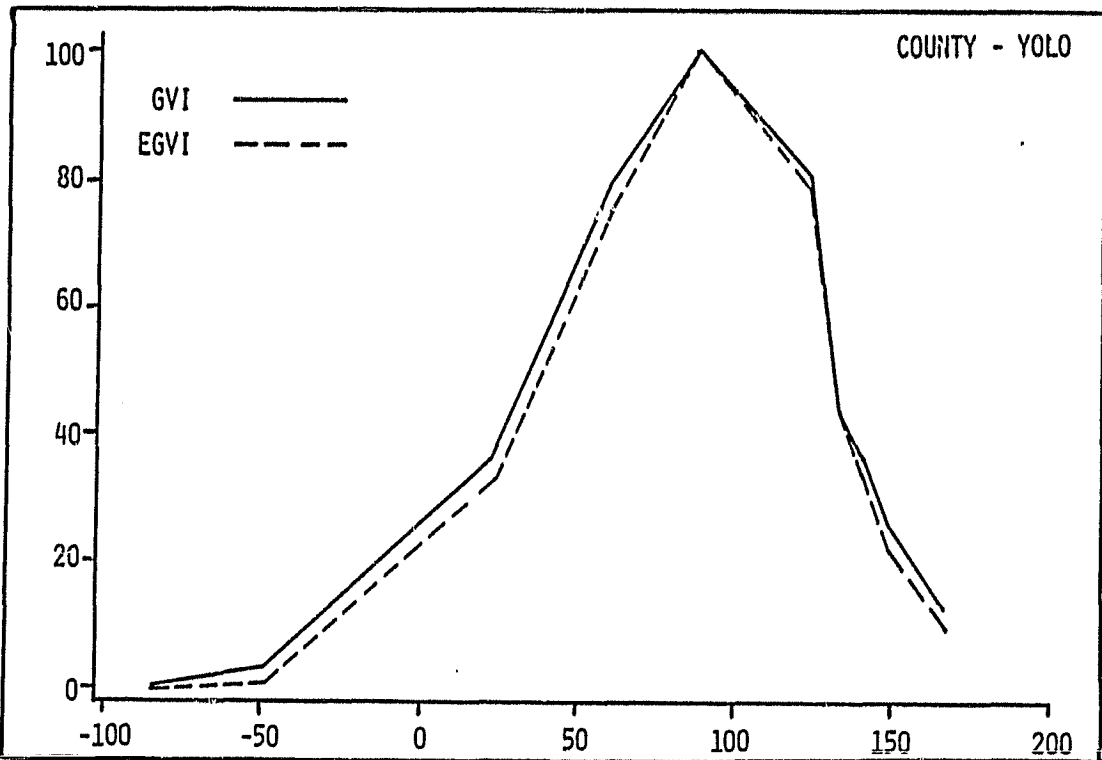


Figure 4. GVI and EGVI versus time using data listed in Appendix A. All VI values have been rescaled 0 to 100.

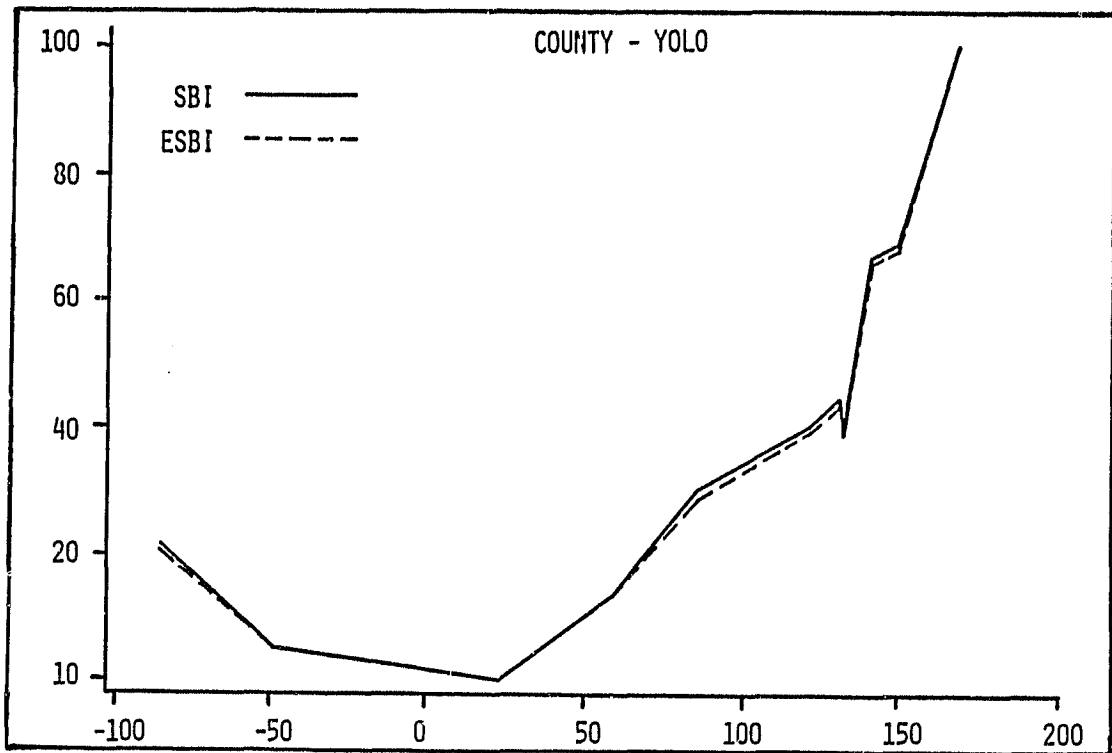


Figure 5. SBI and ESBI versus time using data listed in Appendix A. All VI values have been rescaled from 0 to 100.

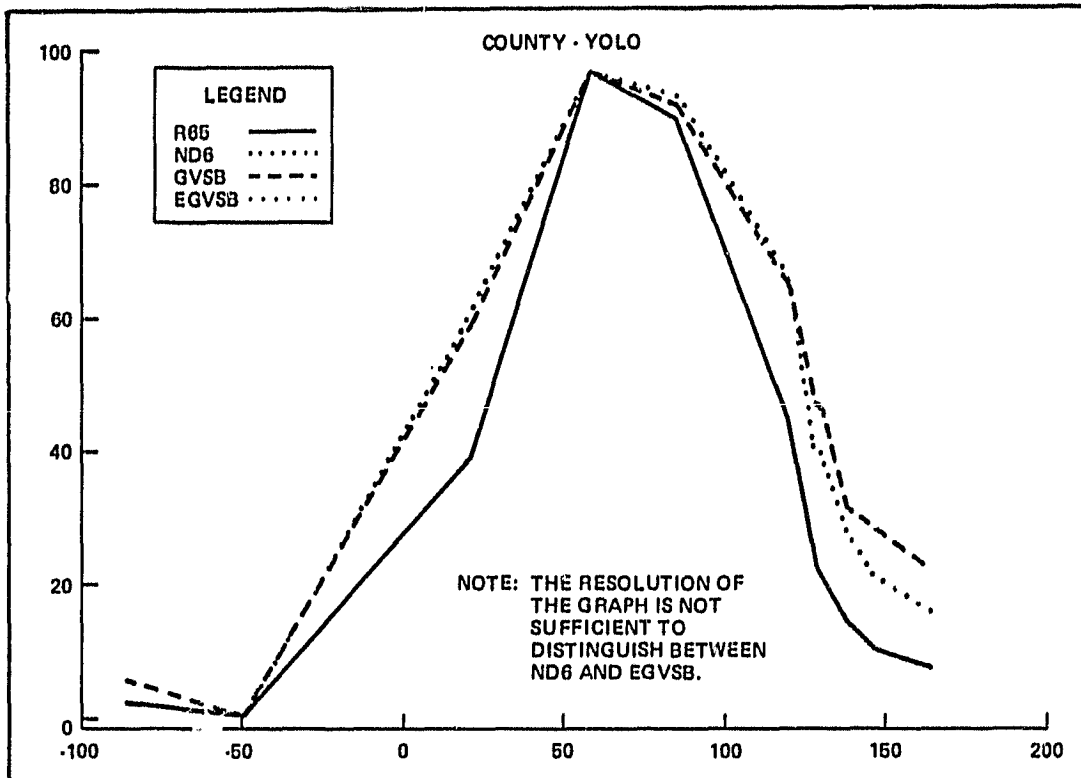


Figure 6. R65, GVSB, ND6, and EGVSB versus time using data listed in Appendix A. All VI values have been rescaled 0 to 100.



## 6. SUMMARY AND CONCLUSIONS

Other researchers have studied the relationships among a few of the VIs considered in this report. Past work has been based exclusively on correlation analysis. Aaronson and Davis (1979) showed conclusively that, during the spring greenup to harvest phase of the crop season, the VIs used operationally by The Foreign Agriculture Service (FAS)/Foreign Crop Condition Assessment Division (FCCAD) were highly correlated and had similar correlations with various plant components such as biomass, plant height, etc.

This study extends analysis to include all VIs found in the literature. Techniques used to investigate relationships between the VIs included variable clustering by correlation, graphical presentations, and functional equivalence for decision making. Variable clustering separated out two large clusters of VIs. One cluster contained those VIs which used channels 5 and 7 data. The other cluster contained VIs using channels 5 and 6 data plus some VIs using all four channels of data. The variable clustering technique also showed that these two clusters were highly correlated. The relationships were stable during the spring greenup to harvest period of the crop season. Graphical presentations reinforced the clustering results, illustrating the relationships over time and through response surfaces. Mathematical techniques were used to formalize the idea of VI equivalence. This equivalence was used to confirm relationships observed earlier and to investigate less apparent relationships.

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## APPENDIX A

### DATA SET DESCRIPTIONS

The data set consisted of Landsat acquisitions from six different sites for the 1977-78 crop year. The six sites were Finney County, Kansas; Grant County, Oklahoma; Greeley County, Kansas; Keith County, Nebraska; Washington County, Colorado; and Yolo County, California. The Finney County site consists of an area 40 pixels by 26 lines or 1040 pixels of data. The Yolo County site consists of an area 40 pixels by 40 lines or 1600 pixels of data. All other sites consist of an area 26 pixels by 26 lines or 676 pixels of data.

One field within each area was also selected, since it had already been defined for another project. The Finney, Grant, Greeley, Keith and Washington County fields were winter wheat and consisted of 85, 79, 67, 100 and 53 pixels of data respectively. The Yolo county field was a barley field and consisted of 500 pixels of data.

The data sets are identified by county, acquisition date and Landsat satellite as follows:

Finney	Keith	Yolo
9-22-77 (2)	10-12-77 (2)	10-07-77 (2)
9-23-77 (2)	11-17-77 (2)	11-12-77 (2)
10-11-77 (2)	12-04-77 (2)	1-23-78 (2)
11-16-77 (2)	3-22-78 (2)	2-28-78 (2)
1-08-78 (2)	3-31-78 (3)	3-27-78 (3)
3-04-78 (2)	4-28-78 (2)	5-02-78 (3)
3-31-78 (3)	5-15-78 (2)	5-11-78 (2)
5-15-78 (2)	5-16-78 (2)	5-12-78 (2)
5-23-78 (3)	5-25-78 (3)	5-20-78 (3)
6-01-78 (2)	6-11-78 (3)	5-29-78 (2)
6-11-78 (3)	6-21-78 (2)	6-16-78 (2)
6-11-78 (3)	6-29-78 (2)	
6-19-78 (2)	7-27-78 (2)	
6-29-78 (3)	8-13-78 (2)	
7-26-78 (2)	8-14-78 (2)	

Grant	Greeley	Washington
10-08-77 (2)	10-11-77 (2)	10-12-77 (2)
11-13-77 (2)	11-16-77 (2)	11-17-77 (2)
12-19-77 (2)	3-22-78 (2)	3-24-78 (2)
3-09-78 (3)	3-31-78 (3)	4-11-78 (2)
3-28-78 (3)	4-27-78 (2)	4-28-78 (2)
4-06-78 (2)	5-15-78 (2)	5-16-78 (2)
4-24-78 (2)	5-25-78 (3)	5-26-78 (3)
5-30-78 (2)	6-11-78 (3)	6-12-78 (3)
6-17-78 (2)	6-29-78 (3)	

The data were calibrated as follows to all look like Landsat II LACIE segment data. Data from Landsat 2 EROS full frame CCT's were calibrated using the calibration below (NASA (1976) and RICE (1977)).

$$CH4 = CH4 * 1.275 - 1.445$$

$$CH5 = CH5 * 1.141 - 2.712$$

$$CH6 = CH6 * 1.098 - 2.950$$

$$CH7 = CH7 * 0.948 + 0.446$$

Data from Landsat 3 were calibrated using the following calibrations which were developed by Wehmanen (1978).

$$CH4 = CH4 * 1.161$$

$$CH5 = CH5 * 1.230$$

$$CH6 = CH6 * 1.246$$

$$CH7 = CH7 * 1.062$$

The field data were adjusted using the X-STAR haze correction procedure developed by Lambeck (1979). Pixel data screened as shadow, water, haze, cloud or garbled through this procedure were deleted from further use. Sun angle correction was also applied which is part of the X-STAR haze correction algorithm.

A partial listing containing descriptive statistics of MSS data by band, date, field or area, and county are attached.

The dates are Julian dates where positive dates are for 1978 and negative dates are for 1977 and indicate the number of days from end of year. The Julian date for 1977 may be obtained by adding 365 to each negative date.

Keith County Field Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=81 -----						
CH4	85	35.33	3.88	26.00	43.00	0.42
CH5	85	42.87	4.80	28.00	55.00	0.52
CH6	85	48.19	5.34	29.00	57.00	0.58
CH7	85	20.19	2.13	11.00	24.00	0.23
----- DATE=98 -----						
CH4	95	30.47	2.30	23.22	37.15	0.24
CH5	95	34.57	3.73	24.60	44.28	0.38
CH6	95	51.13	5.45	32.40	63.55	0.56
CH7	95	20.37	2.54	10.62	23.36	0.26
----- DATE=118 -----						
CH4	99	18.61	1.62	16.00	23.00	0.16
CH5	99	15.49	2.49	11.00	23.00	0.25
CH6	99	46.53	3.70	36.00	53.00	0.37
CH7	99	23.67	2.29	18.00	28.00	0.23
----- DATE=135 -----						
CH4	95	30.71	2.92	25.20	42.00	0.30
CH5	95	28.76	4.39	21.00	48.00	0.50
CH6	95	61.62	2.61	55.00	68.00	0.27
CH7	95	29.51	2.16	24.00	34.00	0.22
----- DATE=136 -----						
CH4	100	25.16	3.22	20.00	35.00	0.32
CH5	100	22.53	4.41	15.00	38.00	0.44
CH6	100	56.42	3.19	47.00	65.00	0.32
CH7	100	27.42	2.21	22.00	33.00	0.22
----- DATE=145 -----						
CH4	100	29.33	3.66	22.06	44.12	0.37
CH5	100	27.06	5.67	18.45	49.20	0.57
CH6	100	62.66	3.86	53.58	69.78	0.39
CH7	100	27.99	2.40	23.36	32.98	0.24
----- DATE=162 -----						
CH4	100	24.99	2.78	19.74	34.83	0.28
CH5	100	25.79	4.82	15.99	43.05	0.48
CH6	100	60.33	4.79	52.33	74.76	0.48
CH7	100	30.81	3.12	25.49	38.23	0.31

Keith County Field Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD EROR OF MEAN
----- DATE=178 -----						
CH4	100	28.59	2.64	24.05	35.53	0.26
CH5	100	30.63	2.55	23.53	41.79	0.35
CH6	100	51.87	5.00	45.36	66.22	0.50
CH7	100	23.25	2.47	17.51	28.89	0.25
----- DATE=180 -----						
CH4	100	33.83	1.69	29.02	35.99	0.17
CH5	100	49.73	3.44	39.36	57.81	0.34
CH6	100	63.23	3.12	57.32	72.27	0.31
CH7	100	26.67	1.83	23.36	32.98	0.18
----- DATE=248 -----						
CH4	100	31.54	3.15	20.00	38.00	0.32
CH5	100	40.23	5.10	20.00	48.00	0.51
CH6	100	46.82	3.98	37.00	58.00	0.40
CH7	100	19.02	1.88	15.00	27.00	0.19
----- DATE=-80 -----						
CH4	100	22.25	2.17	16.40	26.60	0.22
CH5	100	26.82	3.40	18.97	32.66	0.34
CH6	100	37.27	4.88	24.50	48.66	0.41
CH7	100	17.47	1.76	10.87	20.35	0.18
----- DATE=-44 -----						
CH4	100	11.92	1.17	10.03	15.13	0.12
CH5	100	11.45	2.21	7.56	20.11	0.22
CH6	100	27.52	2.27	16.31	33.28	0.23
CH7	100	14.32	1.32	8.03	16.56	0.13
----- DATE=-27 -----						
CH4	95	9.60	1.22	7.00	14.00	0.12
CH5	95	9.68	1.69	7.00	14.00	0.17
CH6	95	13.11	2.29	9.00	19.00	0.24
CH7	95	7.04	1.02	5.00	9.00	0.10

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Keith County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERR. OF MEAN
----- DATE=81 -----						
CH4	676	36.80	4.36	22.00	52.00	0.19
CH5	676	44.92	6.32	28.00	63.00	0.24
CH6	676	49.46	5.49	29.00	64.00	0.21
CH7	676	20.49	2.05	11.00	25.00	0.08
----- DATE=90 -----						
CH4	676	34.06	4.01	22.22	47.60	0.15
CH5	676	40.93	7.00	24.60	63.96	0.28
CH6	676	51.00	7.66	32.40	72.27	0.29
CH7	676	19.29	2.97	10.62	25.49	0.11
----- DATE=118 -----						
CH4	676	22.74	4.09	16.00	34.00	0.16
CH5	676	24.83	7.44	11.00	48.00	0.29
CH6	676	37.69	8.31	12.00	54.00	0.32
CH7	676	17.47	4.59	9.00	28.00	0.19
----- DATE=135 -----						
CH4	676	38.51	6.05	25.00	52.00	0.23
CH5	676	42.42	10.54	21.00	65.00	0.41
CH6	676	57.94	4.72	44.00	73.00	0.18
CH7	676	25.04	3.31	19.00	34.00	0.13
----- DATE=136 -----						
CH4	676	32.91	5.67	20.00	46.00	0.23
CH5	676	35.89	10.28	15.00	56.00	0.40
CH6	676	50.51	5.10	36.00	65.00	0.20
CH7	676	21.36	3.64	16.00	33.00	0.15
----- DATE=145 -----						
CH4	676	38.66	7.46	22.06	52.64	0.29
CH5	676	44.74	14.03	18.45	71.34	0.54
CH6	676	64.60	5.53	49.64	79.50	0.21
CH7	676	25.23	2.12	20.18	33.98	0.08
----- DATE=162 -----						
CH4	676	34.54	8.39	19.74	51.00	0.32
CH5	676	46.15	16.52	15.99	76.26	0.64
CH6	676	66.45	11.53	42.36	90.96	0.44
CH7	676	30.25	4.38	22.30	38.23	0.16

Keith County Area Data by Julian Date

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VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=172 -----						
CH4	676	30.78	3.90	21.50	41.90	0.15
CH5	676	32.77	6.55	15.54	47.49	0.25
CH6	676	50.12	5.73	39.27	70.62	0.22
CH7	676	20.75	2.81	15.67	30.64	0.11
----- DATE=180 -----						
CH4	676	31.49	4.14	26.90	42.95	0.16
CH5	676	41.62	12.31	19.68	61.50	0.47
CH6	676	65.67	6.30	47.35	80.99	0.24
CH7	676	29.31	5.03	19.12	40.36	0.19
----- DATE=208 -----						
CH4	676	29.26	7.69	17.00	52.00	0.30
CH5	676	32.77	14.61	12.00	67.00	0.56
CH6	676	55.45	8.72	32.00	74.00	0.34
CH7	676	25.66	6.66	13.00	39.00	0.26
----- DATE=225 -----						
CH4	676	29.96	5.96	17.00	42.00	0.23
CH5	676	32.18	11.39	14.00	54.00	0.44
CH6	676	51.92	8.25	33.00	71.00	0.32
CH7	676	23.96	6.40	13.00	37.00	0.25
----- DATE=226 -----						
CH4	676	27.46	5.60	16.00	38.00	0.22
CH5	676	29.81	10.73	13.00	49.00	0.41
CH6	676	48.61	9.14	31.00	68.00	0.31
CH7	676	22.13	6.33	13.00	34.00	0.24
----- DATE=-80 -----						
CH4	676	22.59	4.62	13.65	32.99	0.18
CH5	676	25.37	7.90	16.68	48.63	0.30
CH6	676	37.91	7.40	17.91	56.34	0.28
CH7	676	16.64	2.99	9.03	23.25	0.12
----- DATE=-44 -----						
CH4	676	14.88	3.21	8.75	22.78	0.12
CH5	676	18.56	6.64	7.55	32.66	0.26
CH6	676	26.94	4.79	12.42	39.87	0.18
CH7	676	11.86	2.53	4.29	17.57	0.09

Keith County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=27 -----						
CH4	676	10.75	1.57	6.00	15.00	0.06
CH5	676	11.97	2.56	5.00	20.00	0.10
CH6	676	12.59	3.32	6.00	22.00	0.13
CH7	676	6.21	1.63	3.00	11.00	0.06

Yolo County Field Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=23 -----						
CH4	465	12.81	1.13	8.75	15.13	0.05
CH5	465	11.34	1.91	7.56	15.54	0.09
CH6	465	22.37	3.87	12.42	33.28	0.18
CH7	465	10.81	1.96	6.13	16.56	0.09
----- DATE=59 -----						
CH4	465	16.51	1.48	12.00	22.00	0.07
CH5	465	11.95	2.11	8.00	23.00	0.10
CH6	465	45.78	5.86	28.00	62.00	0.27
CH7	465	21.71	3.28	12.00	32.00	0.15
----- DATE=86 -----						
CH4	485	24.04	1.71	18.58	33.67	0.08
CH5	485	17.91	3.15	12.38	34.44	0.14
CH6	485	64.80	7.88	39.87	88.47	0.36
CH7	485	27.87	4.14	15.93	40.36	0.19
----- DATE=122 -----						
CH4	495	32.90	2.39	26.70	41.00	0.11
CH5	495	31.04	3.39	22.14	55.35	0.15
CH6	495	70.32	5.21	54.82	95.97	0.23
CH7	495	28.72	2.02	19.12	35.05	0.09

Yolo County Field Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD. ERR. OF MEAN
----- DATE=131 -----						
CH4	500	34.34	5.27	26.00	43.00	0.15
CH5	500	41.36	6.67	26.00	61.00	0.30
CH6	500	65.66	5.25	54.00	81.00	0.23
CH7	500	29.36	1.91	25.00	36.00	0.09
----- DATE=132 -----						
CH4	500	31.31	3.50	24.00	41.00	0.16
CH5	500	38.98	6.78	23.00	55.00	0.30
CH6	500	68.50	4.86	51.00	77.00	0.22
CH7	500	27.24	1.90	22.00	33.00	0.08
----- DATE=140 -----						
CH4	500	47.19	3.06	40.63	56.69	0.14
CH5	500	61.81	6.78	43.05	78.72	0.30
CH6	500	83.31	3.93	74.76	97.19	0.18
CH7	500	31.02	1.29	27.61	36.11	0.06
----- DATE=149 -----						
CH4	500	47.48	6.34	32.98	71.23	0.28
CH5	500	66.66	11.46	39.58	104.54	0.51
CH6	500	81.69	8.94	67.32	114.54	0.40
CH7	500	34.62	2.58	29.63	45.00	0.13
----- DATE=167 -----						
CH4	500	62.38	7.06	29.35	75.05	0.32
CH5	500	94.10	12.13	52.06	115.95	0.54
CH6	500	106.90	10.01	73.91	128.01	0.45
CH7	500	42.69	2.93	31.73	48.79	0.13
----- DATE=-85 -----						
CH4	265	28.22	4.62	20.23	40.63	0.27
CH5	285	34.54	6.54	20.11	55.48	0.39
CH6	285	34.37	7.64	16.81	57.44	0.45
CH7	265	12.93	2.85	7.08	21.30	0.17
----- DATE=-49 -----						
CH4	320	19.10	2.71	12.58	27.69	0.15
CH5	320	22.56	4.63	12.12	34.94	0.26
CH6	320	21.04	5.81	9.13	35.48	0.32
CH7	320	8.27	1.74	4.24	12.77	0.10

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Yolo County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD. DEVIATION OF MEAN
----- DATE=23 -----						
CH4	1640	12.78	1.51	7.48	17.68	0.24
CH5	1640	11.15	2.45	4.13	21.25	0.06
CH6	1640	23.22	5.74	4.74	46.46	0.14
CH7	1640	3.65	2.87	2.49	21.36	0.07
----- DATE=59 -----						
CH4	1640	16.66	1.78	6.00	27.00	0.04
CH5	1640	12.54	2.28	6.00	28.00	0.06
CH6	1640	42.31	7.95	16.00	68.00	0.20
CH7	1640	19.86	4.33	7.00	34.00	0.11
----- DATE=86 -----						
CH4	1640	25.90	3.90	18.58	41.80	0.10
CH5	1640	21.57	7.24	12.30	54.12	0.18
CH6	1640	68.24	18.62	33.64	88.47	0.26
CH7	1640	25.01	5.68	18.62	40.36	0.15
----- DATE=122 -----						
CH4	1640	34.41	3.59	25.54	49.92	0.10
CH5	1640	34.14	7.14	28.91	63.96	0.18
CH6	1640	68.45	6.68	41.12	85.97	0.16
CH7	1640	27.17	3.79	12.81	36.11	0.09
----- DATE=131 -----						
CH4	1640	35.03	4.24	24.00	50.00	0.10
CH5	1640	41.35	7.53	28.00	63.00	0.19
CH6	1640	61.97	8.23	36.00	82.00	0.20
CH7	1640	27.53	4.88	13.00	39.00	0.12
----- DATE=132 -----						
CH4	1640	31.86	4.32	19.00	47.00	0.11
CH5	1640	38.69	7.64	15.00	58.00	0.19
CH6	1640	57.21	8.42	31.00	77.00	0.21
CH7	1640	25.10	4.91	12.00	38.00	0.12
----- DATE=140 -----						
CH4	1640	47.23	3.56	37.15	56.89	0.09
CH5	1640	61.80	8.10	36.99	78.72	0.20
CH6	1640	90.63	7.99	51.09	98.43	0.20
CH7	1640	29.42	4.89	18.05	37.17	0.10

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Yolo County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=149 -----						
CH4	1640	46.60	5.60	31.70	71.23	0.14
CH5	1640	62.32	12.05	32.65	104.54	0.30
CH6	1640	75.21	12.55	38.77	114.54	0.31
CH7	1640	30.56	6.19	13.77	45.06	0.15
----- DATE=167 -----						
CH4	1640	53.96	8.98	34.25	75.05	0.22
CH5	1640	77.99	17.79	37.22	115.95	0.44
CH6	1640	88.49	20.02	42.07	128.81	0.49
CH7	1640	34.52	8.40	14.72	47.90	0.21
----- DATE=-85 -----						
CH4	1640	30.94	6.13	18.95	61.03	0.15
CH5	1640	37.66	8.94	18.97	65.75	0.22
CH6	1640	36.61	10.65	5.83	67.32	0.26
CH7	1640	12.32	4.27	5.24	28.94	0.11
----- DATE=-49 -----						
CH4	1640	21.01	4.39	12.58	36.80	0.11
CH5	1640	24.88	6.80	10.98	52.06	0.17
CH6	1640	23.75	7.79	8.03	50.85	0.19
CH7	1640	8.09	2.82	1.45	18.51	0.07

Finney County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=8 -----						
CH4	1040	13.00	1.27	9.00	18.00	0.04
CH5	1040	15.73	2.26	11.00	22.00	0.07
CH6	1040	17.33	2.45	12.00	23.00	0.08
CH7	1040	8.36	1.11	6.00	12.00	0.03
----- DATE=63 -----						
CH4	1040	35.20	12.73	17.68	98.00	0.39
CH5	1040	41.43	14.50	23.53	119.37	0.45
CH6	1040	43.22	12.36	28.89	115.63	0.38
CH7	1040	16.35	3.37	9.98	34.63	0.10

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Finney County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD. ERROR OF MEAN
----- DATE=98 -----						
CH4	1040	35.96	3.16	26.70	45.28	0.10
CH5	1040	42.64	5.62	38.29	57.81	0.18
CH6	1040	54.31	4.89	41.12	72.27	0.15
CH7	1040	19.94	2.27	14.67	25.49	0.07
----- DATE=155 -----						
CH4	1007	36.24	7.94	18.95	55.93	0.25
CH5	1007	41.90	12.89	15.54	72.59	0.41
CH6	1007	56.08	5.90	39.87	76.11	0.19
CH7	1007	23.22	3.40	15.67	65.91	0.11
----- DATE=143 -----						
CH4	1040	40.73	6.84	24.38	61.53	0.21
CH5	1040	46.35	12.27	18.45	78.72	0.38
CH6	1040	64.06	6.03	48.59	85.97	0.19
CH7	1040	22.83	1.86	16.99	28.67	0.06
----- DATE=152 -----						
CH4	1040	36.63	6.47	24.00	55.00	0.20
CH5	1040	40.45	10.97	19.00	70.00	0.34
CH6	1040	52.75	6.19	38.00	77.00	0.19
CH7	1040	21.96	1.95	17.00	28.00	0.06
----- DATE=162 -----						
CH4	1040	35.90	6.15	24.38	55.73	0.19
CH5	1040	49.12	12.17	23.37	83.64	0.38
CH6	1040	64.91	8.57	47.35	93.45	0.27
CH7	1040	27.38	2.90	19.12	36.11	0.09
----- DATE=170 -----						
CH4	1040	48.54	18.96	22.00	127.00	0.59
CH5	1040	57.02	21.84	19.00	127.00	0.68
CH6	1040	60.24	20.84	18.00	127.00	0.65
CH7	1040	22.54	7.40	5.00	48.00	0.23
----- DATE=180 -----						
CH4	1040	40.14	4.08	33.67	58.05	0.13
CH5	1040	60.69	6.48	45.51	37.33	0.20
CH6	1040	66.75	6.61	51.09	93.45	0.20
CH7	1040	25.93	2.38	21.24	35.05	0.07

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Finney County Area Data by Julian Date

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
----- DATE=207 -----						
CH4	1040	40.18	4.50	30.00	61.00	0.15
CH5	1040	50.23	7.44	36.00	81.00	0.23
CH6	1040	53.74	6.97	38.00	82.00	0.20
CH7	1040	21.35	2.10	15.00	30.00	0.07
----- DATE=224 -----						
CH4	1040	40.27	5.45	30.00	60.00	0.17
CH5	1040	49.35	8.72	29.00	80.00	0.27
CH6	1040	52.54	6.66	36.00	78.00	0.21
CH7	1040	20.69	2.33	14.00	29.00	0.07
----- DATE=225 -----						
CH4	1040	37.55	5.70	28.00	62.00	0.18
CH5	1040	46.76	8.67	26.00	82.00	0.27
CH6	1040	50.39	7.19	32.00	78.00	0.22
CH7	1040	19.99	2.56	13.00	29.00	0.08
----- DATE=-106 -----						
CH4	1040	27.64	2.99	19.00	37.00	0.09
CH5	1040	33.78	4.61	20.00	46.00	0.14
CH6	1040	38.57	4.62	23.00	50.00	0.15
CH7	1040	15.79	2.17	9.00	22.00	0.07
----- DATE=-99 -----						
CH4	1040	25.58	3.02	18.00	34.00	0.09
CH5	1040	31.95	4.54	18.00	43.00	0.14
CH6	1040	36.00	5.23	19.00	49.00	0.16
CH7	1040	15.13	2.33	9.00	21.00	0.07
----- DATE=-81 -----						
CH4	1040	24.43	3.92	14.00	38.00	0.12
CH5	1040	30.41	5.36	16.00	49.00	0.17
CH6	1040	35.20	5.91	19.00	53.00	0.18
CH7	1040	15.51	2.36	9.00	22.00	0.07
----- DATE=-45 -----						
CH4	1040	15.54	1.96	10.03	21.50	0.06
CH5	1040	17.97	3.22	9.34	28.09	0.10
CH6	1040	23.97	4.59	12.42	34.38	0.15
CH7	1040	9.97	2.56	5.24	16.62	0.08



## APPENDIX B

### CLUSTER TREES

The cluster trees included in this appendix are for the Yolo County and Keith County locations as described in appendix A. Separate trees were produced by date for the area pixels and the field pixels. Data were also combined by area or by field for the period spring greenup to harvest which indicate the correlation coefficients remain high over this time period. Although cluster trees are not attached for other data sets described in appendix A, the results were very similar.





Keith County - November 17, 1977 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NO	NAME	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	AVI	36	33	17.33
PV17	22	PV17	1	33	99.67
ND7	18	ND7	1	33	99.39
TV17	35	TV17	1	33	99.18
CLAI	6	CLAI	21	10	97.82
ND6	17	ND6	34	6	99.90
TV16	34	TV16	6	6	99.62
OLA1	20	OLA1	10	10	99.11
QV1	11	QV1	11	10	99.48
DQV1	30	DQV1	10	10	99.84
HQV1	13	HQV1	10	6	99.76
QVSB	11	QVSB	11	6	98.36
ORAB8	9	ORAB8	21	1	99.45
PV16	21	PV16	27	1	96.89
R65	23	R65	1	10	98.59
R75	27	R75	1	10	96.06
LA1	12	LA1	1	10	94.07
R64	24	R64	26	3	95.57
R74	26	R74	1	3	92.46
BYV1	33	BYV1	23	2	83.58
MYV1	13	MYV1	23	2	90.76
R45	23	R45	31	2	80.76
CH4	2	CH4	31	2	85.78
CH5	3	CH5	31	2	93.97
MNS1	15	MNS1	31	2	93.97
SSD1	32	SSD1	31	2	94.97
S01	29	S01	31	2	99.96
BNS1	31	BNS1	31	2	47.95
CH6	4	CH6	31	2	58.00
CH7	5	CH7	31	2	81.67
ELA1	8	ELA1	31	2	45.30
MNSI	14	MNSI	31	2	64.76
R76	28	R76	31	2	79.32
YV1	36	YV1	31	2	32.20



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Keith County - March 22, 1978 - Area

FREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NAME	NO	98	97	98	98/88	85	84	85	84	71	91	87	90	89/50	59	80/64	76	60	60	59	39	98	10/57	2	11	35	30/13	22	64	07		
AVI	( 1)																															
ND7	( 18)	99/98	99/88	05	85	86	85	73	90	86	89	91/33	62	83/56	67	51	50	50	29	48	1/62	4	11	32	28/10	25	66/2					
R75	( 27)	98	98/87	85	85	86	84	72	89	85	89	91/33	63	84/57	68	51	51	50	30	49	0/61	3	10	32	28/11	24	65/1					
PV17	( 22)	99/88	84	84	85	84	75	89	85	89	89/52	60	81/51	63	45	46	44	23	43	8/66	10	14	33	23/7	26	65/9						
TV17	( 35)	88	85	85	85	84	74	90	85	89	90/52	61	82/54	66	49	48	48	27	47	3/63	6	12	33	25/9	25	65/9						
CLA1	( 6)	98	98	97	98/93/93	89	90	93/48	60	61/41	61	38	37	37	11	36	0/82	35	41	31	7/29	18	26/20									
ND6	( 17)	99/99/99/94/95	93	94	97/61	72	66/47	61	38	38	37	10	32	2/78	33	31	38	19/44	27	18/14												
TV16	( 34)	99/99/95/95	93	93	96/61	71	65/46	60	38	37	37	9	31	1/79	33	31	38	19/45	28	17/13												
R65	( 25)	99/93/95	93	93	97/61	72	67/48	61	39	39	38	11	33	2/77	31	29	37	20/44	25	20/10												
OLA1	( 20)	94/94	92	92	95/56	67	62/44	60	37	37	37	9	32	2/80	35	36	43	14/41	28	17/17												
PV16	( 21)	86	85	87	90/59	68	54/22	36	11	10	18	4	21	90/57	40	35	3/44	38	2/22													
QV1	( 10)	99/99/98/71	79	79	79/66	72	55	54	54	27	44	13/63	9	8	22	42/49	11	33/9														
SGV1	( 30)	99/97/98	85	81/68	70	53	53	52	25	40	13/59	7	0	12	50/58	15	28/7															
HGV1	( 13)	98/98	85	84/62	65	47	46	45	18	35	2/64	12	0	12	46/50	7	35/7															
QV88	( 11)	74	82	81/56	62	42	42	41	13	32	0/70	20	10	20	37/47	11	32/6															
ELA1	( 8)	97/82/82	29	21	21	20	2	3	8/30	0	46	48	75/75	12	11/9																	
R64	( 24)	85/56	39	28	28	27	2	5	4/38	2	36	36	71/74	15	14/10																	
R74	( 26)	63	52	44	44	42	24	29	5/32	18	40	23	68/34	33	63/14																	
CH4	( 2)	90	93	93	93	82	80/70/14	66	42	10	78/47	11	39/12																			
CH5	( 3)	96	96	96/84	93/71	8	46	1	31	45/28	5	41/2																				
SSB1	( 18)	99/99/95	95	83/18	68	20	16	54/24	14	40/6																						
SSB1	( 32)	99/95	93	83/19	68	21	15	54/24	14	40/6																						
SB1	( 29)	99	96	83/19	68	19	17	53/23	14	40/6																						
CH6	( 4)	95/87/43	82	24	13	44	4	27	41/10																							
SNS1	( 31)	80/15	61	0	38	29	0	21	46/0																							
CH7	( 5)	49	69	15	10	37/29	16	6/6																								

VARIABLE NAME	NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	12	25	12 88
ND7	18	35	25	98 70
R75	27	18	25	99 88
PV17	22	35	25	99 27
TV17	35	11	25	98 24
CLA1	6	1	10	93 01
ND6	17	20	10	95 34
TV16	34	17	10	99 17
R65	25	17	10	99 71
OLA1	20	6	10	98 17
PV16	21	11	10	94 30
QV1	10	11	10	98 15
SGV1	30	10	10	99 22
HGV1	13	10	10	99 11
QV88	11	1	10	82 03
ELA1	8	26	10	97 82
R64	24	28	10	83 93
R74	26	1	10	97 82
CH4	2	5	10	88 20
CH5	3	5	10	80 20
SSB1	18	25	10	93 86
SSB1	32	15	10	99 98
SB1	29	13	10	100 00
CH6	4	3	10	96 14
SNS1	31	3	10	95 27
CH7	5	2	10	93 12
GRAB5	9	3	10	37 03
SYV1	33	3	10	35 37
MYV1	16	3	10	80 38
R45	23	3	10	74 43
YV1	36	1	10	90 28
MNS1	14	2	10	34 79
NSI	19	2	10	88 13
R76	28	1	10	29 41
LAI	12	1	10	12 88







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Keith County - May 15, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX CLUSTERING BY AVERAGE DISTANCE METHOD		VARIABLE		OTHER BOUNDARY		NUMBER OF ITEMS		DISTANCE OR SIMILARITY	
NAME	NO	NAME	NO	OF CLUSTER	IN CLUSTER	WHEN CLUSTER FORMED			
AV1	( 1) 99/99/99/99 90 90 90 99 90 99 99 97 97/97 97/95 97/96/91 95/00/07/00/76 91/73 72 71 60/76 56 50/44/32/	AV1	1	19	1	26 99			
PV17	( 22) 99/99/99 90 90 90 99 90 99 97 97/95 97/96/89 94/09/09/00/76 90/71 70 60 50/77 56 49/47/33/	PV17	2	1	1	99 73			
TV17	( 35) 99/99 90 90 90 99 90 99 97 97/96 97/95 96/93/91 93/00/06/00/77 91/74 72 71 61/76 55 50/44/31/	TV17	3	1	1	99 77			
ND7	( 10) 99 90 90 90 90 90 99 97 97/90 99/96 90/96 90 94/00/07/00/75 92/72 71 69 59/75 56 50/45/32/	ND7	4	1	1	99 79			
CLA1	( 6) 99 99/99/99 99 99 99/99 99/90 97/95 95/95/89 94/92/06/03/81 93/71 70 68 50/75 51 55/49/22/	CLA1	5	1	1	99 79			
ND6	( 17) 99/99/99 99 99 99/98 99/98 97/96 96/95/09 94/92/06/01/00 92/70 69 67 56/77 54 59/50/19/	ND6	6	1	1	99 78			
TV16	( 34) 99/99 99 99 99/99 99/98 96/96 95/95/09 94/92/05/00/01 92/71 69 68 56/77 54 60/50/18/	TV16	7	1	1	99 80			
OLA1	( 20) 99 90 90 99/90 90/90 97/95 95/95/00 94/92/05/01/02 94/71 69 68 57/72 50 57/49/19/	OLA1	8	1	1	99 80			
OV1	( 10) 99/99/99/98 99/90 96/97 96/95/90 94/91/06/02/78 90/71 70 68 56/00 57 60/50/21/	OV1	9	1	1	99 86			
SOV1	( 30) 99/99/90 99/97 96/97 96/95/90 94/91/06/01/77 09/70 69 67 54/01 59 62/51/19/	SOV1	10	1	1	99 83			
MOV1	( 13) 99/90 99/90 97/97 97/96/90 93/91/00/03/76 89/69 68 66 55/01 59 60/51/22/	MOV1	11	1	1	99 83			
QV80	( 11) 90 99/90 97/97 97/96/90 94/91/07/03/77 90/70 69 67 55/79 58 59/50/23/	QV80	12	1	1	99 94			
GRAB8	( 9) 99/97 95/95 94/94/03 90/96/90/79/03 91/62 61 59 40/76 40 50/59/17/	GRAB8	13	1	1	99 86			
PV16	( 21) 97 95/96 94/94/06 91/93/07/77/01 90/65 63 61 49/79 52 63/57/13/	PV16	14	1	1	99 84			
R65	( 29) 99/97 96/95/00 92/90/06/01/77 92/69 68 66 54/73 55 57/49/22/	R65	15	1	1	99 83			
R75	( 27) 95 90/95/00 92/06/07/07/72 91/70 69 67 57/71 57 47/45/35/	R75	16	1	1	99 82			
R64	( 24) 90/94/00 00/00/07/70/66 81/64 62 60 44/07 69 66/55/20/	R64	17	1	1	99 06			
R74	( 26) 95/90 90/03/09/09/63 03/68 67 65 52/01 60 51/47/38/	R74	18	1	1	99 83			
LA1	( 12) 06 09/06/07/04/71 07/66 65 63 51/74 57 51/49/30/	LA1	19	1	1	99 84			
CH4	( 2) 96/67/64/01/58 79/90 90 00 76/75 73 54/13/50/	CH4	20	1	1	99 84			
CH0	( 3) 77/60/02/76 91/89 89 07 79/67 54 50/19/25/	CH0	21	1	1	99 78			
SYV1	( 33) 07/62/06 05/42 41 39 20/72 33 64/74/	SYV1	22	1	1	99 83			
CH7	( 5) 00/61 73/33 32 29 19/76 48 40/75/37/	CH7	23	1	1	99 94			
R76	( 20) 50 76/70 69 68 64/60 54 10/21/72/	R76	24	1	1	99 86			
MYV1	( 16) 90/55 51 51 51/37 2 43/43/11/	MYV1	25	1	1	99 83			
R45	( 23) 72 71 70 67/47 25 30/34/19/	R45	26	1	1	99 84			
MSB1	( 15) 99/99/95/44 50 30/24/30/	MSB1	27	1	1	99 72			
SSB1	( 32) 99/95/43 90 29/25/31/	SSB1	28	1	1	99 06			
SB1	( 29) 96/40 48 27/58/30/	SB1	29	1	1	99 83			
SNS1	( 31) 18 25 4/41/37/	SNS1	30	1	1	99 80			
ELA1	( 8) 82/74/50/11/	ELA1	31	1	1	99 83			
YV1	( 36) 56/10/29/	YV1	32	1	1	99 84			
MNS1	( 14) 53/52/	MNS1	33	1	1	99 86			
CH6	( 4) 17/	CH6	34	1	1	99 76			
NS1	( 19) 1/	NS1	35	1	1	99 71			
			36	1	1	99 54			
			37	1	1	91 15			
			38	1	1	88 67			
			39	1	1	85 53			
			40	1	1	82 44			
			41	1	1	80 43			
			42	1	1	81 38			
			43	1	1	81 31			
			44	1	1	99 98			
			45	1	1	99 92			
			46	1	1	84 54			
			47	1	1	85 54			
			48	1	1	82 13			
			49	1	1	86 38			
			50	1	1	84 99			

ORIGINAL PAGE NO.  
OF POOR QUALITY

Keith County - May 16, 1978 - Area

FILE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NO
AVI	1
PV17	22
ND7	18
TV17	35
CLAI	8
ND6	17
TV16	34
OLA1	20
QV1	10
BQV1	30
HQV1	13
QVSB	11
GRAB8	9
PV16	21
R64	24
R74	26
R65	23
R75	27
LA1	12
SYVI	33
CH7	31
CH4	2
CH3	3
R76	28
MYVI	16
R45	23
CH6	4
ELA1	8
YVI	36
MNSI	14
MBSI	15
SSDI	32
SBI	29
SNSI	31
NSI	19

VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	1	25 59
PV17	22	1	99 70
ND7	18	1	99 56
TV17	35	1	99 34
CLAI	8	21	99 92
ND6	17	34	99 82
TV16	34	6	99 65
OLA1	20	6	99 83
QV1	10	11	99 96
BQV1	30	10	99 95
HQV1	13	11	99 43
QVSB	11	6	99 73
GRAB8	9	21	99 89
PV16	21	1	99 92
R64	24	1	99 53
R74	26	27	98 60
R65	23	24	99 36
R75	27	27	96 55
LA1	12	12	95 06
SYVI	33	33	93 42
CH7	31	1	92 16
CH4	2	3	92 66
CH3	3	1	91 43
R76	28	28	88 34
MYVI	16	16	87 00
R45	23	23	82 49
CH6	4	1	69 00
ELA1	8	14	70 00
YVI	36	6	62 62
MNSI	14	1	62 79
MBSI	15	21	52 03
SSDI	32	32	52 03
SBI	29	3	99 85
SNSI	31	1	56 06
NSI	19	1	25 59

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OF POOR QUALITY

Keith County - May 25, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	( 1 )	1	1	27 90
PV17	( 22 )	15	15	99 72
TV17	( 35 )	15	15	99 72
ND7	( 10 )	15	15	99 72
CLAI	( 6 )	15	15	99 72
QV00	( 11 )	15	15	99 72
ND6	( 17 )	15	15	99 72
TV16	( 34 )	15	15	99 72
OLA1	( 20 )	15	15	99 72
QV1	( 10 )	15	15	99 72
MOV1	( 13 )	15	15	99 72
GOV1	( 30 )	15	15	99 72
LA1	( 12 )	15	15	99 72
GRAB8	( 9 )	15	15	99 72
PV16	( 21 )	15	15	99 72
R65	( 25 )	15	15	99 72
R75	( 27 )	15	15	99 72
R74	( 26 )	15	15	99 72
R64	( 24 )	15	15	99 72
R45	( 23 )	15	15	99 72
CH4	( 2 )	15	15	99 72
CH5	( 3 )	15	15	99 72
M001	( 13 )	15	15	99 72
S001	( 32 )	15	15	99 72
S01	( 29 )	15	15	99 72
S001	( 31 )	15	15	99 72
R76	( 20 )	15	15	99 72
MYV1	( 16 )	15	15	99 72
BYV1	( 33 )	15	15	99 72
CH7	( 5 )	15	15	99 72
CH6	( 4 )	15	15	99 72
MNS1	( 14 )	15	15	99 72
NS1	( 19 )	15	15	99 72
ELAI	( 8 )	15	15	99 72
VVI	( 36 )	15	15	99 72

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Keith County - June 11, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	( 1 ) 97/98 96 96/99 90 90 97 97 96 98 98 95 93/89 93/89 90/85 90/85/01 86 73 72 72 73 49/69/ 5 3 42/30	AVI	1	28 23
PV17	( 22 ) 90 97 97/98 97 96 95 95 94 96 96 94 94/90 93 92 93/82 87/84/74 80 64 64 63 64 39/70/ 5 43/30 43/27	PV17	2	99 31
QVI	( 10 ) 97/99 90 90 98 97 97 95 95 96 95 93/93 93/93 96/85 86/76/77 82 66 65 65 65 39/73/ 0 49/ 14 26/23/	QVI	10	99 20
DOVI	( 30 ) 99/97 97 97 96 96 94 94 94 94 92/94 93/94 97/83 84/72/74 79 62 62 61 61 34/78/ 3 52/ 8 23/21/	DOVI	10	99 70
MGVI	( 13 ) 97 96 96 95 95 93 93 93 93 91/94 93/96 97/80 82/73/70 75 57 57 56 56 29/77/10 56/10 28/20/	MGVI	13	97 32
CLA1	( 6 ) 99/99 99 99/98/90 98/97 96/90 94/91 93/88 92/81/79 85 70 70 70 70 43/67/ 5 43/26 34/33/	CLA1	6	99 58
LAI	( 12 ) 99 99 99/98/90 98/97 96/90 94/89 91/88 92/81/82 87 74 73 73 73 49/68/10 38/24 32/31/	LAI	12	99 58
QV80	( 11 ) 90 99/98/99 90/97 97/92 95/87 90/86 92/82/83 88 75 74 74 74 51/69/12 34/23 32/27/	QV80	11	99 58
N86	( 17 ) 99/99 98 98/97 96/90 93/87 90/89 93/79/83 89 75 75 75 75 52/66/14 37/21 27/31/	N86	17	99 70
TV16	( 34 ) 99/98 98/96 95/89 92/87 90/89 93/79/84 89 76 76 75 75 52/67/15 34/21 26/32/	TV16	34	99 71
OLA1	( 20 ) 90 97/90 97/87 91/85 88/90 96/80/82 88 76 75 75 76 53/58/16 35/26 29/36/	OLA1	20	99 33
ND7	( 18 ) 99/97 98/88 93/84 86/85 94/88/84 89 77 77 76 77 53/62/14 29/34 41/30/	ND7	18	98 88
TV17	( 35 ) 94 95/86 93/83 86/87 93/88/86 91 79 79 79 79 58/63/17 28/35 41/32/	TV17	35	99 37
R65	( 25 ) 98/92 95/87 87/83 92/77/78 83 69 68 68 68 43/59/ 6 39/21 30/27/	R65	25	98 87
R75	( 27 ) 90 96/84 85/80 92/83/79 83 70 70 70 70 48/56/ 7 33/32 43/26/	R75	27	98 87
R64	( 24 ) 95/87 91/86 73/66/69 70 54 53 53 50 26/80/ 9 49/ 2 24/ 3/	R64	24	98 17
R74	( 26 ) 84 86/70 82/83/77 79 66 65 65 64 42/71/ 1 34/26 48/ 7/	R74	26	95 42
GRAB8	( 9 ) 98/78 76/61/ 50 59 38 37 37 30 7/70/30 75/ 5 20/30/	GRAB8	9	99 00
PV16	( 21 ) 80 77/60/58 65 45 44 44 44 15/75/20 70/ 1 13/23/	PV16	21	99 88
MYVI	( 16 ) 92/64/74 85 74 74 74 76 53/47/20 34/24 7/66/	MYVI	16	99 88
R45	( 23 ) 80/80 88 79 78 70 80 61/58/26 24/40 30/53/	R45	23	99 88
R76	( 28 ) 78 80 75 74 74 77 63/43/17 0/69 76/23/	R76	28	92 78
CH4	( 2 ) 97/97 97 97 93/87/56/59 16/31 29/17/	CH4	2	77 92
CH5	( 3 ) 96 96 96/84/53/54 4/36 28/34/	CH5	3	91 96
M881	( 15 ) 99/99/99/94/40/72 28/41 28/30/	M881	15	97 99
S881	( 32 ) 99/99/95/40/72 29/41 28/30/	S881	32	100 00
B81	( 29 ) 99/93/39/72 29/41 27/30/	B81	29	99 99
GNS1	( 31 ) 95/35/71 28/48 31/37/	GNS1	31	96 89
CH6	( 4 ) 16/86 56/49 27/27/	CH6	4	67 97
ELA1	( 8 ) 9 41/20 8/20/	ELA1	8	59 47
CH7	( 5 ) 73/18 13/19/	CH7	5	39 47
BYVI	( 33 ) 35 17/18/	BYVI	33	51 75
MNS1	( 14 ) 84/43/	MNS1	14	84 18
N81	( 19 ) 0/	N81	19	29 16
YVI	( 36 ) 0/	YVI	36	20 25

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Keith County - June 21, 1978 - Area

THESE PRINTED DATA ARE CORRELATION MATRICES  
CORRELATIONS ARE AVERAGE OF ALL PAIRWISE MATRICES  
N=111

NAME	AV1	PV17	TV17	GRAB5	PV16	QV1	BQV1	MQV1	CLAI	GVSD	NDA6	TV16	DLAI	R65	ND7	R75	LA1	R64	R74	MYV1	R45	R76	CH6	CH7	BYV1	CH4	CH5	MDB1	SSB1	SB1	SNS1	ELA1	YV1	MNS1	NS1			
VARIABLE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
OTHER BOUNDARY OF CLUSTER																																						
NUMBER OF ITEMS IN CLUSTER																																						
DISTANCE OR SIMILARITY WHEN CLUSTER FORMED																																						

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Keith County - June 29, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	1	1	19
PV17	2	1	2	14
TV17	3	1	3	97
ELAI	4	30	4	99
CLAI	5	30	5	99
ND7	6	30	6	99
QV88	7	30	7	99
ND6	8	30	8	99
TV16	9	30	9	99
GRAB8	10	30	10	99
PV16	11	30	11	99
QV1	12	30	12	99
HQV1	13	30	13	99
BQV1	14	30	14	99
LAI	15	30	15	99
OLAI	16	30	16	99
R65	17	30	17	99
R75	18	30	18	99
BYV1	19	30	19	99
CH5	20	30	20	99
R64	21	30	21	99
R74	22	30	22	99
CH7	23	30	23	99
MYV1	24	30	24	99
R45	25	30	25	99
R76	26	30	26	99
CH4	27	30	27	99
CH6	28	30	28	99
ELAI	29	30	29	99
NSI	30	30	30	99



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Keith County - August 13, 1978 - Area

TRK PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	31	3	99 13
PV17	22	31	3	99 27
ND7	18	31	3	99 34
TV17	35	31	3	99 37
CLA1	6	31	3	99 07
GVDB	11	31	3	99 07
ND6	17	31	3	99 23
TV16	34	31	3	99 27
GV1	10	31	3	99 27
MGV1	13	31	3	99 28
SOVI	30	31	3	99 71
GRAB8	9	31	3	99 07
PV16	21	31	3	99 27
OLA1	20	31	3	99 28
R64	24	31	3	99 00
R74	26	31	3	99 20
R65	25	31	3	99 20
R75	27	31	3	99 28
LA1	12	31	3	99 28
CH7	3	31	3	99 28
GVVI	33	31	3	99 28
R45	33	31	3	99 28
CH4	2	31	3	99 28
CH5	3	31	3	99 28
R76	28	31	3	99 28
RYVI	16	31	3	99 28
CH6	4	31	3	99 28
ELA1	8	31	3	99 28
YVI	36	31	3	99 28
NSI	19	31	3	99 28
MNSI	14	31	3	99 28
MGB1	15	31	3	99 28
GBB1	32	31	3	99 28
GBI	29	31	3	99 28
BNSI	31	31	3	99 28



CONFIDENTIAL  
NATIONAL SECURITY

Keith County - August 14, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX CLUSTERING BY AVERAGE DISTANCE METHOD			
NAME	VARIABLE NO		
AVI	( 11)	...	...
PV17	( 22)	...	...
ND7	( 18)	...	...
TV17	( 23)	...	...
CLA1	( 8)	...	...
QVSB	( 11)	...	...
ND6	( 17)	...	...
TV16	( 24)	...	...
CVI	( 10)	...	...
MQVI	( 13)	...	...
SGVI	( 20)	...	...
GRABB	( 9)	...	...
PV16	( 21)	...	...
DLAI	( 20)	...	...
R64	( 24)	...	...
R74	( 26)	...	...
R63	( 23)	...	...
R73	( 27)	...	...
LAI	( 12)	...	...
CH7	( 5)	...	...
SYVI	( 33)	...	...
R43	( 23)	...	...
CH4	( 2)	...	...
CH3	( 3)	...	...
R76	( 28)	...	...
CH6	( 4)	...	...
HYVI	( 16)	...	...
ELAI	( 8)	...	...
YVI	( 36)	...	...
NSI	( 19)	...	...
MNSI	( 14)	...	...
MSBI	( 15)	...	...
SSBI	( 32)	...	...
SBI	( 29)	...	...
SNSI	( 31)	...	...

NAME	VARIABLE NO.	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	31	3	26.58
PV17	2	1	1	99.97
ND7	3	1	1	99.77
TV17	4	21	1	99.46
CLA1	5	1	1	99.59
QVSB	11	34	1	99.87
ND6	17	34	1	99.93
TV16	24	3	1	99.80
CVI	10	30	1	99.97
MQVI	13	10	1	99.98
SGVI	20	21	1	99.71
GRABB	9	21	1	99.85
PV16	21	1	1	99.30
DLAI	20	1	1	99.02
R64	24	24	1	99.20
R74	26	27	1	99.00
R63	23	1	1	99.32
R73	27	1	1	99.88
LAI	12	1	1	99.51
CH7	5	1	1	96.85
SYVI	33	1	1	96.62
R43	23	1	1	96.62
CH4	2	1	1	92.57
CH3	3	1	1	92.14
R76	28	1	1	87.62
CH6	4	1	1	86.05
HYVI	16	1	1	80.32
ELAI	8	36	1	80.32
YVI	36	1	1	80.00
NSI	19	1	1	80.00
MNSI	14	1	1	47.15
MSBI	15	31	1	88.88
SSBI	32	1	1	99.48
SBI	29	1	1	99.88
SNSI	31	1	1	26.58

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Keith County - March 22 thru July 27, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME VARIABLE NO

AVI	( 1)	97/96	95	98	97	98	98	97	96	96	97	90	97	93	91	92/88	91/84	81/83/40	78	41	70	38	36	34	34	1	59	83/68	2	
PV17	( 22)	96	96	98	97	98	97	96	95	95	96	97	96	92	90	91	88	91/81	79/84	45	82	43/67	32	30	28	28	2	40	82/66	0
GRAB5	( 9)	97/97	97	97/96	92	92	93	90	92	93	90	86	84	82	81/74	78/93	58	83	41/53	19	17	16	17/14	20	67/76	12				
PV16	( 21)	98	98	98/96	94	94	94	91	93	94	91	88	83/86	83/76	77/94	57	81	46/58	22	20	18	17/23	15	65/73	3					
QVI	( 10)	99/99	98	97	97	97	95	96	97	93	92	90/90	90/82	79/88	48	79	47/69	32	31	28	26/17	25	73/68	1						
SOVI	( 30)	97/97	97	96	96	94	95	96	92	91	89/92	90/80	76/88	51	79	51	69	30	28	26	22/22	24	72/65	3						
NOVI	( 13)	97	96	95	95	94	95	94	92	90	89/91	91/78	75/88	52	82	51/67	28	26	23	20/19	28	74/64	6							
CLAI	( 6)	98	99	99/98	98	98/97/94	93/87	88	88	88/84	57	72	34/71	43	41	39	38	8	27	76/75	8									
QVBD	( 11)	99	99/99	98	98/97/96	95/92	93/88	84/78	53	69	42/79	47	43	43	39/14	29	78/65	3												
ND6	( 17)	99/98	98/98/98	96	95/89	89/90	88/80/31	65	33/77	49	48	46	42/14	22	74/71	2														
TV16	( 34)	98	98	98/98	93	93/88	88/90	87/81/32	65	37/76	48	47	45	42/13	21	73/72	3													
ND7	( 18)	99/98	97/97	97	90	93/90	87/74	26	67	34/79	51	50	48	45/2	38	84/65	1													
TV17	( 33)	97/96	94	94/88	91/89	83/77	50	67	38/77	49	47	45	43/3	35	82/68	1														
LAI	( 12)	96/95	94/88	90/88	86/80/33	69	36/73	46	44	42	40/8	29	77/70	2																
DLAI	( 20)	97	95/84	83/91	93/77/23	60	22/73	32	31	49	47	9	20	72/74	9															
R63	( 23)	98/90	91/87	88/72/24	60	27/79	51	50	48	44/12	24	73/63	3																	
R73	( 27)	90	94/87	86/66/21	62	27/80	33	31	49	46/1	40	82/57	6																	
R64	( 24)	96/71	62/69/42	72	62/78	32	30	27	16/33	30	71/38	37																		
R74	( 26)	76	67/63/32	73	54/81	40	38	36	28/9	35	83/38	31																		
CH3	( 3)	90/56	8	33	13/86	79	78	77	75/4	22	70/72	15																		
R43	( 23)	67/3	40	11/63	61	59	59	64/11	15	63/84	38																			
SYVI	( 33)	73	82	37/28	3	6	7	3/23	1	44/77	23																			
CH6	( 4)	82/51/18	66	67	69	69/41	3	11/20	11																					
CH7	( 5)	55/24	24	26	28	27/8	43	64/36	13																					
ELAI	( 8)	38	13	13	16	32/31	15	11	63																					
CH4	( 2)	79	79	77	63/13	32	68/29	34																						

NAME	VARIABLE NO	OTHER BOUND BY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED	
MSBI	( 15)	99/99/93/20	17	43/36	9
SSBI	( 32)	99/93/21	18	44/34	8
SBI	( 29)	96/22	16	42/33	10
SNSI	( 31)	41	19	43/47	34
MNSI	( 14)	64	38	8	46
NSI	( 19)	80/13	23		
R76	( 28)	35	11		
MYVI	( 16)	69			
YVI	( 36)				

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Keith County - October 12, 1977 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NAME	NO.
	AV1	( 1) 97/97
	PV17	( 22) 93 95 94/93
	ND7	( 18) 99/99
	TV17	( 35) 99/93
	R75	( 27) 93 95 92 92 93
	CLA1	( 6) 98/97
	LAI	( 12) 98 98 98/98
	ND6	( 17) 99/99
	TV16	( 34) 99/98
	R65	( 25) 97/97
	QV58	( 11) 91/84
	OLA1	( 20) 84 85 89 87
	GRAB5	( 9) 98/93
	PV16	( 21) 95 96 95/77
	QV1	( 10) 99/99
	SOV1	( 30) 99/89
	MOV1	( 13) 88 84/31
	R64	( 24) 87/80
	R74	( 26) 68 52 8 14/54
	ELA1	( 8) 83/47
	YV1	( 36) 81 65/69
	MYV1	( 16) 85/43
	R45	( 23) 2 56 12 49 11
	CH4	( 2) 80/58
	CH5	( 3) 42 9 76 75 74 73
	CH6	( 4) 91/90
	SYV1	( 33) 70 71 71 67/77
	MSB1	( 15) 99/99
	SSB1	( 32) 99/95
	SB1	( 29) 96/67
	SNS1	( 31) 63/46
	CH7	( 5) 4 30 45
	MNS1	( 14) 79 69
	NS1	( 19) 94
	R76	( 28)

NAME	VARIABLE NO.	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AV1	1	28	1	27 77
PV17	22	1	1	99 37
ND7	18	27	1	99 39
TV17	35	18	1	99 89
R75	27	1	1	96 44
CLA1	6	20	1	95 55
LAI	12	6	1	98 98
ND6	17	6	1	99 38
TV16	34	17	1	98 24
R65	25	17	1	97 69
QV58	11	6	1	92 28
OLA1	20	1	1	94 77
GRAB5	9	1	1	99 71
PV16	21	13	1	90 00
QV1	10	10	1	99 59
SOV1	30	10	1	99 71
MOV1	13	10	1	89 97
R64	24	6	1	79 89
R74	26	8	1	61 06
ELA1	8	8	1	85 40
YV1	36	8	1	37 34
MYV1	16	8	1	80 75
R45	23	13	1	70 59
CH4	2	13	1	91 100
CH5	3	13	1	99 99
CH6	4	13	1	99 99
SYV1	33	31	1	99 99
MSB1	15	15	1	99 99
SSB1	32	32	1	99 99
SB1	29	29	1	99 99
SNS1	31	31	1	99 99
CH7	5	5	1	99 99
MNS1	14	14	1	99 99
NS1	19	19	1	99 99
R76	28	28	1	99 99

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Keith County -- November 17, 1977 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
 CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	NO
AV1	( 11)
PV17	( 22)
ND7	( 18)
TV17	( 33)
R75	( 27)
CLAI	( 6)
DLAI	( 20)
R65	( 23)
GRABS	( 9)
PV16	( 21)
GV1	( 10)
SOVI	( 30)
HCVI	( 13)
QVSB	( 11)
LA1	( 12)
ND6	( 17)
TV16	( 34)
SYVI	( 33)
CH5	( 3)
CH4	( 2)
R64	( 24)
R74	( 26)
CH6	( 4)
CH7	( 3)
ELAI	( 8)
YVI	( 36)
HYVI	( 16)
R45	( 23)
MNSI	( 14)
NSI	( 19)
R76	( 28)
MSBI	( 13)
SSDI	( 32)
SBI	( 29)
SNSI	( 31)

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AV1	1	31	35	18 81
PV17	2	27	35	99 83
ND7	3	18	35	97 86
TV17	4	27	35	99 63
R75	5	34	35	93 83
CLAI	6	6	35	98 86
DLAI	7	6	35	96 86
R65	8	35	35	96 70
GRABS	9	35	35	98 80
PV16	10	10	35	99 64
GV1	11	13	35	99 73
SOVI	12	100	35	97 99
HCVI	13	35	35	98 92
QVSB	14	35	35	99 70
LA1	15	35	35	92 82
ND6	16	17	35	99 90
TV16	17	35	35	92 82
SYVI	18	1	35	88 44
CH5	19	1	35	85 38
CH4	20	22	35	83 40
R64	21	25	35	91 19
R74	22	26	35	72 87
CH6	23	4	35	75 64
CH7	24	5	35	68 40
ELAI	25	23	35	50 96
YVI	26	8	35	91 35
HYVI	27	8	35	91 53
R45	28	15	35	88 11
MNSI	29	14	35	82 15
NSI	30	19	35	93 69
R76	31	28	35	93 82
MSBI	32	3	35	64 88
SSDI	33	3	35	99 92
SBI	34	3	35	99 77
SNSI	35	3	35	18 81

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Keith County - December 4, 1977 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX

CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NAME	VARIABLE NO	CORRELATION MATRIX																																	
AV1	( 1)	99/96	97	94/83/63	72	73	73	72	80	81	72	82	73	63	39	58/71	28	53	20	11	7	6	3	9	43	24	41	47/24	49	0					
PV17	( 22)	93	94	91/84/61	70	70	70	70	80	82	73	81	77	63	42	55/76/21	43	28	3	2	3	4	14	45	23	42	45/22	43	0						
ND7	( 18)	99/99	70/65	74	74	77	76	77	75	68	82	68	38	30	64/32/41	70	3	29	27	27	26	1	35	23	37	49/29	61	3							
TV17	( 33)	97/78/63	75	74	77	75	78	76	70	82	70	60	32	61/55/39	68	7	26	24	23	22	1	37	23	37	48/29	59	3								
R75	( 27)	77/64	73	72	77	76	75	73	67	81	65	56	28	68/49/43	72	0	31	30	29	28	3	34	23	37	48/29	62	3								
R74	( 26)	46	59	52	59	76	80	73	76	56	55	22	47/68/51	34	23	10	1	0	47	67	0	36	37/24	1	50										
CLAI	( 6)	98	98/97/93/90	86	89	91/89	93/82/73/56	17	43	53	22	13	14	15	34	68	44	41	32/60	47	3														
ND6	( 17)	99/98/98/95	91	94	97/89	93/75/77/41	28	50	48	17	6	7	8	37	72	40	30	20/50	45	6															
TV16	( 34)	98/97/93	91	93	97/89	93/76/74/42/27	49	49	18	7	8	9	38	72	40	31	21/50	44	6																
OLA1	( 20)	97/90	83	87	93/86	88/71/76/36/26	58	38	4	2	1	0	22	40	29	26	14/39	59	6																
R63	( 23)	94	90	92	96/87	91/72/83/59/31	53	44	13	2	3	4	33/71	38	28	18/49	48	6																	
QVI	( 10)	99/99/98/91	94/73/72/60/30	39	37	29	16	17	19	50	82	37	17	10/50	28	22																			
HQVI	( 13)	98/97/90	93/71/68/66/29	32	61	34	22	27	25	56	85	35	12	8/22	19	28																			
SGVI	( 30)	96/88	93/74/70/56/32	33	62	37	21	22	24	60	88	48	26	20/24	17	32																			
QV88	( 11)	88	91/67/74/53/37	49	47	17	3	6	7	44	77	32	14	6/32	36	20																			
CRAB6	( 9)	89/64/71/1	8	19	71	38	40	41	42	35	67	25	18	13/55	38	10																			
PV16	( 21)	90/67/37	6	19	74	48	38	39	40	53	82	51	40	35/45	24	10																			
BYVI	( 33)	50/53/33	9	86	62	63	64	64	42	64	50	53	53/62	20	15																				
LA1	( 12)	22/33	34	23	2	12	11	10	15	51	25	20	8/41	47	2																				
CH7	( 3)	23	21	63	46	59	59	60	36	48	13	35	23/3	2	4																				
CH4	( 2)	70	41	40	71	71	68/21	31	18	8	22/39	2	64																						
CH5	( 3)	49	72	81	80	80/30	1	15	15	37/29	71	6																							
CH6	( 4)	91/89	89	90/68	72	55	45	56/20	27	13																									
SNSI	( 31)	91	91	92/76	64	63	49	63/10	61	34																									
MSB1	( 13)	99/99/49	38	32	29	47/7	43																												
SSB1	( 32)	99/49	38	32	30	48/9	42	2																											
SBI	( 29)	51	41	33	30	48/7	43																												
ELAI	( 8)	86/73	40	50/37	64	73																													
R64	( 24)	71	40	42	8	23	62																												
MNSI	( 14)	89	87	1	38	51																													
NSI	( 19)	93/32	13	10																															
R76	( 28)	21	30	14																															
HYVI	( 16)	79/78																																	
R45	( 23)	69																																	
YVI	( 36)																																		

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Keith County - March 22, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NAME	VARIABLE NO.	ABSOLUTE CORRELATION MATRIX																																			
AV1	1	1	97	98	96	94	72/73	65	65	65	65	77	70	74	76	47	30	30	3	21	49/35	46	15	30	29	29	29	4	40	3	12	14	31	6			
ND7	18	99	99	99	97	77	72	64	64	64	65	74	67	76	76	51	36	41	8	24	52	21	31	1	15	14	14	13	20	48	1	13	7	26	7		
R75	27	99	97	76	72	65	65	64	65	74	67	76	76	51	35	40	8	24	51	22	32	2	16	15	15	15	19	48	13	15	8	26	6				
TV17	33	97	77	71	64	64	64	65	73	66	76	76	52	38	41	9	25	52	18	27	1	12	11	10	10	33	50	16	14	6	24	11					
PV17	22	73	73	63	63	63	64	71	63	74	75	57	35	40	13	25	50	4	15	14	0	2	2	3	37	59	27	20	3	25	6						
R74	26	36	40	41	40	36	60	60	64	68	52	71	68	10	32	50	29	15	2	1	0	8	7	24	22	4	42	52	40	3							
CLAI	6	96	96	96	96	91	86	91	87	90	43	56	30	44	18	5	23	23	5	1	2	2	15	78	54	59	13	48	1								
ND6	17	99	99	99	95	93	93	93	92	59	71	57	56	30	13	25	22	7	1	0	0	8	72	51	47	2	31	0									
TV16	34	99	99	95	93	96	93	92	59	71	57	56	30	13	25	22	7	1	0	0	8	73	51	47	2	31	1										
R65	25	99	94	93	95	92	92	59	71	57	56	31	13	25	22	7	1	0	0	8	72	51	47	3	31	2											
QLAI	20	93	91	94	90	91	63	53	52	55	29	10	25	22	5	1	0	0	8	74	52	53	3	38	1												
QV1	10	99	97	98	81	66	77	57	41	13	35	31	3	9	20	19	19	2	56	28	22	27	17	0													
SQV1	30	96	97	80	73	83	66	47	20	37	39	5	5	19	19	18	4	33	27	15	35	7	1														
QVSB	11	98	87	73	82	53	38	12	19	24	21	8	2	1	0	15	68	42	25	19	11	1															
MCV1	13	84	75	83	53	55	8	23	26	18	6	4	4	3	14	64	37	18	25	6	0																
PV16	21	60	69	50	58	38	22	12	57	43	35	36	36	40	91	78	57	19	23	0																	
ELAI	8	97	68	33	21	15	3	31	33	13	13	14	21	37	27	27	54	57	1																		
R64	24	75	44	28	21	6	27	26	6	6	7	14	43	29	16	51	43	4																			
MNS1	14	84	73	36	27	1	2	18	18	17	32	14	13	4	30	25	8																				
NS1	19	94	0	6	22	18	6	6	6	19	35	44	44	1	14	6																					
R76	28	11	10	27	27	16	16	16	15	20	39	35	6	2	10																						
CH4	2	93	87	86	95	95	95	85	36	77	49	80	8	2																							
CH5	3	88	93	96	96	86	41	65	18	34	26	0																									
CH6	4	97	94	96	97	90	77	91	42	54	11	0																									
SNS1	31	97	97	97	87	62	81	25	43	29	1																										
MSB1	15	99	99	92	62	82	36	61	13	0																											
SSB1	32	99	92	63	82	36	62	12	0																												
SB1	27	92	63	82	35	60	14	0																													
CH7	3	69	75	27	53	12	2																														
CRAB8	9	92	70	52	32	3																															
SYV1	33	71	64	22	1																																
MYV1	16	82	61	5																																	
YV1	36	64	6																																		
R45	23	2																																			
LAI	12																																				

VARIABLE NAME	VARIABLE NO.	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OF SIMILARITY WHEN CLUSTER FORMED
AV1	1	1	1	3
ND7	18	1	1	67
R75	27	1	1	99
TV17	33	1	1	99
PV17	22	1	1	96
R74	26	1	1	73
CLAI	6	1	1	67
ND6	17	1	1	99
TV16	34	1	1	99
R65	25	1	1	99
QLAI	20	1	1	96
QV1	10	1	1	97
SQV1	30	1	1	97
QVSB	11	1	1	99
MCV1	13	1	1	98
PV16	21	1	1	93
ELAI	8	1	1	88
R64	24	1	1	60
MNS1	14	1	1	79
NS1	19	1	1	94
R76	28	1	1	94
CH4	2	1	1	35
CH5	3	1	1	94
CH6	4	1	1	97
SNS1	31	1	1	97
MSB1	15	1	1	99
SSB1	32	1	1	100
SB1	27	1	1	92
CH7	3	1	1	95
CRAB8	9	1	1	92
SYV1	33	1	1	70
MYV1	16	1	1	82
YV1	36	1	1	82
R45	23	1	1	2
LAI	12	1	1	3

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Keith County - March 31, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NO.	NAME	NO
11	AVI	11
10	ND7	10
27	R75	27
96	TV17	96
89	PV17	89
44	R74	44
97	CLAI	97
20	OLA1	20
17	NDS	17
34	TV16	34
23	R65	23
10	GV1	10
30	SGV1	30
13	MGV1	13
11	QVSB	11
12	LAI	12
9	GRAB6	9
21	PV16	21
33	SYV1	33
8	ELA1	8
24	R64	24
2	CH4	2
3	CH5	3
4	CH6	4
13	MSB1	13
32	SSB1	32
29	SB1	29
31	SNS1	31
3	CH7	3
14	MNS1	14
19	NS1	19
28	R76	28
16	HYV1	16
23	R45	23
36	YVI	36

VARIABLE NO.	NAME	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
1	AVI	1	1	89
2	ND7	2	1	81
3	R75	3	1	93
4	TV17	4	1	48
5	PV17	5	1	96
6	R74	6	1	93
7	CLAI	7	1	32
8	OLA1	8	1	12
9	NDS	9	1	71
10	TV16	10	1	98
11	R65	11	1	98
12	GV1	12	1	69
13	SGV1	13	1	39
14	MGV1	14	1	60
15	QVSB	15	1	31
16	LAI	16	1	91
17	GRAB6	17	1	43
18	PV16	18	1	45
19	SYV1	19	1	74
20	ELA1	20	1	82
21	R64	21	1	93
22	CH4	22	1	04
23	CH5	23	1	93
24	CH6	24	1	48
25	MSB1	25	1	59
26	SSB1	26	1	98
27	SB1	27	1	17
28	SNS1	28	1	30
29	CH7	29	1	76
30	MNS1	30	1	99
31	NS1	31	1	98
32	R76	32	1	77
33	HYV1	33	1	50
34	R45	34	1	77
35	YVI	35	1	97

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Keith County - April 21, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NAME	NO
AV1	( 1 )	99/95/94 95 95 92 91 91 97 96 96 93 89 94 95 92/74 77 04 03 63/64 02 91 5 29 30 5 35 54 26 20 33 30
PV17	( 22 )	96/94 94 95 90 90 90 96 95 95 93 89 94 95 92/75 77/02 81 63/63 02 91 4 30 74 4 36 55 28 31 35 31
CH7	( 31 )	03 84 85 78 78 79 86 85 86 80 83 88 90 86/77 72/64 67 40 53 77 88 8 35 24 0 43 57 45 47 51 43
CLAI	( 41 )	96 98 98 97/97/97 97 96/96 93 94 93 92/74 87/92 95 02/56 76 73/26 10 62/16 13 35 20 23 27 24
CVSB	( 11 )	99 98 98/97/97 97 97 93 94 94 97 97 97/77 84/91 86 66/74 70 89 1 35 45/29 11 33 19 22 27 33
LAI	( 12 )	99 97/97 98 98 96/96 95 97 96 96/77 86/92 91 73/66 84 85/11 35 53/24 11 34 21 24 28 31
ND6	( 17 )	99/98 96 96 94/95 95 96 95 95/76 87/93 92 75/66 83 81/14 22 58/31 1 25 17 20 25 31
TV16	( 34 )	97/96 96 94/95 95 96 94 95/76 87/93 92 75/66 83 81/14 22 58/31 1 25 17 20 24 30
R63	( 25 )	95 95 96 94 94 95 94 94/77 87/91 93 77/64 83 81/17 22 57/30 3 25 20 23 27 32
ND7	( 18 )	99/98 92 88 93 93 91/67 77/94 91 75/68 80 87/16 23 47 9 26 40 9 12 17 18
TV17	( 35 )	97/92 88 93 93 91/67 77/94 90 73/68 80 86/16 22 47/10 25 48 9 12 16 18
R75	( 27 )	91 87 92 92 90/67 76 91 90 75/67 80 87/18 23 43 7 28 49 11 14 18 18
GRAB8	( 9 )	98 98 97 97/89 94 81 87 69/53 83 80 9 21 59/32 2 23 44 47 51 49
PV14	( 21 )	98 97 98/92 96 79 83 63/58 87 79 0 29 56/46 9 11 46 48 52 57
QVI	( 10 )	99/99 88 90/83 83 61 67 91 88 3 34 46/36 3 25 38 40 45 50
MVVI	( 13 )	99/88 89 81 80 58/68 92 90 7 40 42/34 9 28 39 44 46 52
SGVI	( 30 )	89 91 80 80 57/68 93 87 8 40 44/42 0 20 40 42 47 55
CH6	( 4 )	93/50 61 39/39 81 67 18 34 46/37 21 6 75 76 79 82
SVVI	( 33 )	69 81 66 56 74 61/11 10 71/52 26 7 57 59 61 60
CH5	( 3 )	92 81 68 70 73/30 11 55 13 12 37 15 12 8 1
DLAI	( 20 )	94/42 59 60/49 12 76 12 3 27 7 11 13 7
R43	( 23 )	16 30 35 75 42 84 6 4 25 4 1 1 16
CH4	( 2 )	85 85/42 77 15/31 18 33 17 16 9 22
R64	( 24 )	92/38 69 14/51 0 17 31 33 39 60
R7	( 26 )	29 64 3 15 37 52 18 19 25 37
ELI	( 8 )	87/71 40 2 11 27 25 29 58
YVI	( 36 )	58/41 10 11 14 13 19 53
MVVI	( 16 )	22 39 21 21 24 22 5
MNSI	( 14 )	82 74/39 40 42 73
NSI	( 19 )	96/23 24 22 40
R76	( 28 )	25 25 22 38
MSBI	( 15 )	99/99 86
SSBI	( 32 )	99/86
BSI	( 29 )	88
SNSI	( 31 )	

VARIABLE NO.	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
1	1	1	0
22	1	2	99 93
31	1	3	96 00
3	1	4	94 16
30	1	5	98 68
34	1	6	99 29
12	1	7	99 97
17	1	8	97 78
33	1	9	97 54
23	1	10	98 25
18	1	11	99 85
35	1	12	96 68
27	1	13	98 15
16	1	14	98 77
9	1	15	99 69
32	1	16	99 83
30	1	17	90 79
4	1	18	93 73
39	1	19	81 85
37	1	20	87 05
74	1	21	94 52
42	1	22	78 64
59	1	23	85 48
49	1	24	92 73
14	1	25	72 78
39	1	26	64 33
41	1	27	87 77
99	1	28	32 92
88	1	29	94 98
89	1	30	54 38
81	1	31	78 75
80	1	32	87 94
83	1	33	99 70
86	1	34	28 04



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Keith County - May 15, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	( 1 )	99/99		1	0
PV17	( 22 )	99/99 98/97		2	0.40
ND7	( 18 )	99/99 98/98 98/97		3	0.37
TV17	( 33 )	99/99 98/98 98/97 97/96		4	0.30
R73	( 27 )	99/99 98/98 98/97 97/96 95/94		5	0.36
CLAI	( 6 )	98/99 99/99 98/97		3	0.30
QVSB	( 11 )	99/99 99/99 99/98		3	0.44
LAI	( 12 )	99/99 99/99 98/98		3	0.30
ND6	( 17 )	99/98 98/98 98/97		3	0.36
TV16	( 34 )	98/98 98/98 97/97		3	0.36
QVI	( 10 )	99/99 97/98		2	0.44
MCVI	( 13 )	99/96 97/97		2	0.47
BOVI	( 30 )	96/97 98/93		2	0.47
R63	( 23 )	97/96 93/97		2	0.33
GRAB8	( 9 )	98/91 96/99		2	0.30
PV16	( 21 )	90/93 81/91		2	0.37
CH5	( 3 )	93/90 83/87		2	0.34
DLAI	( 20 )	78/79 82/80		2	0.17
CH4	( 2 )	91/92 74/77		2	0.70
R64	( 24 )	92/80 26/33		2	0.69
R74	( 26 )	92/79 63/39		2	0.63
CH7	( 3 )	27/66 48/63		2	0.42
MYVI	( 16 )	80/44 79/23		2	0.47
R45	( 23 )	30/73 63/61		2	0.14
CH6	( 4 )	82/20 22/26		2	0.24
SVVI	( 33 )	28/26 24/9		2	0.10
MSB1	( 13 )	99/99 87/21		2	0.33
SSB1	( 32 )	99/87 22/31		2	0.33
SB1	( 29 )	89/24 50/69		2	0.29
SNS1	( 31 )	38/64 74/59		2	0.71
MNS1	( 14 )	82/63 47/30		2	0.30
NS1	( 19 )	93/3 24/		2	0.24
R76	( 20 )	1/32/		2	0.32
ELAI	( 8 )	89/		2	0.89
YVI	( 36 )			2	0.36

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Keith County - May 16, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	NO																								
AVI	( 1)	99/99	98/97	97 98	96 96	97 97	95/95	97/94	93/94	92/05	09 94	94/61	76/25	74/21	58 25	57 55	50 17	39 71							
PV17	( 22)	98 98	97 97	96 95	96 97	93 94	97/94	92/93	92/04	89 94	93/62	76/25	74/21	57 23	54 53	48 16	40 71								
N37	( 18)	99 98	98 98	97 96	96 96	95 96	98/93	92/97	94/87	89 94	90/57	74/27	70/10	57 28	63 61	57 23	36 69								
TV17	( 33)	98 98	99 98	98 96	96 95	96 93	92/98	94/00	88 92	08/55	74/60	77/19	57 20	65 63	59 25	35 69									
CLA1	( 6)	97 99	98 98	97 96	96 97	96 97	96/93	97/80	86 08	08/63	84/42	83 9 48	33/54	52 40	17 24	39									
QVSB	( 11)	99 99	99/99	98 98	96 96	96 95	96 96	93/90	94 94	00/64	78/25	72/29	65 43	60 58	53 11	24 59									
LAI	( 12)	97 99	98 98	96 96	96 96	96 95	96 91	92/00	65 81	33 77	21 57	39/50	56 51	14 24	39										
ND6	( 17)	99 98	98 98	97 96	96 97	96 96	96 91	90/83	66 83	36 78	20 57	44 58	55 51	12 17	54										
TV16	( 34)	98 97	98 96	94 96	96 97	95/86	70 90	85/65	83/36	77 21	57 44	59 56	52 13	17 34											
QV1	( 10)	99 99	96 94	97 98	93/92	86 94	92/90	73 85	30 71	29 62	48 49	47 41	0 17	33											
HQV1	( 13)	99 96	95 97	98 92	91/87	95 94	91/73	83/26	69 32	65 47	49 46	41 0 19	34												
SOV1	( 30)	96 93	97 98	92/90	87 95	92/88	75 85	27 68	33 65	32 48	46 40	3 13	49												
R65	( 25)	98 93	95 92	95/81	91 90	87/69	83/33	80/13	54 41	50 47	43 7 19	32													
R73	( 27)	92 91	92/94	83 89	93/91	60 74	26 78	14 56	27 36	34 50	18 36	67													
GRAB8	( 9)	99 99	94 74	87 83	90/79	92/46	79 14	47 44	57 35	30 2 11	47														
PV16	( 21)	89 92	78 91	86 86	81 92	41 73	24 55	55 30	36 30	8 3 40															
CH3	( 31)	93 89	85 88	78 46	70 30	77 16	55 32	75 73	69 34	28 63															
DLA1	( 20)	72 78	80/81	60 84	54 92	6 35	30 53	31 48	23 17	53															
CH4	( 2)	92 93	72/40	50 12	43 36	86 44	75 75	70 17	30 61																
R64	( 24)	96 84	69 72	3 49	53 82	57 48	47 40	11 17	49																
R74	( 26)	90 56	62 2 54	45 78	34 58	57 51	7 41	69																	
CH7	( 5)	69 73	18 63	23 54	18 32	30 25	0 46	70																	
CH6	( 4)	90 41	44 26	37 67	20 22	28 61	28 1																		
BYV1	( 33)	66 74	2 26	58 8 5 0	26 22	12																			
MYV1	( 16)	74 67	51 11	9 11	10 7 36	15																			
R45	( 23)	44 2 4	42 40	39 30	16 45																				
ELAI	( 8)	87 55	15 16	10 42	1 7																				
VV1	( 36)	54 47	47 41	18 21	39																				
MNS1	( 14)	1 2 7	61 67	40																					
MSB1	( 15)	99 99	74 45	66																					
SSB1	( 32)	99 74	46 63																						
SB1	( 29)	78 46	63																						
SNS1	( 31)	58 59																							
NS1	( 19)	91																							
R76	( 28)																								

NAME	VARIABLE NO	0	BOUNDARY CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1			28	38 06
PV17	22			1	99 93
ND7	18			35	99 64
TV17	33			1	98 83
CLA1	6			30	98 18
QVSB	11			34	99 35
LAI	12			34	99 66
ND6	17			34	99 92
TV16	34			10	98 65
JVI	103			30	99 83
HQV1	13			10	99 91
SOV1	30			27	97 31
R65	25			1	98 37
R73	27			1	96 34
GRAB8	9			21	99 01
PV16	21			1	95 64
CH3	31			1	94 24
DLA1	20			1	94 03
CH4	2			26	92 71
R64	24			1	90 57
R74	26			1	88 49
CH7	5			1	87 33
CH6	4			1	71 49
BYV1	33			3	74 60
MYV1	16			23	51 19
R45	23			1	57 71
ELAI	8			1	39 94
VV1	36			1	36 96
MNS1	14			1	39 94
MSB1	15			2	36 96
SSB1	32			15	99 67
SB1	29			1	75 63
SNS1	31			1	91 59
NS1	19			2	38 06
R76	28			1	

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Keith County - May 25, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NAME	NO
AVI	( 1)	99/98
PV17	( 22)	98/97
ND7	( 18)	99/98
TV17	( 35)	97/98
R75	( 27)	97/97
CLA1	( 6)	99/99
QV58	( 11)	99/99
LAI	( 12)	99/99
ND6	( 17)	99/98
TV16	( 34)	98/97
R65	( 23)	96/93
DLA1	( 20)	91/89
GRAB8	( 9)	98/96
PV16	( 21)	97/97
QV1	( 10)	99/99
HQV1	( 13)	99/93
GOV1	( 30)	94/91
R64	( 24)	94/84
R74	( 26)	86/82
CH4	( 2)	89/80
CH5	( 3)	82/82
R45	( 23)	87/83
CH7	( 5)	10/8
MSB1	( 15)	99/99
SSB1	( 32)	99/91
SB1	( 29)	93/83
SNB1	( 31)	71/17
CH6	( 4)	80/51
BYV1	( 33)	37/16
MYV1	( 14)	76/57
NSI	( 19)	92/10
R76	( 28)	13/31
ELA1	( 8)	82/72
VVI	( 36)	59/
MYV1	( 16)	/

VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	16	1	28 42
PV17	35	1	99 66
ND7	33	1	98 47
TV17	35	1	97 82
R75	6	1	98 17
CLA1	25	1	99 33
QV58	34	1	99 34
LAI	34	1	99 35
ND6	34	1	99 35
TV16	6	1	98 64
R65	30	1	97 23
DLA1	30	1	95 65
GRAB8	9	1	97 10
PV16	21	1	98 76
QV1	10	1	99 77
HQV1	13	1	99 85
GOV1	30	1	94 38
R64	24	1	94 70
R74	26	1	89 00
CH4	2	1	89 27
CH5	3	1	83 25
R45	23	1	77 78
CH7	5	1	76 69
MSB1	15	1	92 26
SSB1	32	1	99 98
SB1	29	1	99 70
SNB1	31	1	49 27
CH6	4	1	80 01
BYV1	33	1	46 50
MYV1	14	1	66 75
NSI	19	1	92 90
R76	28	1	48 81
ELA1	8	1	65 86
VVI	36	1	83 70
MYV1	16	1	28 42



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Keith County - June 21, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD  
VARIABLE NAME

VARIABLE NAME	NUMBER OF ITEMS IN CLUSTER	OTHER BOUNDARY OF CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1		00
PV17	2	AVI	26
ND7	3	AVI PV17	97
R75	4	AVI ND7	99
TV17	5	AVI ND7 TV17	99
CLAI	6	AVI ND7 TV17 CLAI	99
LAI	7	AVI ND7 TV17 CLAI LAI	99
ND6	8	AVI ND7 TV17 CLAI LAI ND6	99
TV16	9	AVI ND7 TV17 CLAI LAI ND6 TV16	99
R65	10	AVI ND7 TV17 CLAI LAI ND6 TV16 R65	99
OLAI	11	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI	99
QV08	12	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08	99
QV1	13	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1	99
BQV1	14	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1	99
MOVI	15	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI	99
GRAB8	16	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8	99
PV16	17	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16	99
BYVI	18	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI	99
ELAI	19	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI	99
R64	20	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64	99
R74	21	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74	99
MYVI	22	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI	99
R45	23	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45	99
YVI	24	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI	99
CH4	25	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4	99
CH5	26	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5	99
CH6	27	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6	99
M801	28	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801	99
B801	29	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801	99
B81	30	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81	99
BNS1	31	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81 BNS1	99
CM7	32	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81 BNS1 CM7	99
MNS1	33	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81 BNS1 CM7 MNS1	99
NS1	34	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81 BNS1 CM7 MNS1 NS1	99
R76	35	AVI ND7 TV17 CLAI LAI ND6 TV16 R65 OLAI QV08 QV1 BQV1 MOVI GRAB8 PV16 BYVI ELAI R64 R74 MYVI R45 YVI CH4 CH5 CH6 M801 B801 B81 BNS1 CM7 MNS1 NS1 R76	99

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Keith County - June 29, 1978 - Field

TREE PRINTED OVER ADDITIVE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
AVI	1	11	97/97	97/97	97/97	93	91	90	91	90	89	94	94	94	91	93/79	83/03	64	83/07	60/67	67	30/29	10	9	8	27	14	16	59																																																																								
ND7	1	181/99	99/99	99/97	93	91	91	92	91	90	94	94	94	91	94/00	06/05	64	82/03	59/60	68	39/30	14	10	10	20	13	14	50																																																																									
PV17	1	221/99	99/97	96	93	90	89	90	89	80	93	93	94	91	93/79	02/04	64	84/07	61/65	65	36/20	8	5	4	23	15	16	61																																																																									
TV17	1	331/99	97	92	90	90	90	90	89	94	94	94	91	93/79	06/06	64	82/03	50/67	66	30/30	15	12	11	29	15	16	59																																																																										
R70	1	271/97	93	91	91	92	92	90	94	94	94	91	94/81	83/03	64	81/03	60/60	69	39/20	13	9	9	27	13	13	57																																																																											
CLA1	1	61	98/97	97	97	97	96/97	97	97	95/96	90/87	86	66	74/80	69/70	74	43/22	7	3	3	21	0	3	41																																																																													
GRAD0	1	91/98	98	98	98	98/97	96	95	95/95	96/02	84	64	67/70	77/02	77	50/12	3	8	7	11	7	16	29																																																																														
ND6	1	171	99/99	99/99	99	98	96	97/96	94/87	89	72	68/70	73/79	71	41/26	6	2	2	13	20	25	21																																																																															
TV16	1	341	99/99	99/98	98	96	97/96	94/87	89	72	68/70	73/79	71	41/26	6	2	2	12	20	26	21																																																																																
R63	1	231	99/98	98	98	96	97/96	94/87	87	71	68/71	73/79	72	42/25	6	2	2	13	18	24	22																																																																																
CLA1	1	201	98/96	96	94	93/93	93/00	83	64	63/60	71/23	78	30/18	7	1	3	18	14	25	22																																																																																	
PV16	1	211	98	98	97	94	96/01	09	74	68/73	00/77	68	39/22	4	8	8	2	24	20	18																																																																																	
QV1	1	101	99/99	99/97	97	96	93	79	79/70	73/70	62	30/35	4	0	0	7	17	14	31																																																																																		
QV8	1	111	99/99	97	09/06	93	74	79	77/72	70	62	30/37	8	4	3	10	17	14	32																																																																																		
MQV1	1	131	99/98	87	01/74	82	83	81/76	64	57	24/37	1	2	3	3	17	9	33																																																																																			
SOV1	1	301	98/89	81/95	84	80/76	77/65	56	23/39	1	1	3	1	25	18	26																																																																																					
LAI	1	121	88/83	87	72	76/78	71/71	66	35/29	5	1	1	13	10	10	35																																																																																					
QV1	1	331	72/76	57	48/65	83/07	78	55	3	17	22	21	0	23	39																																																																																						
CH3	1	31/74	53	60/48	31/76	73	47/40	52	49	49	56	2	8	34																																																																																							
ELA1	1	81	90/84	72/70	48	36	3/54	6	3	0	4	31	13	28																																																																																							
R64	1	241	84/58	67/18	4	31/70	1	3	7	30	34	20	11																																																																																								
R74	1	261	80/31	17	15	18/65	10	8	5	0	1	31	62																																																																																								
CH7	1	51/70	40	43	19/11	27	30	31	7	22	35	67																																																																																									
CH4	1	41/50	30	15	4	60	63	64	53	42	36	4																																																																																									
MYV1	1	161	96/86	24	7	3	7	30	3	35	4																																																																																										
R40	1	231	92/32	11	7	11	50	26	15	20																																																																																											
VV1	1	361	79	6	2	8	53	40	12	10																																																																																											
CH4	1	21	55	55	50	8/33	8	20																																																																																													
MSB1	1	131	99/99	03/21	16	23																																																																																															
SSB1	1	321	99/81	21	17	22																																																																																															
SS1	1	291	84/23	16	21																																																																																																
SNS1	1	311	61	32	43																																																																																																
MNS1	1	141	82	73																																																																																																	
ND1	1	191	88																																																																																																		
R76	1	201																																																																																																			

NAME	NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	1	1	19
ND7	1	1	1	99
PV17	1	1	1	99
TV17	1	1	1	99
R70	1	1	1	99
CLA1	1	12	1	96
GRAD0	1	1	1	98
ND6	1	21	1	98
TV16	1	21	1	99
R63	1	17	1	99
CLA1	1	1	1	99
PV16	1	1	1	99
QV1	1	1	1	99
QV8	1	1	1	99
MQV1	1	1	1	97
SOV1	1	1	1	99
LAI	1	1	1	97
QV1	1	1	1	99
CH3	1	26	1	88
ELA1	1	1	1	84
R64	1	1	1	90
R74	1	1	1	75
CH7	1	1	1	75
CH4	1	1	1	68
MYV1	1	36	1	89
R40	1	1	1	76
VV1	1	1	1	53
CH4	1	1	1	25
MSB1	1	1	1	83
SSB1	1	1	1	99
SS1	1	1	1	99
SNS1	1	1	1	45
MNS1	1	1	1	79
ND1	1	1	1	00
R76	1	1	1	19

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Keith County - July 27, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERED BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	( 1) 97/99/97 97/95 93 93 93 93 93 93 93 93 91 90/77 91/69/60/23 64/59 74 5/36 82 41 39 30 30/34 8 12 63	1	1	32
PV17	( 22) 99/97 97/95 93 92 93 93 95 95 93 95 92 91/78 91/72/70/30 70/59 73 4/51 77 34 32 31 32/34 7 13 63	28	28	99
TV17	( 33) 98 96/94 92 92 92 91 94 94 92 94 90 09/76 90/67/66/23 63/58 73 5/55 81 40 39 38 38/34 5 15 63	18	18	99
ND7	( 18) 99/96 94 93 94 95 95 95 93 96 91 90/70 91/71/72/27 66/59 76 6/53 80 37 36 35 33/52 8 11 62	27	27	99
R75	( 27) 95 94 92 94 96 94 93 92 95 91 90/78 90/71/73/20 66/59 77 7/51 78 35 33 32 32/48 9 9 59	17	17	99
CLA1	( 6) 99 99 99/98/97 96 96 98/97 97/80 83/84/65/37 62/72 80 13/46 78 30 28 28 27/53 24 14 40	17	17	99
ND6	( 17) 99/99/98/98 97 97 96/96 98/84 84/83/63/59 60/68 75 8/49 77 30 28 27 23/61 34 21 33	34	34	99
TV16	( 34) 99/97/98 97 97 98/96 98/84 83/84/63/40 59/68 75 8/49 78 30 28 27 23/62 35 23 31	20	20	99
CLA1	( 20) 98/97 96 96 98/96 97/82 82/83/63/38 59/70 79 11/47 78 30 29 28 25/57 30 20 34	23	23	99
R65	( 23) 96 96 95 98/95 96/84 83/81/71/39 61/66 77 8/48 76 29 27 26 23/36 29 14 37	10	10	99
QV1	( 10) 99/99/99/94 97/89 90/77/65/36 62/58 68 3/57 79 34 32 31 24/69 35 13 40	13	13	99
HQV1	( 13) 99/99/93 97/91 92/77/60/40 66/53 63 8/57 75 30 28 27 19/72 36 10 42	30	30	99
SGV1	( 30) 99/92 97/92 90/76/66/38 61/53 62 10/59 77 32 30 29 19/74 42 16 36	11	11	99
QVSB	( 11) 94 97/89 90/79/68/38 63/59 69 2/53 77 31 30 28 22/67 34 13 40	9	9	99
CRAB8	( 9) 98/76 78/92/64/54 73/76 79 24/27 64 10 8 8 11/53 22 17 34	21	21	99
PV16	( 21) 83 81/89/63/53 67/68 71 9/40 68 17 15 14 10/63 38 26 26	24	24	99
R64	( 24) 90/63/63/45 58/22 31 41/62 38 20 19 16 4/89 63 21 23	26	26	99
R74	( 26) 54/72/29 68/25 44 31/65 68 32 31 29 18/72 24 19 62	33	33	99
SYV1	( 33) 50/75 71/80 72 39/3 37 20 22 22 16/42 29 41 4	12	12	99
LAI	( 12) 31 60/29 48 6/33 45 12 11 10 9/35 8 15 47	4	4	99
CH6	( 4) 76/29 15 12/39 25 74 75 76 75/41 37 37 19	5	5	99
CH7	( 5) 34 39 10/8 10 38 40 41 35/43 1 20 47	16	16	99
MYV1	( 16) 93/76 7 52 10 8 10 30/3 8 31 9	23	23	99
R45	( 23) 64/12 68 29 27 29 48/2 18 7 36	36	36	99
YV1	( 36) 59 0 19 21 18 16/61 53 8 1	2	2	99
CH4	( 2) 79 83 83 82 58/59 36 8 37	3	3	99
CH5	( 3) 82 81 81 76/38 12 1 47	15	15	99
MSB1	( 15) 99/99/92/11 2 17 39	32	32	99
SSB1	( 32) 97/91/11 2 18 38	29	29	99
SB1	( 29) 92/8 4 18 38	31	31	99
SNS1	( 31) 19 35 29 48	8	8	99
ELA1	( 8) 74/26 6	14	14	99
MNS1	( 14) 76 36	19	19	99
NS1	( 19) 84	20	20	99
R76	( 20) 84	28	28	99











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OF POOR QUALITY

Yolo County - March 27, 1978 - Area

FILE PRINTED OVER ABSOLUTE CORRELATION MATRIX

CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	( 1) 97/98 97 99 98 97/98 98 98 98 97 97 97/93 97/94 93 96/84 93 93/83 84/84/73 86/62 8 30 32 36 47 1 33/	1	1	28 99
PV17	( 22) 98 97 99 98 99/98 98 98 98 97 96 96 93 98/93 93 96/86 93 96/83 83/84/70 84/62 8 33 36 40 50 2 33/	2	2	99 93
GRABS	( 9) 99/99 99 99/97 96 96 97 96 93 93/96 93/93 93 94/92 98 97/88 82/74/62 78/72 7 43 47 51 61 3 48/	3	3	99 46
PV16	( 21) 99 99 99/97 93 97 97 96 96 93/97 93/92 93 94/92 98 96/87 81/72/64 79/75 11 44 46 50 61 6 31/	4	4	99 81
QVI	( 10) 99/99/98 97 98 98 97 97 96/97 97/93 93 93/88 96 93/83 82/77/70 83/72 4 36 39 43 53 6 35/	5	5	99 95
SGVI	( 30) 99/97 97 98 98 97 97 93 98 97/93 93 94/89 96 93/83 81/76/69 82/73 6 38 40 44 56 8 36/	6	6	99 96
HQVI	( 13) 98 97 98 98 97 96 93/97 97/93 93 93/89 96 96/84 81/77/69 82/72 3 30 41 45 56 7 36/	7	7	98 61
CLAI	( 6) 99/98 99 99 98/97/93 93/97 97 96/82 93 91/89 90/80/72 89/63 0 26 29 32 43 8 43/	8	8	99 71
ND7	( 18) 99 99 99 98/98/94 96 97 96 96/79 90 90/84 88/83/77 90/60 8 21 24 28 39 3 31/	9	9	99 27
QVSB	( 11) 99/99 99/98/93 96/93 93 94/81 91 91/84 83/81/77 89/67 0 24 27 31 44 2 33/	10	10	99 68
LAI	( 12) 99 99/98/94 93/96 93 94/81 92 91/83 86/81/76 89/63 1 24 27 31 43 0 32/	11	11	99 52
ND6	( 17) 99/98/94 94/97 93 94/80 91 89/86 88/79/77 90/67 2 22 24 28 41 2 30/	12	12	99 88
TV16	( 34) 99/93 93/96 93 93/79 90 88/86 86/79/77 90/66 1 20 23 27 39 1 30/	13	13	99 62
TV17	( 33) 91 93/93 91 92/73 87 88/82 83/86/79 91/39 8 16 19 23 33 0 31/	14	14	99 87
R64	( 24) 98/88 93 93/88 93 93/76 74/72/71 78/77 7 38 41 45 59 17 67/	15	15	99 16
R74	( 26) 89 94 93/84 90 93/74 77/83/73 81/64 1 33 35 39 52/12 63/	16	16	97 33
QLAI	( 20) 97 96/73 88 83/90 96/76/71 89/38 0 18 21 24 34/23 33/	17	17	98 19
R73	( 27) 81 90 91/83 91/79/68 83/38 7 28 31 33 44/13 46/	18	18	98 69
CH6	( 4) 96/94/78 62/54/33 49/79 23 73 76 79 86/19 44/	19	19	99 83
SYVI	( 33) 93/89 78/63/49 68/78 21 37 39 63 71 3 41/	20	20	94 73
CH7	( 5) 79 73/77/31 66/64 3 37 39 62 69/12 30/	21	21	93 56
MYVI	( 16) 89/53/44 73/61 25 33 38 40 44/30 7/	22	22	96 84
R43	( 23) 69/62 85/42 3 8 11 14 19/49 14/	23	23	89 83
R76	( 28) 71 78/17 36 3 3 9 13 0 46/	24	24	98 72
CH4	( 2) 92/41 21 34 32 28 8 7 69/	25	25	99 97
CH3	( 3) 44 14 19 16 12 1/16 46/	26	26	99 35
MNSI	( 14) 63/31 33 33 72/34 37/	27	27	98 69
MSI	( 19) 36 36 33 42 9 7/	28	28	99 41
MSDI	( 15) 99/99/93/28 8/	29	29	93 56
SSDI	( 32) 99/93/27 9/	30	30	96 84
S8T	( 29) 96/29 13/	31	31	89 83
SNSI	( 31) 40 35/	32	32	98 72
ELAI	( 8) 63/	33	33	99 97
YVI	( 36) 1/	34	34	99 81



OF POOR QUALITY

Yolo County - May 11, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE	NO	NAME
AVI	( 1 )	99/99/90 98 97 97 96/97 96 98 98 98 97/97/93 97/92 92 93/88/76 71/64 83 78 51/46/40 86/ 2 0 3 16 39 49/
PV17	( 22 )	98/98 98 96 97 94/97 97 98 98 98 97/97 94 97/90 91 94/89/73 67/69 87 81 54/47/42 86/ 4 6 10 22 75 44/
ND7	( 18 )	99 98 98 98 97/96 95 97 96 96/96/93 96/94 95 97/86/79 76/58 78 74 46/44/36 83/ 9 7 3 9 45 57/
CLA1	( 6 )	98 99 99/98/97 97 98 97 97/95/92 94/94 96 96/90/75 73/62 79 73 43/49/27 78/ 5 3 0 12 50 58/
QVSB	( 11 )	99 99/97/97 98 99 99 98/97/96 97/92 94 95/90/77 72/65 81 81 53/56/28 79/ 1 0 3 18 40 48/
ND6	( 17 )	99/99/97 97 98 97 97/95/93 94/94 96 96/90/77 76/61 76 75 45/55/21 75/ 7 6 2 11 50 57/
TV16	( 34 )	98/97 98 98 98 97/96/94 94/92 95 95/90/76 74/63 78 78 47/56/23 76/ 4 2 0 14 47 53/
OLA1	( 20 )	95 95 96 95 94/93/89 90/93 97 96/89/75 78/57 73 68 36/49/19 73/11 9 6 6 37 64/
GRAB5	( 9 )	99/98 98 98/95/93 93/89 92 92/96/64 62/76 87 79 48/56/25 76/13 15 18 30 43 47/
PV16	( 21 )	99 99 99/95/95 94/89 92 91/96/67 62/75 86 82 53/62/21 73/11 13 17 30 40 44/
QV1	( 10 )	99/99/96/96 96/91 93 93/92/75 68/70 85 82 56/59/28 78/ 4 5 9 24 38 44/
SOV1	( 30 )	99/96/97 97/90 92 92/92/74 65/72 86 85 59/62/27 77/ 7 8 12 28 34 41/
HGV1	( 13 )	96/97 97/89 91 92/92/72 63/74 88 85 60/60/31 80/ 9 11 15 30 32 39/
TV17	( 35 )	92 94/65 87 90/87/72 65/67 83 83 55/48/40 86/ 4 5 9 22 33 41/
R64	( 24 )	97/86 89 89/87/75 59/73 84 88 70/69/26 74/10 11 15 33 21 29/
R74	( 26 )	88 89 92/84/78 64/67 85 85 66/54/43 85/ 3 5 9 25 22 34/
LA1	( 12 )	95 95/81/77 80/47 66 60 54/42/23 70/19 17 14 2 34 64/
R65	( 25 )	98/85/74 80/51 67 61 34/49/15 67/16 15 11 0 38 68/
R75	( 27 )	82/78 80/50 70 63 37/40/29 76/17 15 11 0 32 65/
SYV1	( 33 )	45 46/84 87 76 41/63/ 9 61/50 32 35 44 44 41/
CH4	( 2 )	87/14 38 37 51/40/26 65/52 31 47 26 26 43/
CH5	( 3 )	2 22 28 6/17/11 53/69 68 65 33 68 79/
CH6	( 4 )	92/81 63/66/18 49/73 74 77 84 4 9/
CH7	( 3 )	88 67/51/48 78/31 52 55 65 2 6/
ELA1	( 8 )	86/70/55 71/56 36 40 58 12 10/
YV1	( 36 )	66/38 53/34 34 38 59 57 42/

VARIABLE	NO	NAME	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
MNS1	( 14 )	55 10/31 32 54 34 1 8/		14	27 34
NS1	( 19 )	79 6 6 8 8 30 9/		19	49 76
R76	( 28 )	0 1 4 13 9 26/		28	98 85
MS01	( 15 )	99/99/95/44 55/		15	98 64
SS01	( 32 )	99/95/42 54/		32	99 47
SD1	( 29 )	96/43 54/		29	99 82
SNB1	( 31 )	47 36/		31	99 88
HYV1	( 16 )	93/		16	97 85
R45	( 23 )			23	96 84
AVI				1	97 92
PV17				22	97 83
ND7				18	98 91
CLA1				6	98 37
QVSB				11	99 82
ND6				17	99 88
TV16				34	95 85
OLA1				20	97 92
GRAB5				9	94 52
PV16				21	96 87
QV1				10	98 87
SOV1				30	87 41
HGV1				13	71 61
TV17				35	70 68
R64				24	73 48
R74				26	86 12
LA1				12	64 81
R65				25	64 40
R75				27	50 19
SYV1				33	49 78
CH4				2	99 89
CH5				3	99 83
CH6				4	93 74
CH7				3	27 54
ELA1				8	
YV1				36	
MNS1				14	
NS1				19	
R76				28	
MS01				15	
SS01				32	
SD1				29	
SNB1				31	
HYV1				16	
R45				23	

# ORIGINAL LISTING OF POOR QUALITY

Yolo County - May 12, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	OTHER CLUSTER	BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1			1	73
PV17	22			2	99
PV17	22			2	98
PV17	22			2	98
GRAB8	9			3	99
PV16	21			4	99
TVI	10			5	99
SVVI	30			6	99
MGVI	13			7	99
CLAI	6			8	99
ND6	17			9	99
TV16	34			10	99
QVSD	11			11	99
ND7	18			12	99
CLAI	20			13	99
R64	24			14	99
R74	26			15	99
LAI	12			16	99
R65	23			17	99
R75	27			18	99
SVVI	33			19	99
CH6	4			20	99
CH7	5			21	99
CH4	2			22	99
CH5	3			23	99
ELAI	8			24	99
YVI	36			25	99
MNSI	14			26	99
NSI	19			27	99
R76	28			28	99
MSDI	13			29	99
SSDI	32			30	99
SBI	29			31	99
SNSI	31			32	99
HYVI	16			33	99
R45	23			34	99

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OF POOR QUALITY

Yolo County - May 20, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NAME	NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
AVI	( 1)	99/99/98	96 96 95 94/95 93 97 97 95 93/93/02/71 81 07/04/65/24 01/63 49 32 8 39 66 14 13 11 7 14																																																																																																		
ND7	( 10)	99/99/97	96 96 95 95/96 94 97 97 96 95/94/04/72 83 91/04/63/23 81/62 46 50 11 43 69 10 8 6 2 19																																																																																																		
PV17	( 22)	98/96 95 95 93/96 94 97 97 96 95/84/76 84 93/81/60/26 84/57 42 44 15 48 73 4 3 1 2 20																																																																																																			
R75	( 27)	98 96 96 97/94 95 96 96 94 94/91/82/66 80 87/87/63/20 78/66 51 56 5 38 64 15 14 12 8 16																																																																																																			
CLAI	( 6)	98 98 98 98/96 95 96 97 94 94/89/86/65 77 82/87/63 7 69/71 61 62 3 35 58 20 18 17 13 19																																																																																																			
ND6	( 17)	99/99 99/97 97 98 98 95 96/87/88/69 82 83/83/65 1 64/68 58 50 3 40 58 16 14 13 7 32																																																																																																			
TV16	( 34)	99 98/97 97 98 98 96 97/90/89/71 83 84/84/63 1 63/66 57 55 4 42 60 14 12 10 5 33																																																																																																			
OLAI	( 20)	97/95 94 95 96 92 93/86/86/62 76 78/86/64 2 62/72 65 65 5 34 53 21 20 18 14 23																																																																																																			
R65	( 25)	94 94 95 96 92 93/85/83/62 78 80/80/66 2 61/71 62 63 2 34 53 21 20 18 13 27																																																																																																			
GRAB8	( 9)	99/98 97 97 97/92/95 76 85 87/79/69 4 70/52 49 46 10 57 73 4 6 7 10 35																																																																																																			
PV16	( 21)	98 98 98 98/91/95/81 90 88/77/53 2 66/50 45 41 17 59 73 6 7 9 11 45																																																																																																			
QV1	( 10)	99/99 99/93/90/80 90 91/81/63 7 72/57 44 43 19 52 70 3 1 0 6 38																																																																																																			
QV80	( 11)	99 99/93/89/79 87 91/81/63 7 72/58 44 44 18 51 70 4 3 0 5 37																																																																																																			
MGV1	( 13)	99/94/90/85 93 94/76/58 11 75/48 34 33 28 60 77 6 8 10 16 42																																																																																																			
SOV1	( 30)	99/90/84 93 93/78/61 5 71/51 37 36 26 57 74 3 4 6 13 45																																																																																																			
TV17	( 35)	83/82 86 93/66/51 28 85/41 29 30 26 58 80 9 10 12 16 27																																																																																																			
SVVI	( 33)	75 82 78 65/26/14 55 33 44 36 10 71 75 24 26 27 28 49																																																																																																			
ELAI	( 8)	95 90/41/39 12 66 8 10 16 66 79 85 40 40 43 53 63																																																																																																			
R64	( 24)	95/59/51 7 67/24 4 2 37 73 82 27 28 30 41 64																																																																																																			
R74	( 26)	64/53/54 86/30 7 10 49 66 87 20 21 23 31 39																																																																																																			
LAI	( 12)	69 4 54 78 65 69 15 10 33 40 38 37 33																																																																																																			
CH4	( 2)	8 40/81 36 44 10 19 6 64 63 61 48 12																																																																																																			
NSI	( 19)	72 6 32 14 23 3 37 7 6 7 3 54																																																																																																			
R76	( 28)	27 4 14 31 46 79 12 13 15 15 7																																																																																																			
CH5	( 3)	81 86/46/38 12 82 81 80 77/18/																																																																																																			
MYVI	( 16)	96/77/27 16 61 60 60 66/21																																																																																																			
R45	( 23)	78/36 16 69 68 69 74/35																																																																																																			
YVI	( 36)	61 56 59 58 60 73/62																																																																																																			
CH6	( 4)	98/83 83 85 87/65																																																																																																			
CH7	( 5)	62 63 65 66/40																																																																																																			
MSB1	( 15)	99/99/97/45																																																																																																			
SSB1	( 32)	99/97/46																																																																																																			
SB1	( 29)	97/47																																																																																																			
SNSI	( 31)	61																																																																																																			
MNSI	( 14)																																																																																																				

VARIABLE NAME	NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	14	1	99
ND7	10	14	1	99
PV17	22	14	1	99
R75	27	14	1	99
CLAI	6	25	1	98
ND6	17	25	1	99
TV16	34	25	1	99
OLAI	20	25	1	99
R65	25	30	1	96
GRAB8	9	30	1	98
PV16	21	30	1	99
QV1	10	30	1	99
QV80	11	30	1	99
MGV1	13	30	1	99
SOV1	30	30	1	99
TV17	35	30	1	99
SVVI	33	30	1	99
ELAI	8	28	1	97
R64	24	28	1	95
R74	26	28	1	95
LAI	12	28	1	95
CH4	2	28	1	95
NSI	19	28	1	95
R76	28	28	1	95
CH5	3	14	1	95
MYVI	16	14	1	95
R45	23	14	1	95
YVI	36	14	1	95
CH6	4	14	1	95
CH7	5	14	1	95
MSB1	15	14	1	95
SSB1	32	14	1	95
SB1	29	14	1	95
SNSI	31	14	1	95
MNSI	14	14	1	95



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OF POOR QUALITY

Yolo County - May 29, 1978 - Area

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	NO	ABSOLUTE CORRELATION MATRIX																												
AVI	( 1)	99	90/90	98	96	97	96	95	92	93	90	96	97	95/93	76	02	00/75	75/35	01/47	46	0	7	6	4	27	50	30	37	14	14
ND7	( 10)	99	99/99	97	97	96	95/94	94	90	97	90	97	95	00	06	91/77	73/30	03/40	38	0	1	2	4	33	57	31	33	20	19	
R75	( 27)	97	97/90	97	96	97	97/92	93	97	95	97	95/91	74	02	00/74	70/33	79/44	43	5	4	3	1	29	51	30	40	13	16		
PV17	( 22)	97	95	95	94	93	95	95	90	97	90	90/96	04	00	93/79	60/42	06/34	31	7	0	9	11	42	63	26	26	25	20		
CLAI	( 6)	99	99/99	98/93	95	98	96	97	95	90/73	00	04/70	70/22	72/44	47	0	7	6	4	20	40	46	43	6	20					
ND6	( 17)	99	99/99	99/94	96	98	97	98	95/89	75	02	03/79	70/15	60/45	47	7	3	3	29	47	46	44	0	20						
TV16	( 34)	99	98/95	97	98	97	98	96/90	77	03	04/79	76/16	67/43	45	5	3	3	1	31	49	44	42	10	30						
OLA1	( 20)	99	94	95	97	95	97	93/88	72	79	01/78	77/14	67/44	40	9	0	7	5	26	45	49	40	4	25						
R65	( 25)	92	93	96	94	96	92	85/68	70	00	75/03	12	65/47	51	13	12	11	8	23	41	50	50	3	24						
GRAB8	( 9)	99	96	96	96	97	92/83	87	08/95	64/26	74/16	19	21	22	23	24	35	69	30	26	10	33								
PV16	( 21)	97	98	97	98/92	83	87	08/70	66/21	71/23	23	16	17	10	21	31	66	29	25	22	41									
QV1	( 10)	99	97/98	93/83	88	90/80	72/26	75/41	30	0	1	3	6	37	56	33	32	22	33											
SOV1	( 30)	99	99/94	96/96	92	92	82/68	27	76/37	31	7	0	10	14	44	61	26	24	29	39										
QV80	( 11)	99	94	85	70	92/81	70/29	78/37	33	5	6	7	11	41	60	29	20	25	33											
MQV1	( 13)	95	89	93	94/84	63/34	80/30	23	13	16	17	21	30	60	19	17	34	30												
PV17	( 35)	80	89	94	70/55	40	08/26	19	17	18	19	22	49	70	13	12	35	25												
ELA1	( 8)	96	94	78/31	46	77/8	9	42	43	44	50	70	82	19	24	63	53													
R64	( 24)	97	80/43	41	70/16	0	36	36	38	44	66	79	11	13	62	37														
R74	( 26)	76	48/37	90/21	5	29	30	31	36	59	78	8	6	36	37															
QV1	( 33)	43/13	30/17	10	69	49	50	49	75	79	16	9	20	46																
LA1	( 12)	3	38/61	71	44	44	43	42	14	2	68	71	27	1																
Y31	( 19)	81/7	25	34	34	35	36	38	59	49	38	54	28																	
R76	( 28)	18	5	23	24	25	27	47	72	10	5	45	2																	
CH4	( 2)	90	84	83	82	76/62	42/40	54	12/8																					
CH5	( 3)	91	91	90	89/70	52/80	83	50/27																						
CH81	( 15)	99	99/90	92	80/66	71	57/41																							
CH31	( 32)	99	98/93	81/65	71	57/41																								
CH6	( 4)	94	48/34	61/34																										
CH7	( 5)	41	44	63/41																										
MYV1	( 16)	97	82/20																											
R45	( 23)	80/38																												
VVI	( 36)	58																												
MNSI	( 14)																													

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1		1	30
ND7	18		14	30
R75	27		27	99
PV17	22		22	98
CLAI	6		6	98
ND6	17		17	98
TV16	34		34	99
OLA1	20		20	99
R65	25		25	99
GRAB8	9		9	96
PV16	21		21	97
QV1	10		10	97
SOV1	30		30	99
QV80	11		11	99
MQV1	13		13	99
PV17	35		35	99
ELA1	8		8	95
R64	24		24	97
R74	26		26	84
SVV1	23		23	80
LA1	12		12	66
M31	19		19	81
R76	28		28	80
CH4	2		2	66
CH5	3		3	81
CH81	15		15	90
MNSI	14		14	98
SE81	33		33	98
SD1	32		32	99
MSI	31		31	99
CH6	4		4	83
CH7	5		5	74
MYV1	16		16	81
R45	23		23	97
VVI	36		36	33
MNSI	14		14	30

ORIGINAL PAGE IS  
OF POOR QUALITY

Yolo County - June 16, 1978 - Area

REE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD  
VARIABLE

NAME	NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
AVI	( 1)	96	92	91	91	92	94	95	95	93	89	84	88/68	83	76	81	80	79/50	80/43	87	1	18	18	17	15	18	25	3	21	15	22	82																																																																					
CLAI	( 6)	97	97	97	97/96	97	96/97	94	91	93	75	71	80	85	81	85/58	76	76	22	15	2	2	1	0	32	44	12	17	10	24	49																																																																						
ND6	( 17)	97/99	99/95	95	94	90	97	93	96	89	77	82	86	85	90	27	71	10	13	24	6	6	7	10	39	52	27	11	1	31	47																																																																						
TV16	( 34)	99/98	98/95	95	94	90	97	94	96/82	79	83	87	86	91	27	71/16	11	26	8	8	9	12	41	54	30	9	0	33	44																																																																								
OLAI	( 20)	99/93	93	93/96	96	92	94/79	75	80	86	84	88/27	70	18	14	23	5	5	6	9	37	51	25	13	4	29	47																																																																										
R65	( 25)	95	96	93/96	95	90	93/76	73	79	83	82	86/26	69/23	19	18	0	0	1	4	33	47	22	16	8	26	33																																																																											
ND7	( 18)	99/97	96	97	94	94/83	80	90	92	84	86/53	88/16	9	26	9	10	10	13	45	49	16	1	7	39	44																																																																												
R75	( 27)	97/95	95	91	93/79	76	87	89	81	84/51	83/20	14	21	4	4	5	7	40	45	12	4	0	36	50																																																																													
PV17	( 22)	96	96	95	93/80	80	90	92	85	87/55	88/15	7	28	11	11	12	15	47	50	6	2	9	41	39																																																																													
QV1	( 10)	98	96	98/85	82	87	88	85	90/55	76/20	11	26	7	8	9	12	43	51	30	1	7	42	40																																																																														
QV8	( 11)	98	98/91	89	93	93	90	94/39	80/6	2	39	21	22	23	26	54	61	37	10	19	50	35																																																																															
MOV1	( 13)	99/94	93	95	92	93	96/39	79/3	13	49	32	32	33	37	63	68	45	2	30	58	26																																																																																
SOV1	( 30)	90	89	92	90	89	94/34	75/8	1	30	20	20	21	26	33	60	42	11	20	53	32																																																																																
ELAI	( 8)	97/96	87/87	71/41	76/19	53	63	49	49	58	59	75	73	58	45	55	74	7																																																																																			
R64	( 24)	96/85	87	90/56	72/22	58	67	53	53	54	59	78	74	66	52	60	81	6																																																																																			
R74	( 26)	92/86	88/57	88/10	25	55	41	41	42	46	71	64	44	42	48	73	17																																																																																				
TV17	( 35)	85	86/54	87/2	12	44	29	29	30	33	61	60	38	29	34	20																																																																																					
GRAB8	( 9)	98/27	88/32	55	68	54	54	55	56	78	87	90	21	32	47	15																																																																																					
PV16	( 21)	23	67/22	27	62	46	47	47	50	72	82	55	20	31	31	19																																																																																					
MS1	( 19)	84/7	3	11	7	7	8	8	32	5	32	33	25	37	10																																																																																						
R76	( 28)	3	4	30	18	18	19	21	32	39	0	26	26	49	24																																																																																						
CH4	( 2)	96	86	93	93	93	90/76	72/48	59	61	27/50																																																																																										
CH5	( 3)	92	97	97	97	96/83	73/61	78	80	52/54																																																																																											
CH6	( 4)	98	98	98	98/97	92/72	72	78	63/36																																																																																												
MSB1	( 15)	99/99	99/92	85/66	75	79	56/45																																																																																														
SSB1	( 32)	99/99	92	85/66	74	79	56/45																																																																																														
SB1	( 29)	99/93	85/67	75	79	57/45																																																																																															
SNB1	( 31)	93	85/72	78	83	64/43																																																																																															
CH7	( 5)	92/83	71	76	68/26																																																																																																
SYV1	( 33)	68	43	54	48/14																																																																																																
MNS1	( 14)	59	69	71/28																																																																																																	
MV1	( 16)	96/86	50																																																																																																		
R45	( 23)	87/51																																																																																																			
YV1	( 36)	23																																																																																																			
LAI	( 12)	1																																																																																																			

NAME	VARIABLE NO.	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1		1	96
CLAI	6		6	97
ND6	17		17	97
TV16	34		34	99
OLAI	20		20	99
R65	25		25	95
ND7	18		18	99
R75	27		27	97
PV17	22		22	96
QV1	10		10	98
QV8	11		11	98
MOV1	13		13	99
SOV1	30		30	90
ELAI	8		8	97
R64	24		24	96
R74	26		26	92
TV17	35		35	85
GRAB8	9		9	98
PV16	21		21	87
MS1	19		19	84
R76	28		28	3
CH4	2		2	96
CH5	3		3	92
CH6	4		4	98
MSB1	15		15	99
SSB1	32		32	99
SB1	29		29	99
SNB1	31		31	93
CH7	5		5	92
SYV1	33		33	68
MNS1	14		14	59
MV1	16		16	96
R45	23		23	87
YV1	36		36	23
LAI	12		12	1

ORIGINAL PAGE IS  
OF POOR QUALITY

Yolo County - All Dates Combined - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

NAME	VARIABLE NO	DATE	...
AVI	( 1)	97/95	93/97/76/03/96/92/91/91/92/00/94/91/06/05/05/07/79/03/37/25/05/52/39/38/39/38/64/10/0/38/16/17
QVI	( 10)	99/98/97/03	92/97/92/92/92/90/00/93/09/86/03/89/06/73/06/56/42/40/39/26/25/25/23/33/2/12/84/24/23
GGVI	( 30)	99/97/00	94/96/92/91/91/08/07/91/09/05/02/90/06/73/04/60/44/37/35/20/19/19/18/48/7/17/88/27/22
HGVI	( 13)	98/92	97/94/90/08/89/86/04/00/07/02/00/91/06/67/79/59/39/37/24/9/8/8/7/38/18/28/66/34/23
PV17	( 22)	07/91/94	90/00/00/00/04/09/09/02/01/00/08/69/70/43/24/31/31/17/16/17/16/45/9/23/37/29/22
GRAD0	( 9)	98/79	73/70/72/65/6/67/70/64/60/76/70/44/69/63/43/17/12/25/26/26/27/3/31/59/09/46/42
PV16	( 2)	06/01	00/00/74/73/77/77/73/69/05/76/35/77/68/50/20/3/10/11/11/12/19/38/45/81/40/37
CLA1	( 6)	98/98	98/96/96/95/92/91/91/90/03/03/50/37/3/46/32/31/32/30/88/3/4/43/16/18
QV00	( 11)	99/99/98	97/95/97/94/93/94/93/04/74/51/33/49/47/33/32/33/31/57/8/2/39/19/4
ND6	( 17)	99/98	98/96/96/94/93/92/91/00/70/51/37/46/51/38/37/37/35/61/12/3/36/13/8
TV16	( 34)	97/95/96/92	90/91/90/85/70/52/37/45/49/36/35/35/33/59/10/1/38/18/9
ND7	( 18)	98/96/96/95	96/91/94/90/72/40/24/59/55/42/41/42/40/64/10/6/29/3/0
OLA1	( 20)	95/93/96	93/89/89/92/73/40/36/43/52/39/38/39/37/61/15/3/32/2/7
LA1	( 12)	98/94	93/00/88/90/82/46/36/47/58/46/45/45/44/68/21/10/30/2/11
TV17	( 33)	07/08	91/80/70/40/22/60/46/33/32/32/30/55/8/3/37/22/4
R65	( 25)	98/91	91/92/71/48/33/44/51/38/37/37/35/59/14/5/31/5/1
R73	( 27)	98/91	65/59/22/54/53/40/39/40/30/60/18/6/25/6/4
R64	( 24)	96/70/62/61	32/40/29/13/12/13/9/38/11/21/52/32/4
R74	( 26)	73/56/40	11/61/37/23/22/22/20/45/0/14/39/23/11
R45	( 23)	75/31	33/45/68/60/60/60/59/76/40/33/6/34/10
MYVI	( 16)	40/62	15/45/39/38/38/39/62/15/11/40/0/38
MNS1	( 14)	85/35	5/16/17/17/21/2/36/20/63/31/11
ND1	( 19)	54/3	2/2/2/0/17/12/1/43/4/44
R76	( 28)	45/38	37/38/38/44/30/10/13/3/27
CH4	( 2)	98/98	98/97/97/90/83/54/38/25
MND1	( 13)	99/99/99/95/95	91/63/47/19
DD1	( 29)	99/99/93/96	91/63/47/19
DD01	( 32)	99/95/96	91/63/47/19
DN01	( 31)	94/96	91/66/49/15
CH5	( 3)	83/76	39/35/6
CH6	( 4)	97/83	56/27
CH7	( 5)	84/59	23
SVVI	( 33)	55/40	
ELA1	( 8)		
VVI	( 36)		

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1		1	100
QVI	10		10	97
GGVI	30		30	99
HGVI	13		13	98
PV17	22		22	96
GRAD0	9		9	98
PV16	2		2	98
CLA1	6		6	89
QV00	11		11	85
ND6	17		17	99
TV16	34		34	98
ND7	18		18	98
OLA1	20		20	97
LA1	12		12	96
TV17	33		33	95
R65	25		25	98
R73	27		27	93
R64	24		24	96
R74	26		26	91
R45	23		23	83
MYVI	16		16	75
MNS1	14		14	45
ND1	19		19	85
R76	28		28	48
CH4	2		2	80
MND1	13		13	85
DD1	29		29	100
DD01	32		32	100
DN01	31		31	99
CH5	3		3	95
CH6	4		4	97
CH7	5		5	90
SVVI	33		33	97
ELA1	8		8	90
VVI	36		36	58

ORIGIN OF POOR QUALITY

Yolo County - October 7, 1977 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
 CLUSTERING BY AVERAGE LINKAGE METHOD  
 VARIABLE

NAME NO

AV1	( 1)	77	77	90	74/36	31	27	26	28	22	21	72	60	61	7	4	37	42	50	32	39	39	39	41	12	15	18/28	43	60/22	10	11	39	
ND7	( 18)	99	99	99	99	51	66	56	55	56	53	58	60	61	75	33	36	75/17	12	29	23	23	23	20	49	62	36/19	34	59/15	13	8	7	
R75	( 27)	93	92	91	66	56	55	57	53	58	60	61	75	33	36	75/17	12	30	23	23	24	21	49	63	36/20	34	55/16	13	9	7			
PV17	( 22)	89	40	86	47	46	40	43	40	74	65	74	19	22	63	3	9	9	1	2	2	0	30	49	10/23	39	59/20	12	1	19			
TV17	( 33)	76	61	51	51	51	48	52	65	59	71	29	32	70/10	6	23	17	17	17	15	41	53	29/16	32	33/11	9	4	7					
CLA1	( 6)	84	95	95	95	95	86/76	75	74/32	53	27/23	12	39	27	27	27	20	30	76	61/41	55	30/37	55	25	19								
QV00	( 11)	96	96	95	96/93	76	81	80/83	85	70/30	41	64	53	53	54	58	62	84	72/31	39	22/19	15	0	27									
ND6	( 17)	99	99	99	99	76	79	82/72	74	40/36	32	58	46	46	46	49	49	84	73/52	55	37/28	37	14										
TV16	( 34)	99	99	99	99	76	78	81/73	73	48/36	32	58	46	46	46	50	50	83	73/52	55	38/27	37	14										
R63	( 25)	98	95	77	80	83/71	74	47/36	31	37	45	46	46	49	49	84	73/52	55	36/31	38	19												
CLA1	( 20)	92	92	76	79/70	77	50/36	34	58	47	47	47	51	50	81	71/54	54	40/29	32	10	13												
PV16	( 21)	70	74	81/70	76	54/52	49	73	62	62	63	65	66	93	85/49	32	30/29	36	20	11													
QV1	( 10)	98	95	46	52	51/20	19	8	5	5	5	0	10	49	23/41	21	8/30	10	25	3													
QV1	( 30)	96	58	66	56/15	9	18	3	3	4	12	16	51	20/36	30	10/26	0	34	11														
NOV1	( 13)	64	72	72	3	9	35	21	21	22	29	38	65	42/46	19	1/23	0	25	17														
ELA1	( 8)	96	71/39	56	68	60	60	61	70	61	59	60/66	40	36	3	23	27	71															
R64	( 24)	74	40	58	72	62	62	63	73	64	63	64/72	43	35	0	25	31	70															
R74	( 26)	27	44	53	48	48	48	54	60	52	40/16	24	33	8	40	33	58																
CH4	( 2)	94	91	93	93	89	80/73	88	0	24	18	0	33	60	21																		
CH5	( 3)	95	98	98	98	97/92	64	82/17	22	20/10	1	30	52																				
CH6	( 4)	98	98	98	98/95	83	94	30	35	26	1	13	31	45																			
M001	( 15)	99	99	98	95/76	90/20	27	21	3	12	36	44																					
B001	( 32)	99	98	95	76	90/20	27	21	2	12	37	44																					
B01	( 29)	98	95	76	90/20	27	21	3	11	33	45																						
DN01	( 31)	93	74	88	54	33	27	5	0	21	54																						
CH7	( 3)	81	86	7	5	3	2	5	30	42																							

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AV1	1		1	48
ND7	18		18	88
R75	27		27	95
PV17	22		22	87
TV17	33		33	90
CLA1	6		6	30
QV00	11		11	64
ND6	17		17	21
TV16	34		34	89
R63	25		25	95
CLA1	20		20	73
PV16	21		21	31
QV1	10		10	82
QV1	30		30	97
NOV1	13		13	17
ELA1	8		8	24
R64	24		24	81
R74	26		26	67
CH4	2		2	53
CH5	3		3	50
CH6	4		4	31
M001	15		15	94
B001	32		32	94
B01	29		29	89
DN01	31		31	85
CH7	3		3	42
GRAB8	9		9	21
QV1	33		33	48
MND1	14		14	50
ND1	19		19	22
R76	28		28	16
LA1	12		12	34
MV1	16		16	76
YV1	36		36	60
R45	23		23	1

ORIGINAL PAGE IS  
OF POOR QUALITY

Yolo County - November 12, 1977 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD  
VARIABLE

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1		1	100
PV17	2		2	99
ND7	3		3	99
R73	4		4	99
TV17	5		5	99
MYV1	6		6	99
YV1	7		7	99
R43	8		8	99
CH4	9		9	99
CH5	10		10	99
CH6	11		11	99
MSB1	12		12	99
SSB1	13		13	99
SBI	14		14	99
SNS1	15		15	99
CH7	16		16	99
ELA1	17		17	99
R64	18		18	99
MNS1	19		19	99
NS1	20		20	99
R76	21		21	99
CLA1	22		22	99
QV3B	23		23	99
ND6	24		24	99
TV16	25		25	99
R65	26		26	99
OLA1	27		27	99
GRABS	28		28	99
PV16	29		29	99
SVV1	30		30	99
CV1	31		31	99
MGV1	32		32	99
SGV1	33		33	99
R74	34		34	99
LAI	35		35	99



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Yolo County - February 28, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE NAME	NO	CORRELATION MATRIX (Upper Triangle)																			
AVI	( 1)	97/97	89/90	96/94	97/97	96/95	93/93	95/95	90/95	93/91	95/64	91/72	61/82	69/75	76/77	73/26	23/24	14/20			
PV17	( 22)	98/90	90/96	94/94	97/97	96/94	92/94	89/89	94/92	91/94	84/90	70/61	81/67	77/77	79/74	25/23	34/24	13/20			
CH7	( 5)	92/89	94/92	94/93	93/87	84/87	80/80	86/84	83/88	80/80	87/55	56/71	57/85	85/87	80/22	27/34	13/5	20/20			
CH6	( 4)	97/96	97/95	95/85	83/85	81/81	79/78	84/80	83/83	78/50	68/70	53/93	93/94	94/53	10/19	7/2	19/19				
BYVI	( 33)	98/98	95/95	93/92	87/90	88/87	84/83	89/84	80/74	62/81	82/69	87/88	88/88	86/53	16/16	5/20	5/20				
GRABS	( 9)	99/98	98/98	95/92	95/91	91/91	90/92	91/84	83/68	74/84	84/71	83/84	85/82	43/0	33/13	17/12					
PV16	( 21)	99/98	98/94	93/95	92/92	90/90	93/89	88/84	69/72	82/67	82/83	84/85	52/8	23/21	12/19						
QVI	( 10)	99/99	95/95	96/94	93/93	92/94	92/91	89/72	66/82	66/79	80/81	82/47	0/34	29/8	23/8						
MGVI	( 13)	99/94	95/96	92/92	93/92	93/71	90/71	64/80	64/80	80/82	83/46	3/37	29/5	28/5							
SOVI	( 30)	94/95	96/93	93/92	91/93	91/92	89/71	65/80	64/79	80/81	84/51	2/31	31/5	29/5							
CLAI	( 6)	95/98	97/97	96/96	95/95	79/80	84/78	74/84	84/66	67/68	64/34	3/39	22/34	3/3							
QVDC	( 11)	99/98	98/98	98/95	94/90	90/87	61/87	71/59	60/62	66/46	1/38	47/11	29/29								
LAI	( 12)	99/98	98/95	94/86	86/86	69/90	76/64	65/66	67/41	2/39	36/20	18/18									
ND6	( 17)	99/97	98/96	93/85	83/90	71/92	78/57	50/60	62/46	5/31	39/24	17/17									
TV16	( 34)	97/98	94/91	84/82	90/70	91/78	56/57	59/61	46/6	31/40	23/17										
ND7	( 18)	99/95	97/84	88/89	64/91	78/56	57/59	58/30	13/49	40/24	18/18										
TV17	( 35)	93/94	83/83	86/90	64/90	77/54	55/57	57/31	11/48	41/23	18/18										
R63	( 25)	97/86	84/84	69/92	80/62	63/64	66/44	2/32	35/28	17/17											
R75	( 27)	83/80	83/61	90/79	60/61	62/60	26/19	51/33	27/18												
R64	( 24)	94/67	36/62	40/63	63/66	79/62	4/26	39/23	61/61												
R74	( 26)	69/29	63/44	59/60	62/69	34/26	34/57	18/36													
CH5	( 3)	57/87	79/18	19/21	25/29	0/35	35/35	12/12													
MYVI	( 16)	83/86	60/61	60/48	31/31	3/29	67/49														
QLAI	( 20)	96/49	50/51	44/26	2/31	16/58	15/15														
R45	( 23)	38/39	39/26	9/1	28/2	77/39															
MSBI	( 15)	99/99	93/39	5/14	22/0	6/5															

VARIABLE NAME	NO	OTHER CLUSTER	BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OF SIMILARITY WHEN CLUSTER FORMED
AVI	1			1	23
PV17	22	36		1	80
CH7	5	1		1	99
CH6	4	30		1	84
BYVI	33	4		1	96
GRABS	9	30		1	97
PV16	21	9		1	89
QVI	10	10		1	98
MGVI	13	30		1	59
SOVI	30	10		1	84
CLAI	6	1		1	94
QVDC	11	27		1	44
LAI	12	35		1	95
ND6	17	11		1	98
TV16	34	6		1	27
ND7	18	34		1	16
TV17	35	11		1	99
R63	25	35		1	93
R75	27	1		1	96
R64	24	6		1	67
R74	26	1		1	87
CH5	3	1		1	27
MYVI	16	1		1	50
QLAI	20	1		1	94
R45	23	1		1	90
MSBI	15	1		1	53
SSBI	32	3		1	60
SBI	29	3		1	83
SNSI	31	3		1	34
MNSI	14	3		1	56
NSI	19	3		1	31
R76	28	3		1	94
CH4	2	3		1	94
ELAI	8	3		1	99
YVI	36	3		1	99

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Yolo County - March 27, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE

NAME	NO
AVI	1
PV17	22
CH7	31
GRABS	9
PV16	21
CVI	10
MGVI	13
SGVI	20
CLAI	6
QVSB	11
LAI	12
ND6	17
TV16	34
ND7	18
TV17	35
NS5	23
R73	27
R64	24
R74	26
CH6	4
SYVI	33
CH5	3
DLAI	20
R43	23
MYVI	16
MSB1	13
SSB1	32
SB1	29
SNS1	31
MNS1	14
NS1	19
R76	28
CH4	2
ELAI	8
YVI	36

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	36	1	30.92
PV17	22	1	2	99.95
CH7	31	1	3	97.77
GRABS	9	30	4	99.33
PV16	21	9	5	99.60
CVI	10	30	6	99.81
MGVI	13	10	7	99.94
SGVI	20	10	8	96.73
CLAI	6	27	9	95.67
QVSB	11	35	10	98.52
LAI	12	11	11	99.60
ND6	17	11	12	99.94
TV16	34	11	13	99.26
ND7	18	35	14	99.38
TV17	35	6	15	98.40
NS5	23	27	16	94.64
R73	27	1	17	96.00
R64	24	26	18	91.53
R74	26	1	19	97.92
CH6	4	33	20	90.36
SYVI	33	1	21	81.13
CH5	3	16	22	97.13
DLAI	20	33	23	89.04
R43	23	33	24	79.32
MYVI	16	33	25	96.98
MSB1	13	15	26	99.93
SSB1	32	31	27	66.73
SB1	29	14	28	80.17
SNS1	31	14	29	37.81
MNS1	14	14	30	41.23
NS1	19	14	31	33.92
R76	28	1	32	30.92
CH4	2	36	33	
ELAI	8	36	34	
YVI	36	1	35	



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Yolo County - May 2, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE

NAME NO

AV1	( 11	99/95	92	95/93	93	90	91	93	87	85/87	84	92	92	89/71	83/30	67	2	4	37	63/52	69	78	9	10	12	13	23	9	38	
PV17	( 22	93	90	93	94	91	88	88	93	83	82/87	86	92	93	90/71	82/24	61	4	3	37	60/57	72	83	16	18	19	20	26	10	37
ND7	( 18	98/98	94	90	94	93	95	92	91/76	75	86	84	82/69	82/47	84	8	2	34	73/52	56	58	16	14	13	9	19	3	41		
R73	( 27	94/92	92	91	90	93	93	91/74	72	83	81	79/67	80/43	82/14	3	32	73/30	34	26	15	14	13	9	17	4	40				
TV17	( 33	94	94	93	94	94	88	89/76	75	86	85	83/68	80/48	84	3	1	33	69/52	56	58	16	14	12	8	20	6	41			
CLA1	( 61	94	96	96	97	94/93	91	89	93	91	90/67	68/22	72	14	21	76	79/54	77	68	8	10	11	12	31	29	18				
QVSB	( 11	98	98/90	95/89	84	87	94	93	93/84	82/48	78/10	9	36	62/48	68	60	2	1	0	11	47	30	1							
ND6	( 17	99/98	97/94	86	88	93	91	92/78	73/39	79/2	4	67	72/48	73	56	1	0	1	9	47	37	8								
TV16	( 34	98/96	94/86	88	93	91	92/77	73/40	80/0	4	67	71/48	72	56	2	0	0	9	47	37	9									
LA1	( 12	96/92	89	89	95	94	93/77	78/35	74/0	4	65	70/53	74	66	4	6	8	14	42	30	17									
R63	( 23	94/84	83	90	88	89/76	71/37	77/8	6	66	73/47	71	54	1	0	1	9	46	38	6										
DLA1	( 20	80	78	82	79	79/55	55/26	81/33	31	78	90/37	67	47	8	6	5	6	27	30	13										
CRABB	( 9	98/95	95	95/70	59/4	41/2	21	79	59/83	93	84	47	48	49	30	34	30	3												
PV16	( 21	97	97	97/78	62/4	42/13	9	74	33/84	93	79	44	46	47	33	66	38	14												
QV1	( 10	99/99	85	76/23	56/17	1	65	54/73	86	77	28	30	31	40	39	44	2													
MOV1	( 13	99/86	79/22	53/22	3	61	49/74	85	80	31	32	34	43	39	42	4														
SCV1	( 30	88	76	23	53/23	6	62	49/75	86	76	30	32	34	44	65	48	2													
R64	( 24	86/53	49/36	31	22	16/36	39	35	12	13	16	39	73	41	5															
R74	( 26	63	61	43	49	7	22/31	37	61	10	9	6	9	30	6	44														
CH4	( 31	71/36	68	34	3/38	26	19	74	74	71	48	10	21	34																
CH3	( 31	19	3	33	70/12	19	8	60	39	38	30	6	2	36																
ELA1	( 8	83/49	70/26	2	18	19	18	21	47	52	14	13																		
YV1	( 36	71	62/13	30	9	23	24	21	7	31	11	6																		
MYV1	( 16	82/60	83	48	36	38	37	25	31	56	23																			
R45	( 23	16	30	27	15	13	14	27	3	15	17																			

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AV1	1	28	33	34
PV17	22	1	33	34
ND7	18	35	33	34
R73	27	18	33	34
TV17	33	1	33	34
CLA1	11	20	33	34
QVSB	11	34	33	34
ND6	17	11	33	34
TV16	34	11	33	34
LA1	12	11	33	34
R63	23	1	33	34
DLA1	20	1	33	34
CRABB	9	30	9	30
PV16	21	9	30	30
QV1	10	30	10	30
MOV1	13	10	10	30
SCV1	30	1	10	30
R64	24	2	10	30
R74	26	1	10	30
CH4	31	3	10	30
CH3	31	3	10	30
ELA1	8	3	10	30
YV1	36	3	10	30
MYV1	16	3	10	30
R45	23	1	10	30
CH6	4	28	4	28
SYV1	33	4	28	28
CH7	33	4	28	28
MSB1	15	31	15	31
SSB1	32	15	15	31
SB1	29	15	15	31
SNS1	31	14	14	31
MNS1	14	28	14	28
NS1	19	14	14	28
R76	28	1	1	1



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Yolo County - May 12, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD  
VARIABLE

NAME	NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AVI	1	28	1	27 96
PV17	2	27	2	99 00
ND7	3	18	3	99 702
TV17	4	18	4	98 00
R75	5	30	5	96 25
CLAI	6	26	6	98 60
DLAI	7	26	7	98 93
CVSB	8	11	8	99 80
LAI	9	34	9	99 96
ND6	10	17	10	99 35
TV16	11	17	11	98 23
R65	12	34	12	99 63
QVI	13	30	13	99 19
MOV1	14	30	14	98 23
SOVI	15	21	15	91 25
GRAB8	16	21	16	90 48
PV16	17	26	17	82 98
R64	18	16	18	84 43
R74	19	23	19	73 64
MYVI	20	11	20	65 86
R45	21	11	21	77 20
SVVI	22	4	22	90 61
CH4	23	31	23	96 89
CH5	24	31	24	99 97
MND1	25	1	25	87 17
SSD1	26	1	26	31 27
SBI	27	1	27	31 27
SNSI	28	1	28	31 27
CH6	29	1	29	31 27
CH7	30	1	30	31 27
ELAI	31	1	31	31 27
YVI	32	1	32	31 27
MNSI	33	1	33	31 27
NSI	34	1	34	31 27
R76	35	1	35	31 27

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Yolo County - May 20, 1978 - Field

TREE PRINTED OVER ABSOLUTE CORRELATION MATRIX  
CLUSTERING BY AVERAGE DISTANCE METHOD

VARIABLE  
NAME

AV1	( 1)	99/99/99	90/97	96	92	92	92	93	93	94	91	00	09	05/61	54	51	70/72	92	79	70	78	78	41	77	81	43/17	4	58/1
TV17	( 35)	99/99/99	90/97	96	92	92	92	93	93	94	91	00	90	05/61	54	51	70/72	92	70	70	70	77	40/77	81	45/17	4	58/10	
PV17	( 22)	99/99/99	90/97	90	91	91	91	92	92	93	91	00	90	05/62	54	51	00/69	09	74	74	74	74	36/73	79	44/18	6	60/17	
ND7	( 18)	99/97	96	93	93	93	94	93	94	91	00	90	05/62	53	51	79/70	90	76	75	75	75	37/76	81	45/16	4	58/12		
R75	( 27)	97	96	93	92	93	94	92	94	91	00	90	05/62	51	52	79/69	09	74	74	74	74	36/76	81	44/16	3	57/14		
CLA1	( 6)	97/97	97	97	90/96	96	93/96	92/74	54	53	71/67	91	74	73	73	73	31/05	06	31	6	13	42	5					
LA1	( 12)	90	90	90	97/97	98	96	93/93	93/74	62	61	75/70	90	72	72	71	68	27/00	80	42	2	18	38	3				
ND6	( 17)	99/99/99/90	99	96	97/96	97/79	63	63	70/70	89	70	69	69	64	21/02	79	41	13	31	23	9							
TV16	( 34)	99/90/98	99	96	97/96	97/79	63	65	70/70	89	71	70	70	69	22/02	79	41	13	31	24	1							
R65	( 25)	99/90	98	96	96/96	96/79	63	65	71/68	08	69	68	68	63	20/81	79	40/13	30	23	2								
OLA1	( 20)	96	96	93	93/96	94/79	54	55	64/63	90	71	70	71	69	26/07	86	31	4	27	29	1							
QV1	( 10)	99/99	99/93	97/77	74	73	79/74	06	67	67	66	59	17/74	70	29	18	29	27	7									
QV8B	( 11)	99	90/94	96/73	72	72	79/73	00	70	69	69	62	20/74	72	30/13	26	30	3										
MOV1	( 13)	99/94	96/76	78	78	03/73	02	62	61	61	52	10/68	64	21/22	20	27	14											
SOV1	( 30)	93	97/77	00	00	00/74	01	62	61	60	51	9/68	63	19/29	36	19	8											
ORAB5	( 9)	97/09	57	57	64/51	79	55	54	54	54	5/05	01	30	9	31	23/17												
PV16	( 21)	09/70	71	67/59	77	53	52	52	46	0/77	70	33/29	43	11/11														
BYV1	( 33)	46	49	35/16	49	16	17	18	32/77	65	46/33	60	12/24															
CLA1	( 8)	73/70	74	49	37	37	35	14	8/17	7	33/60	40	3/7															
R64	( 24)	79/69	43	29	28	26	5	19/14	6	40/67	45	0/14																
R74	( 26)	78	63	53	53	52	40	16/25	30	16/10	12	53/33																
CH4	( 2)	02	05	05	04	67/56	33	36	10/14	3	32/32																	
CH5	( 3)	94	93	94	90/62	79	02	47/14	5	43/29																		
MSB1	( 15)	99/99/93	03/62	68	37/26	12	40/47																					
SOB1	( 32)	99/93	03/61	67	37/26	12	48/48																					
SB1	( 29)	96/84	62	69	39/27	12	48/48																					
SN51	( 31)	06/71	00	60/49	24	58/41																						
CH6	( 4)	30	43	34/59	47	54/60																						
MYV1	( 16)	96/03	17	26	21/14																							
R45	( 23)	86/36	5	40/10																								
YV1	( 36)	56	4	29/10																								
MNS1	( 14)	84/77	7																									
NS1	( 19)	83/23																										
R76	( 28)	33																										
CH7	( 5)																											

NAME	VARIABLE NO	OTHER BOUNDARY OF CLUSTER	NUMBER OF ITEMS IN CLUSTER	DISTANCE OR SIMILARITY WHEN CLUSTER FORMED
AV1	1	1	1	100
TV17	35	1	2	99
PV17	22	1	3	99
ND7	18	27	4	99
R75	27	1	5	99
CLA1	6	21	6	99
LA1	12	20	7	99
ND6	17	17	8	99
TV16	34	17	9	99
R65	25	17	10	99
OLA1	20	10	11	99
QV1	10	10	12	99
QV8B	11	10	13	99
MOV1	13	10	14	99
SOV1	30	10	15	99
ORAB5	9	21	16	99
PV16	21	1	17	99
BYV1	33	1	18	99
CLA1	8	1	19	99
R64	24	1	20	99
R74	26	1	21	99
CH4	2	1	22	99
CH5	3	1	23	99
MSB1	15	31	24	99
SOB1	32	31	25	99
SB1	29	31	26	99
SN51	31	31	27	99
CH6	4	31	28	99
MYV1	16	31	29	99
R45	23	31	30	99
YV1	36	31	31	99
MNS1	14	31	32	99
NS1	19	31	33	99
R76	28	31	34	99
CH7	5	31	35	99





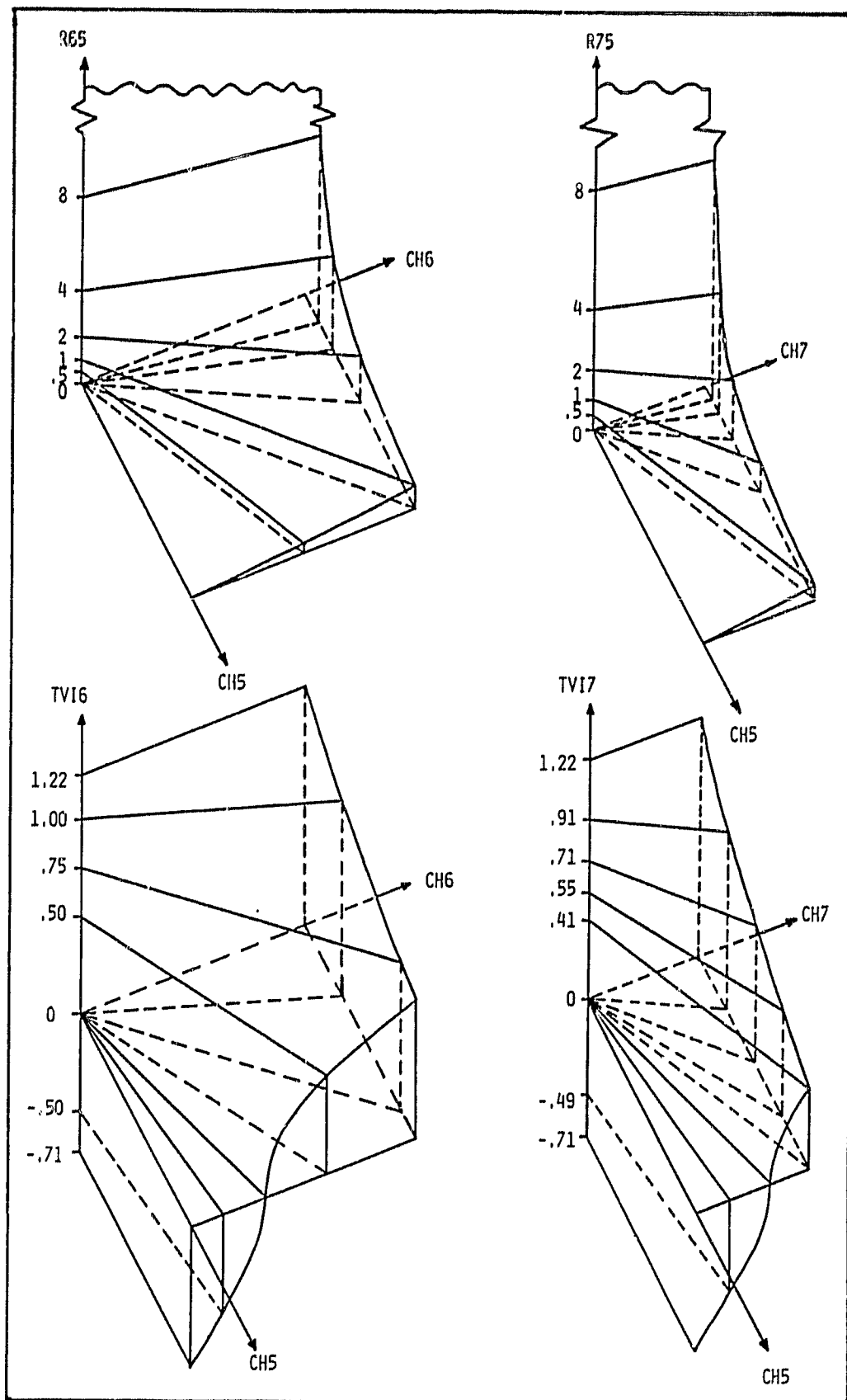
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APPENDIX C

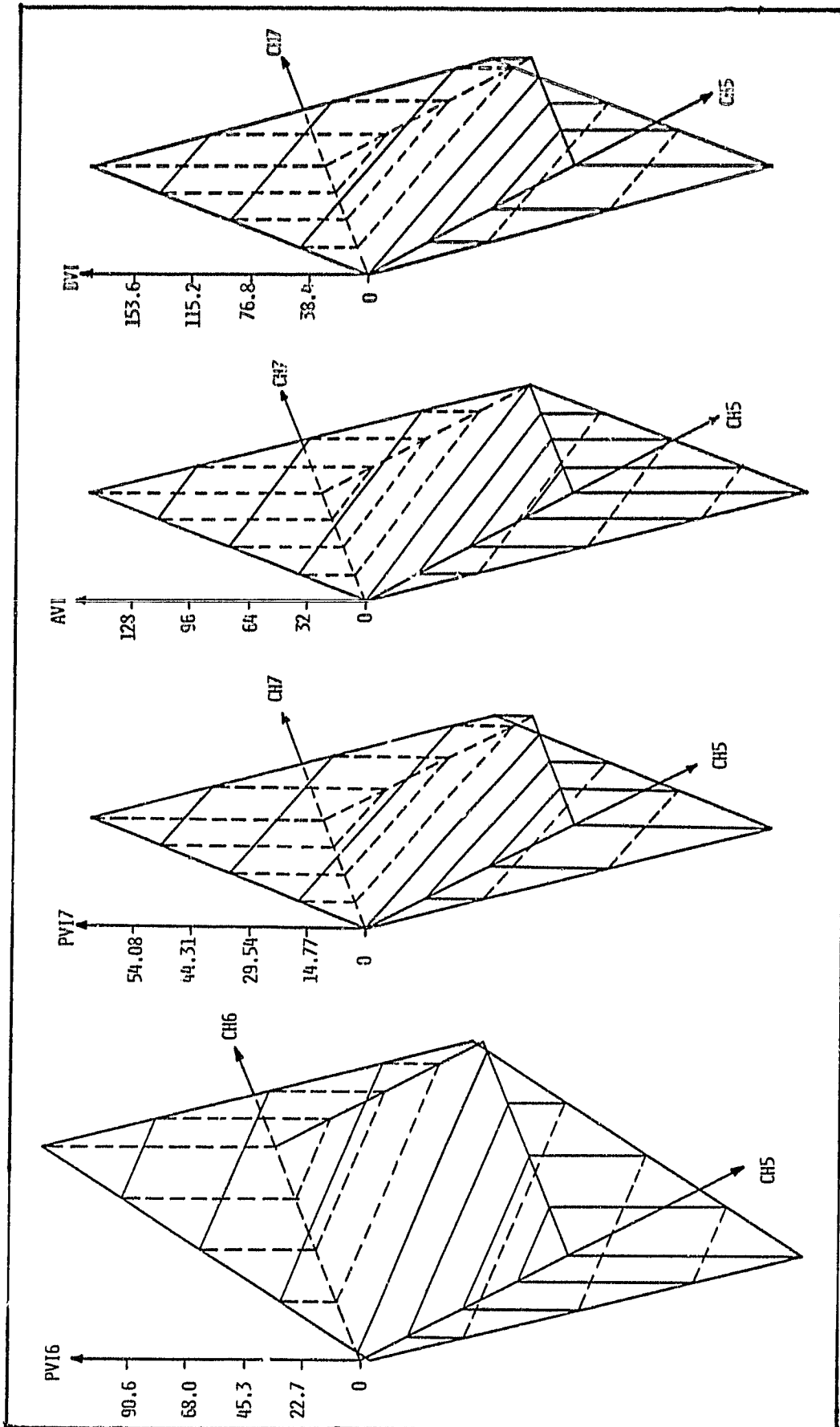
GRAPHICAL REPRESENTATION OF VEGETATION INDICES

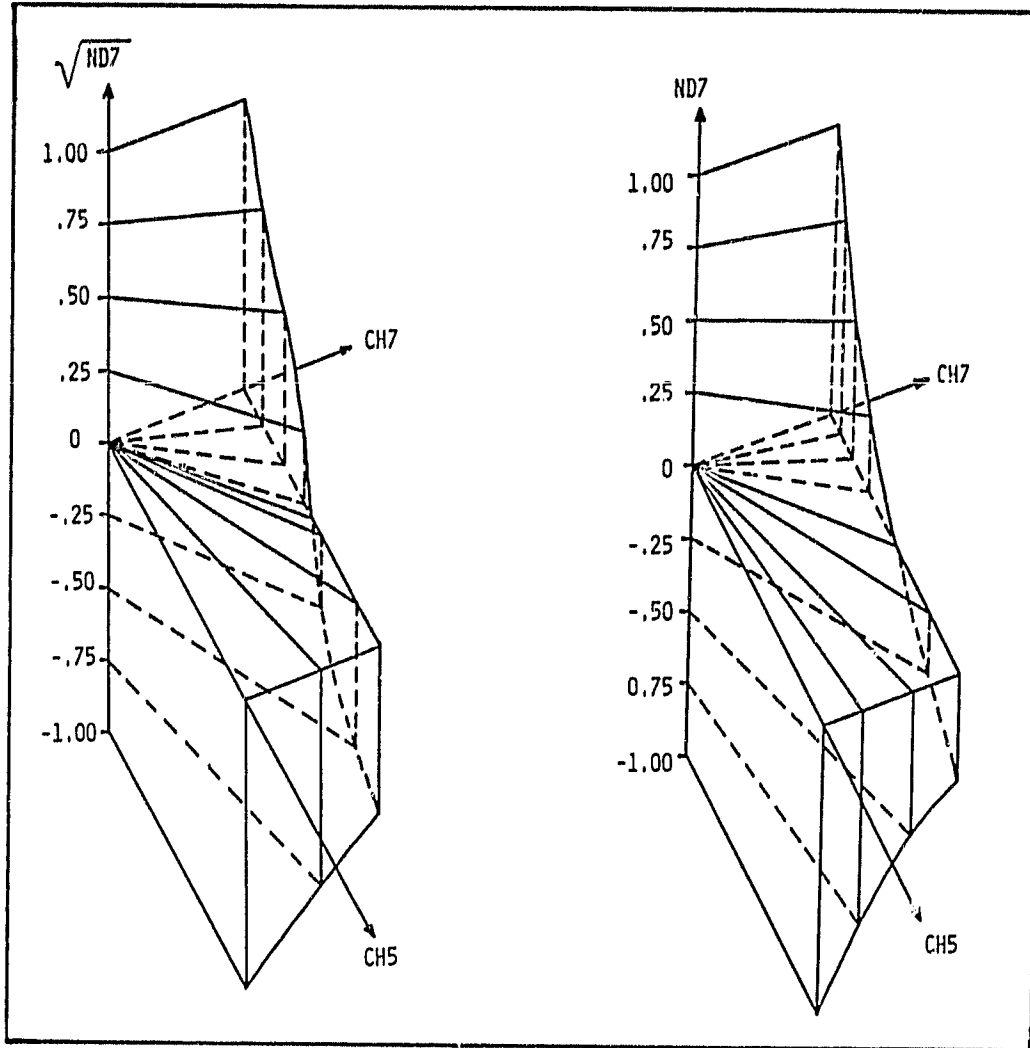
Part 1. Graphical representation of response surfaces and equivalent classes associated with VIs involving two MSS channels.

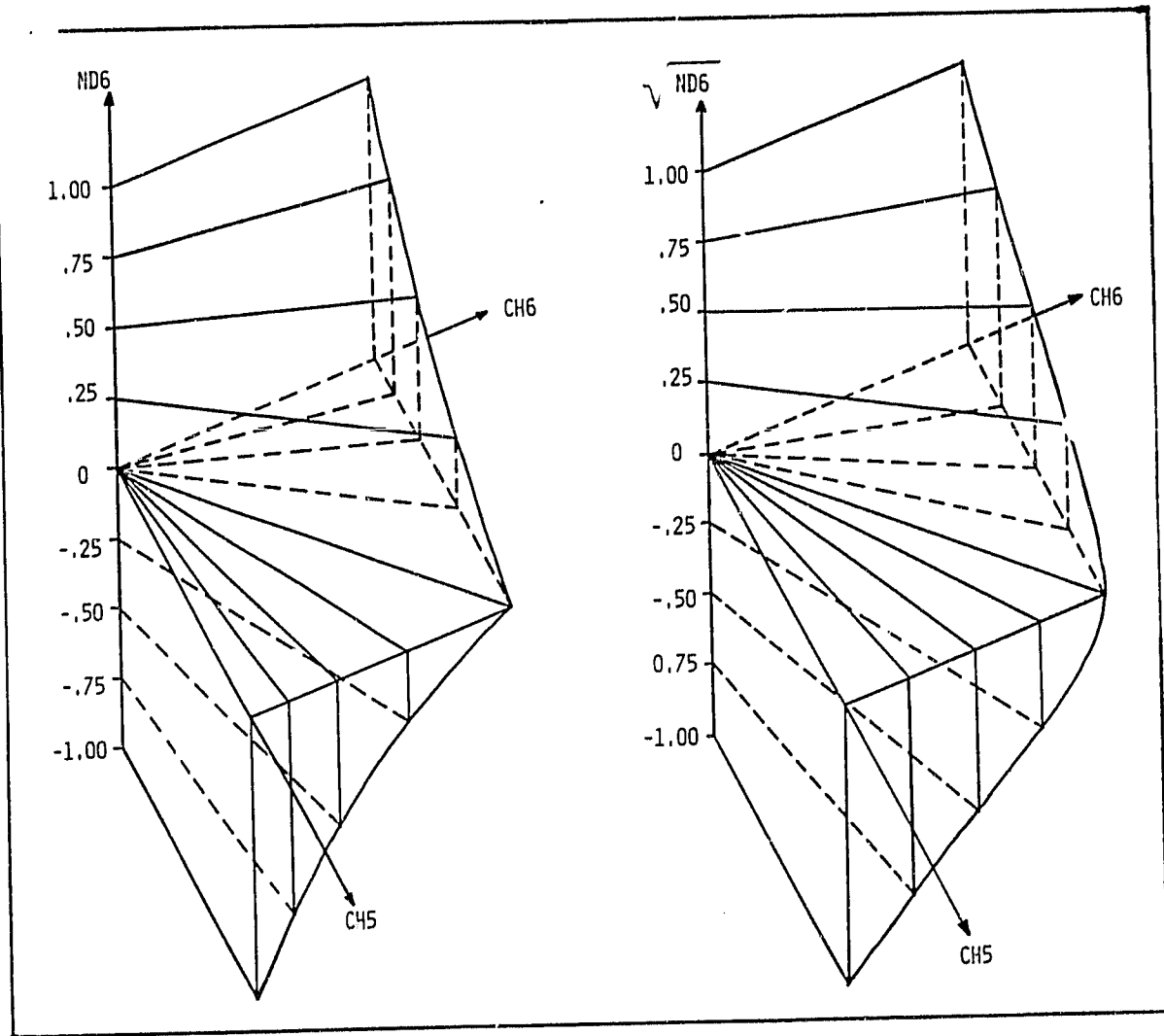
Graphs for the square root of ND6 and ND7 are included in this appendix. They probably have been studied by other investigators; however, we found no specific reference to them.











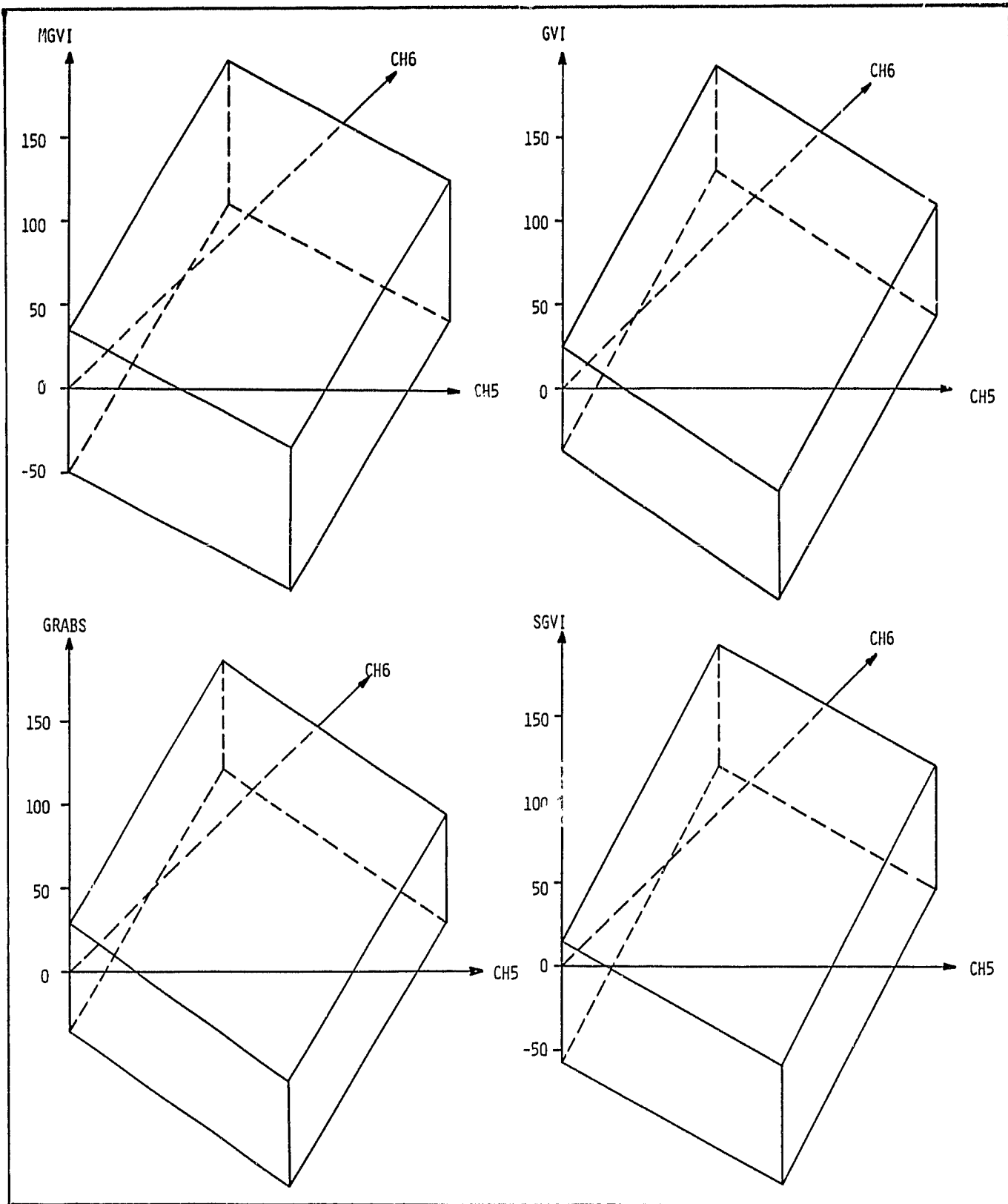
C-2

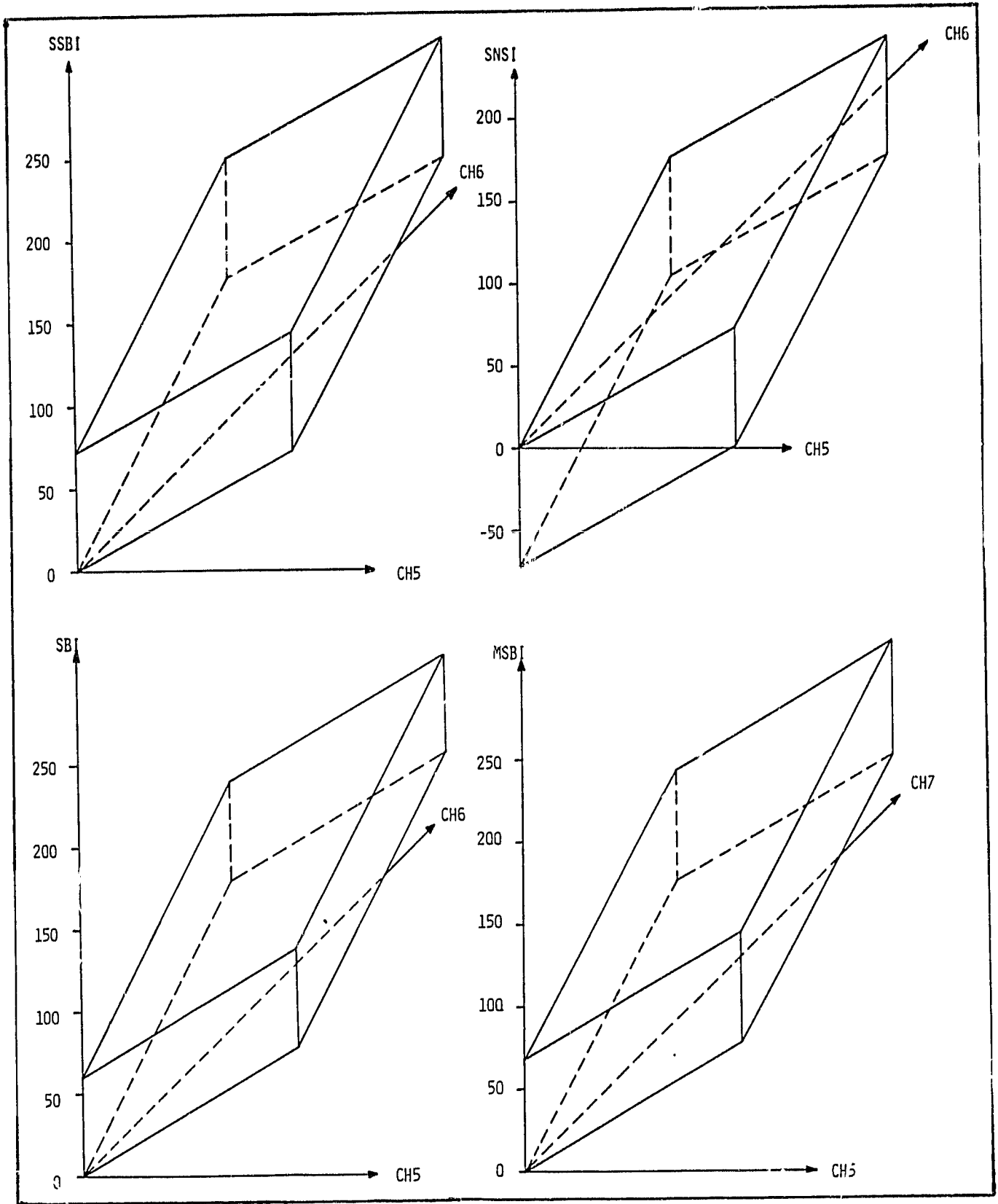
## APPENDIX C

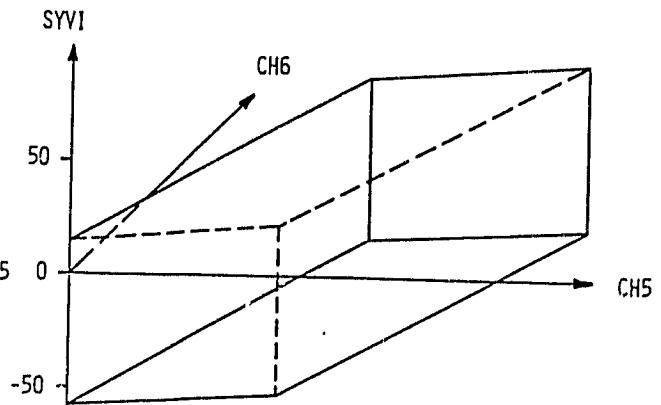
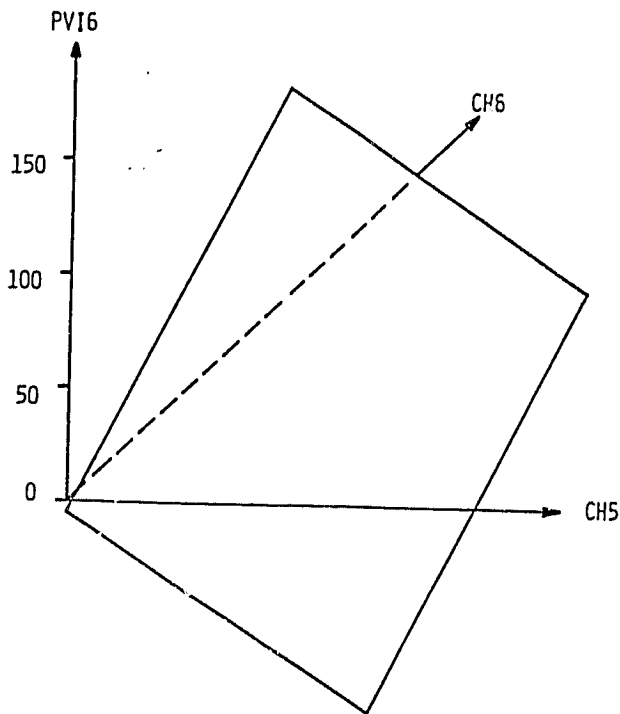
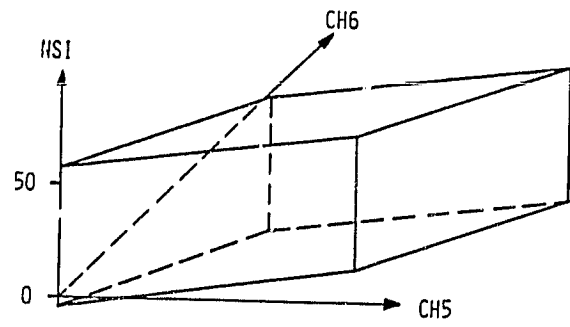
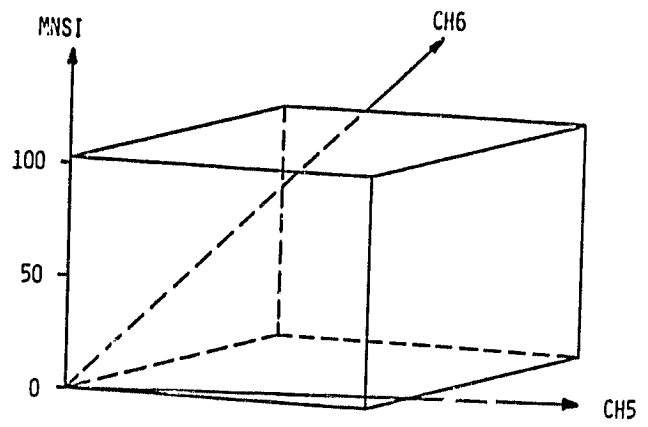
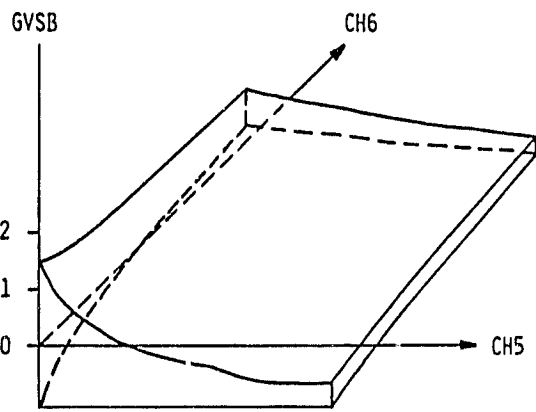
### GRAPHICAL REPRESENTATION OF VEGETATION INDICES

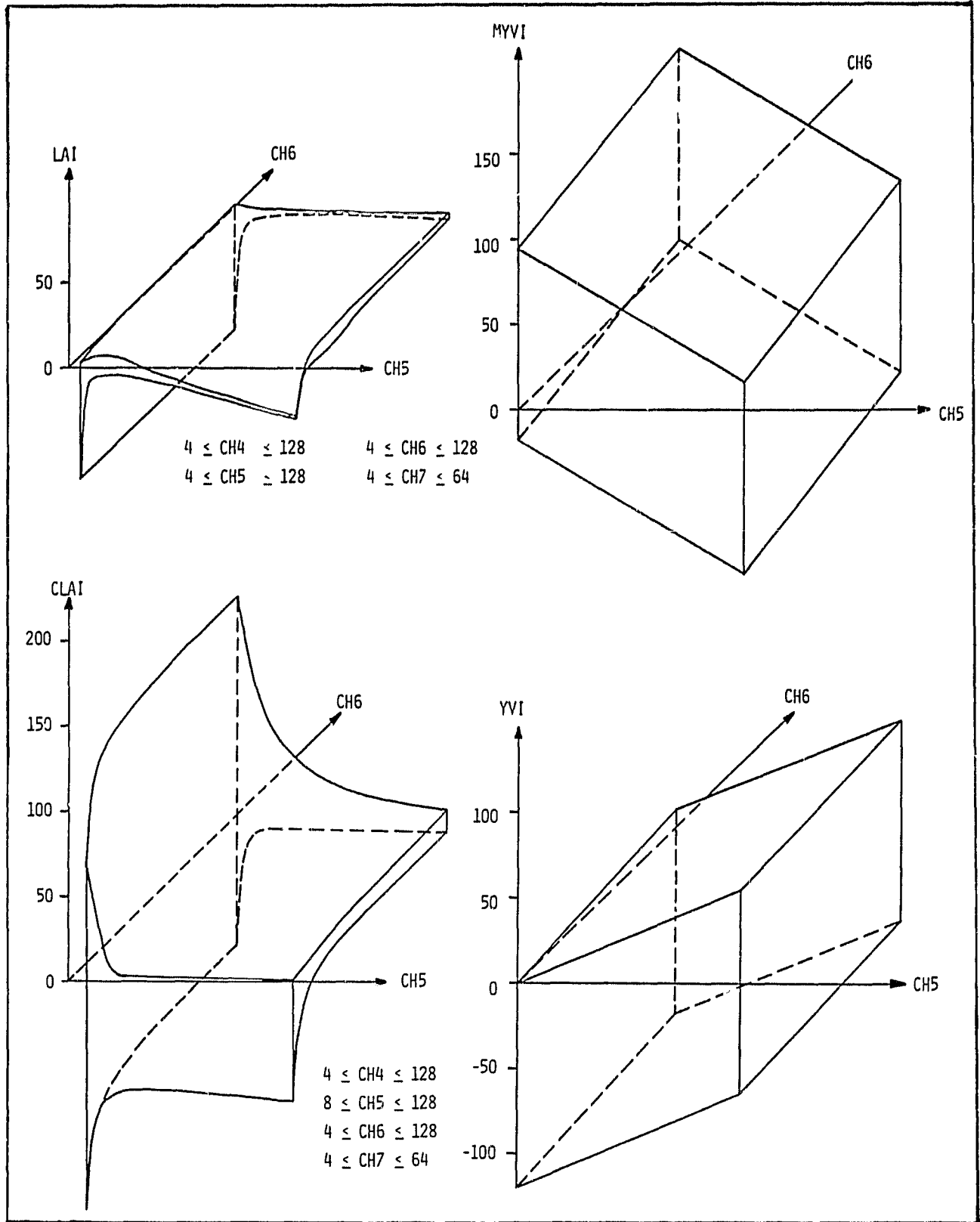
#### Part 2. Generalized representation of VIs involving more than two MSS channels.

Representation in 3 dimension of vegetative indices involving more than two MSS channels is not possible. However, insight into this behavior is obtained by studying their range as a function of two MSS channels. In these graphs, the VI's range is represented on the vertical axis for fixed two-dimensional subsets of the MSS data. Care should be used in interpreting these graphs, and consideration should be given to the high correlations that are known to exist between (CH4 and CH5) and (CH6 and CH7). Even with these limitations, these graphs show the close relationship between the soil brightness components and greenness components of the Kauth-Thomas and the two Misra-Wheeler transformations.

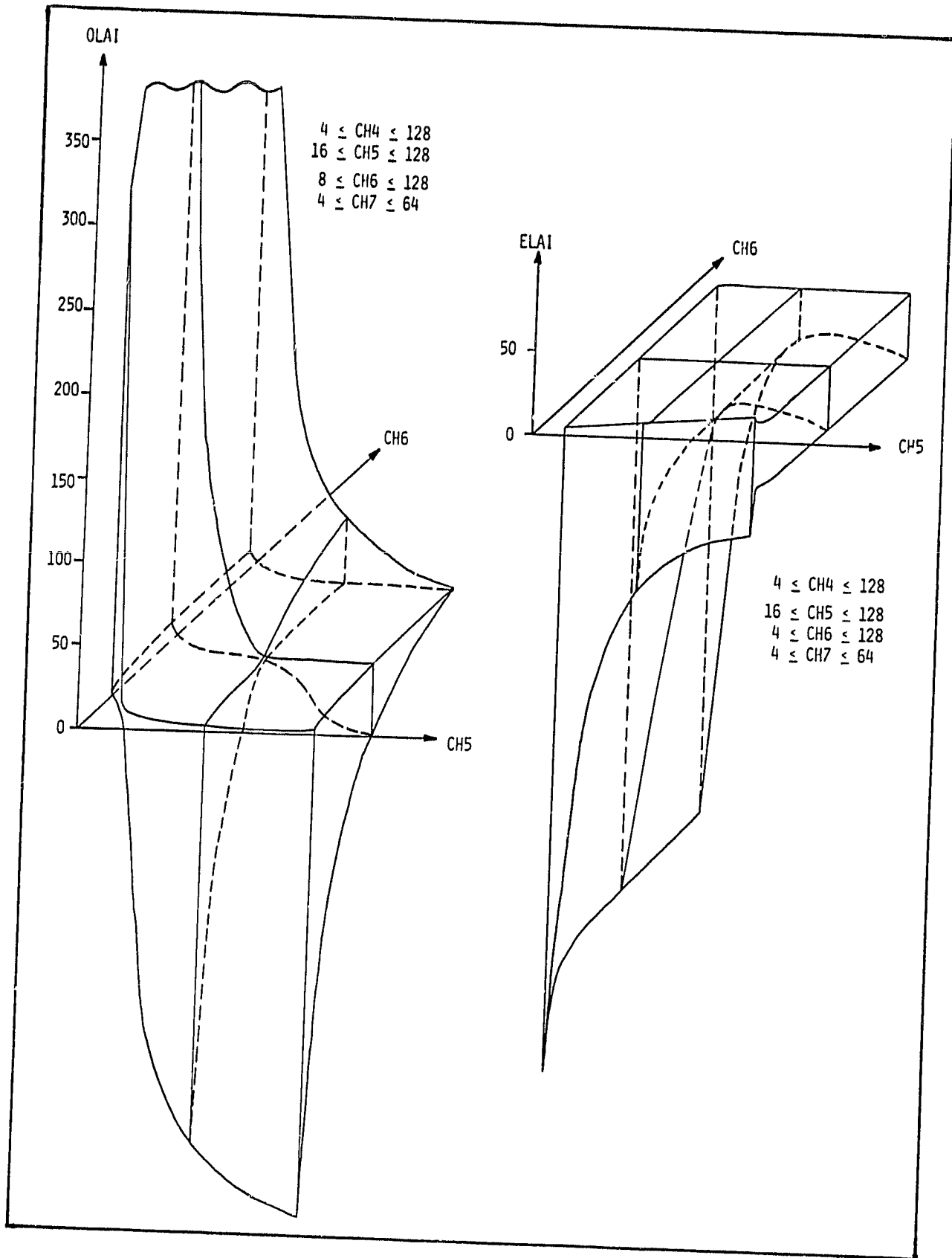


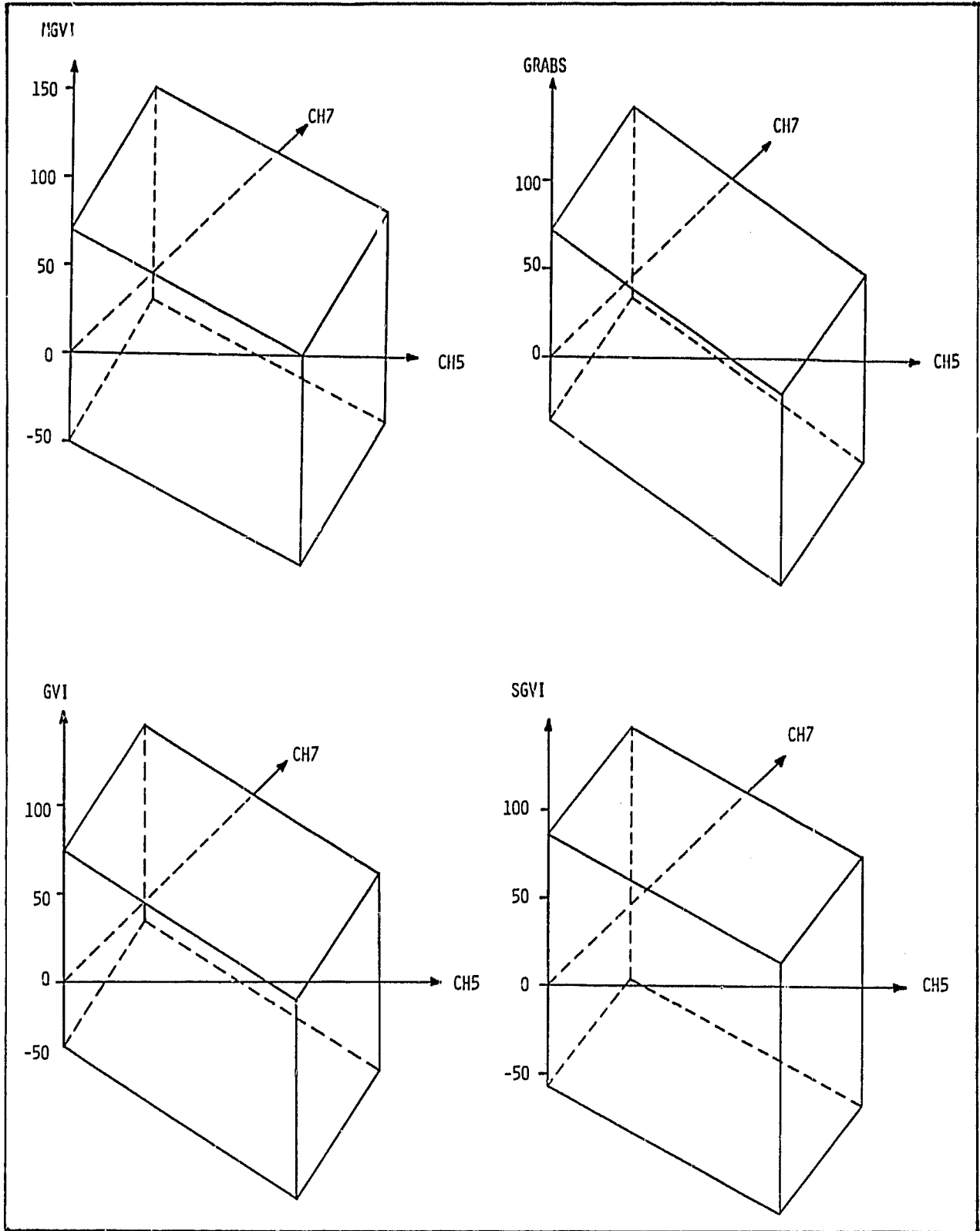


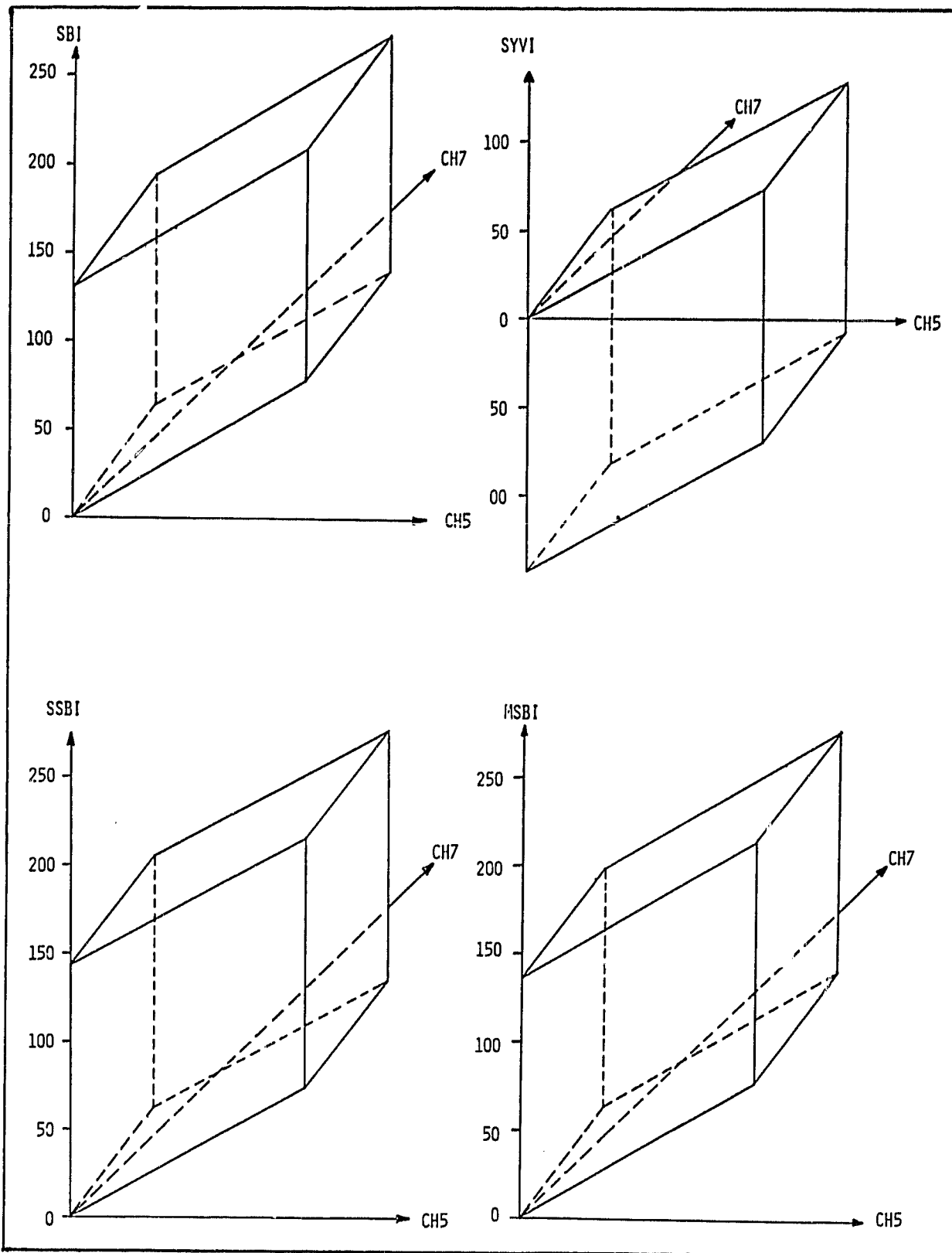


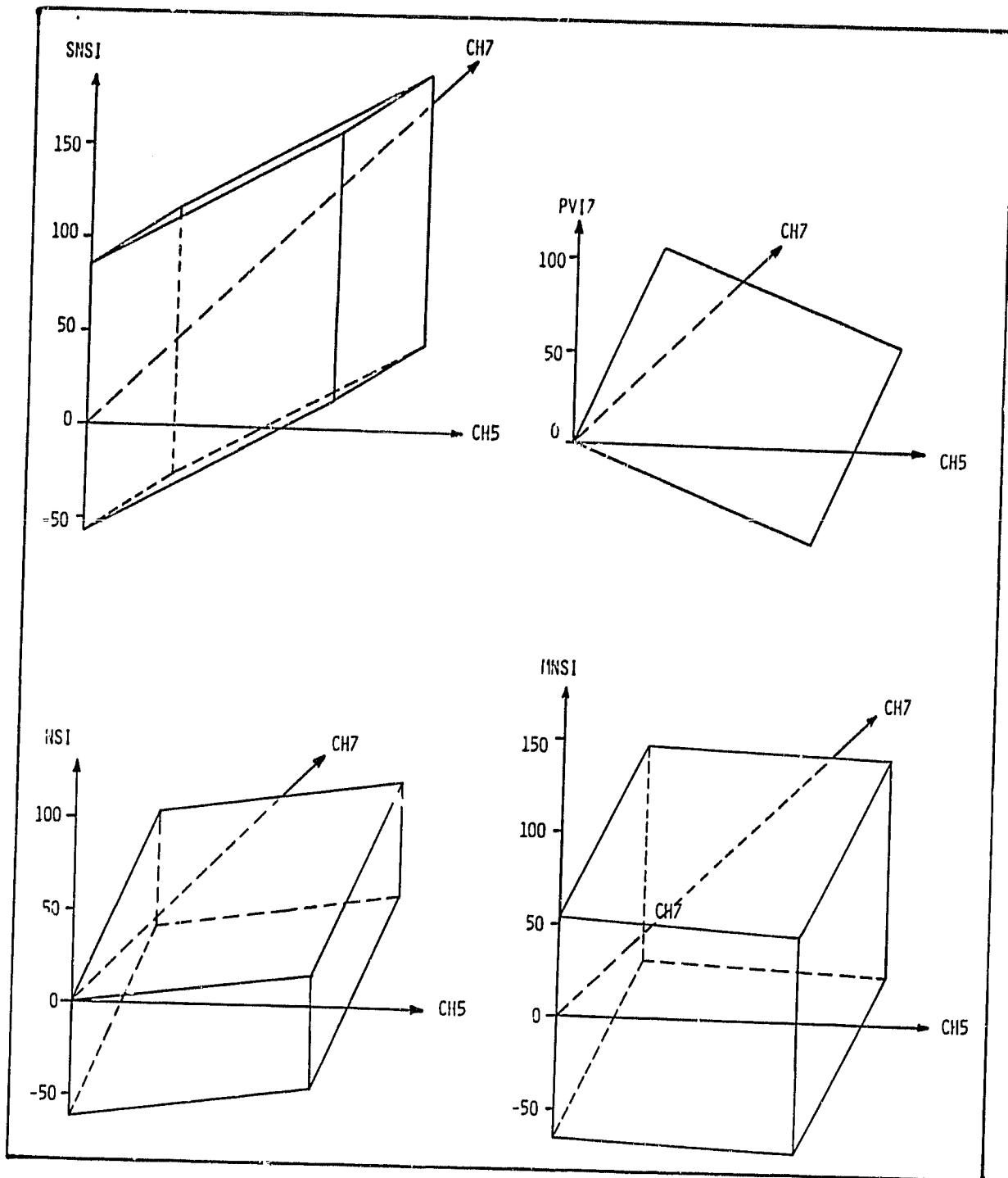


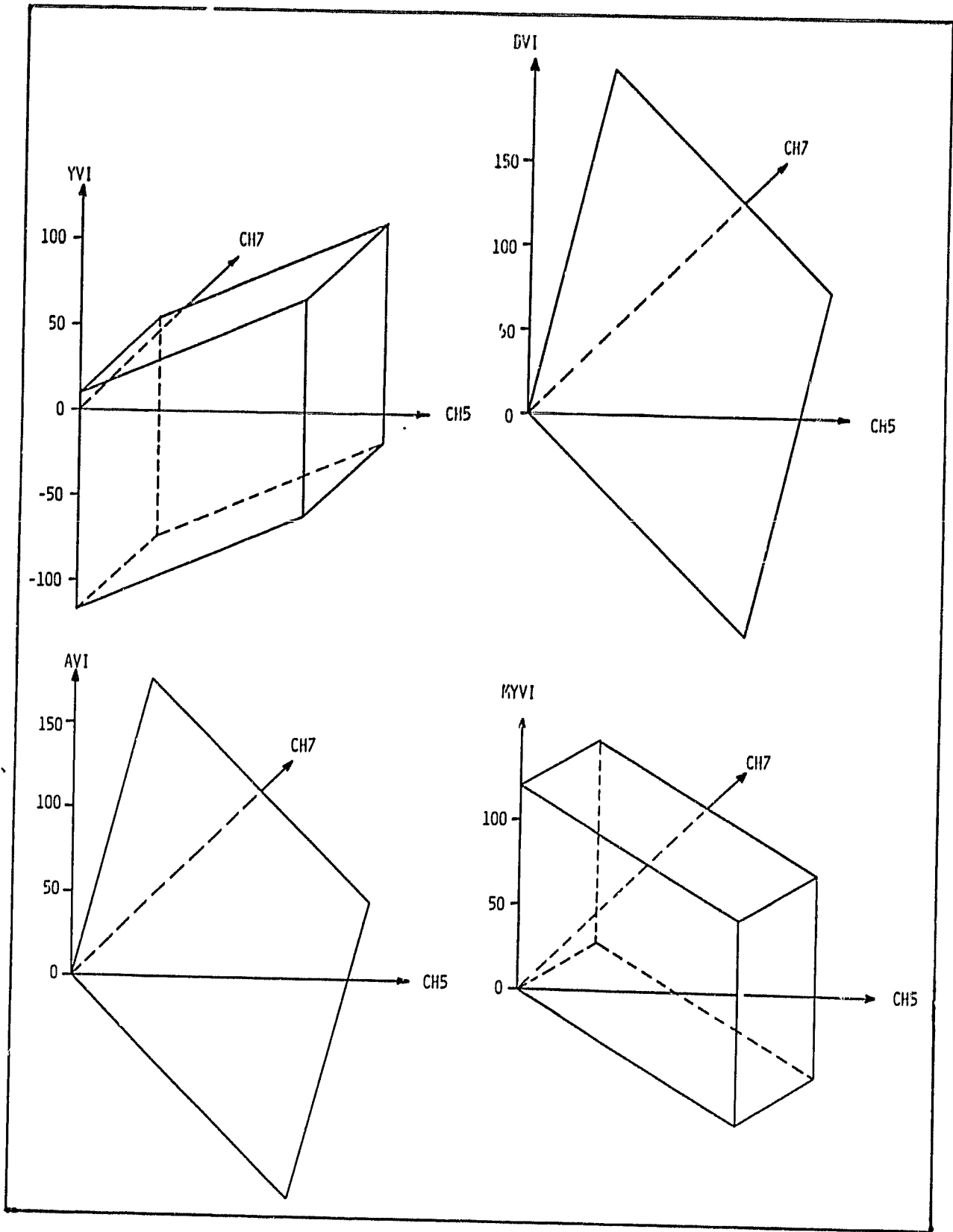












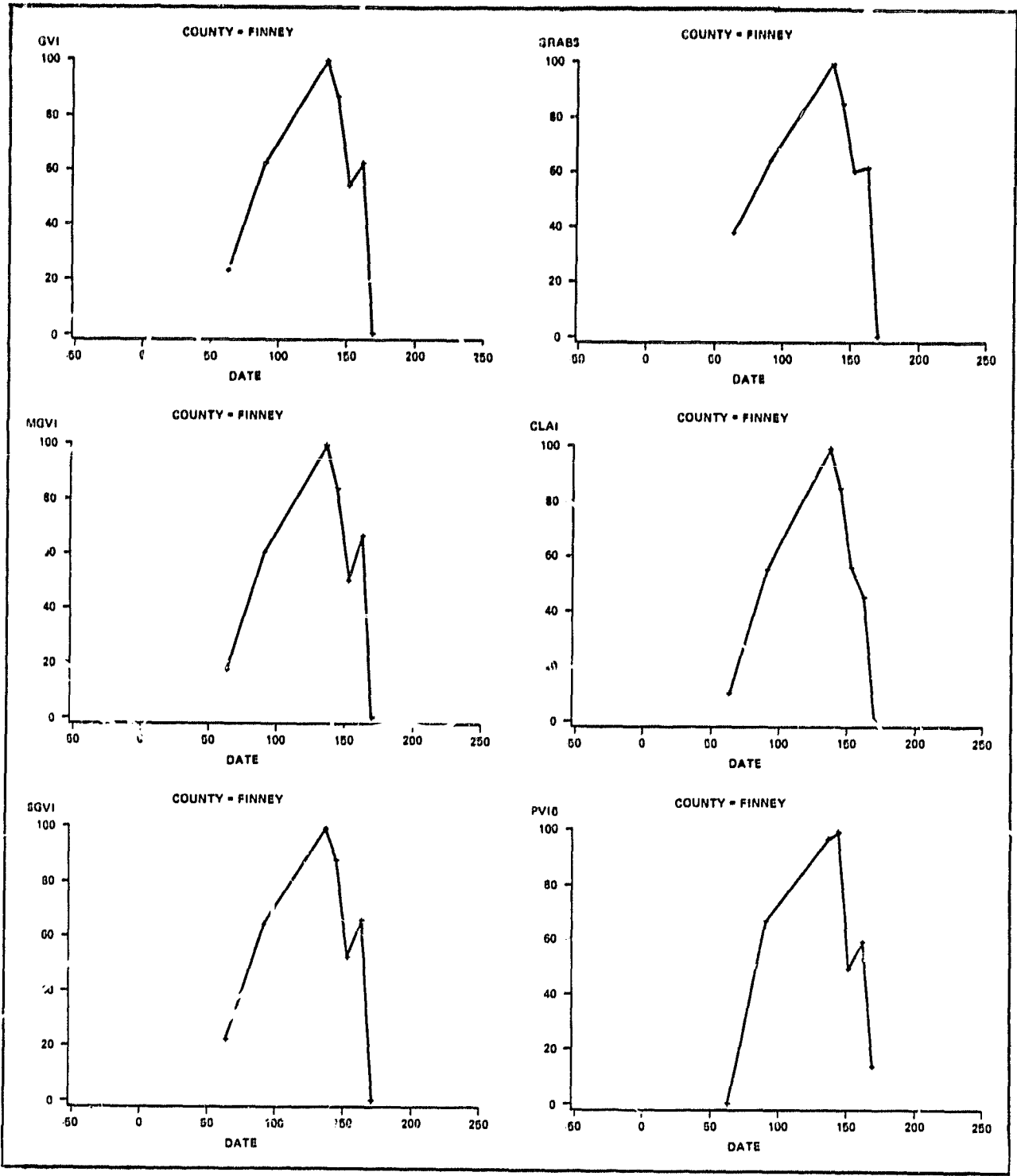
## APPENDIX D

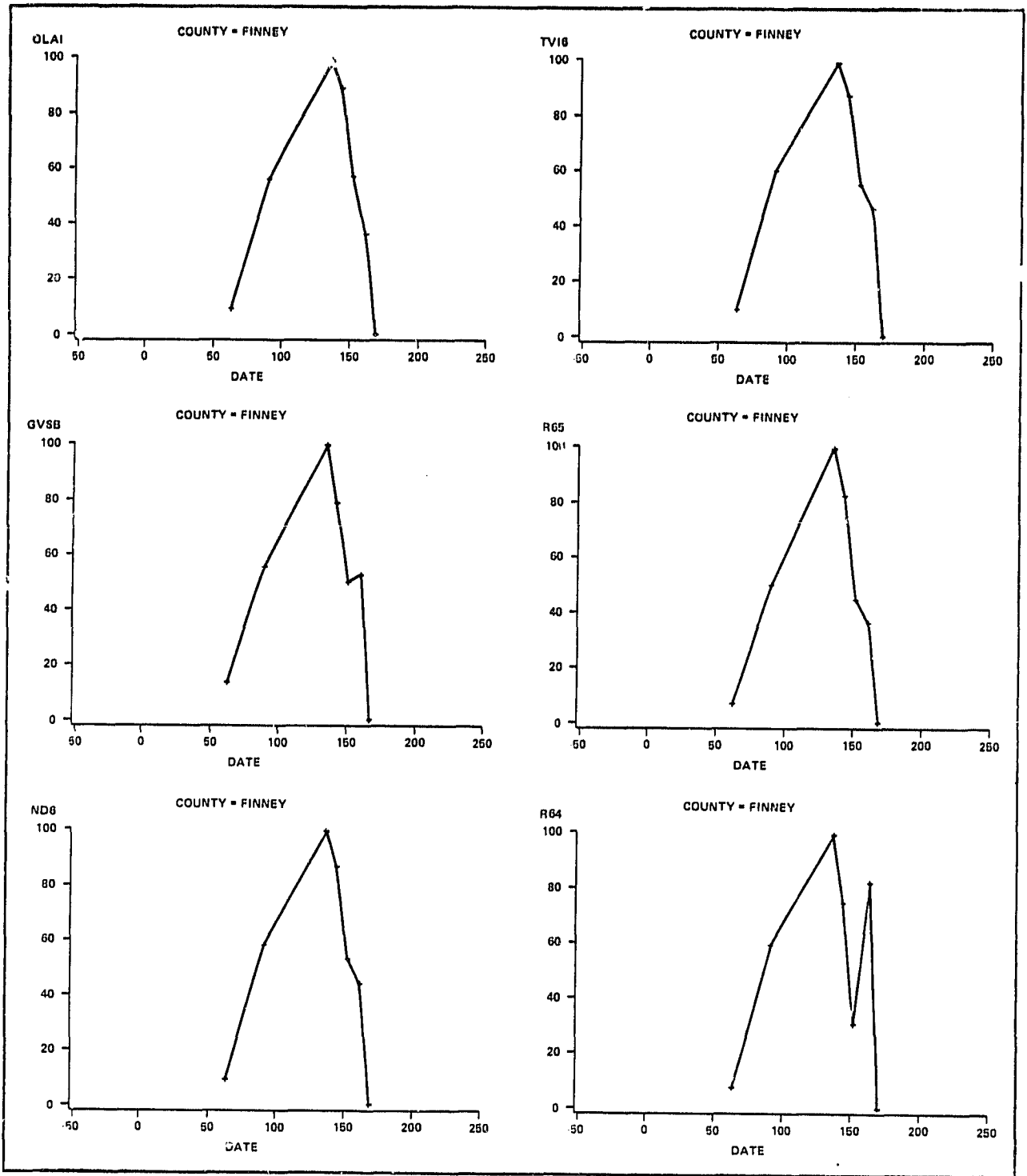
### VEGETATION INDICES TRAJECTORIES

It is well known that two quantities may be functionally related and yet have zero linear correlation. This possibility was studied by graphing VIs over time. All VIs were rescaled to range from 0 to 100 to facilitate interpretations.

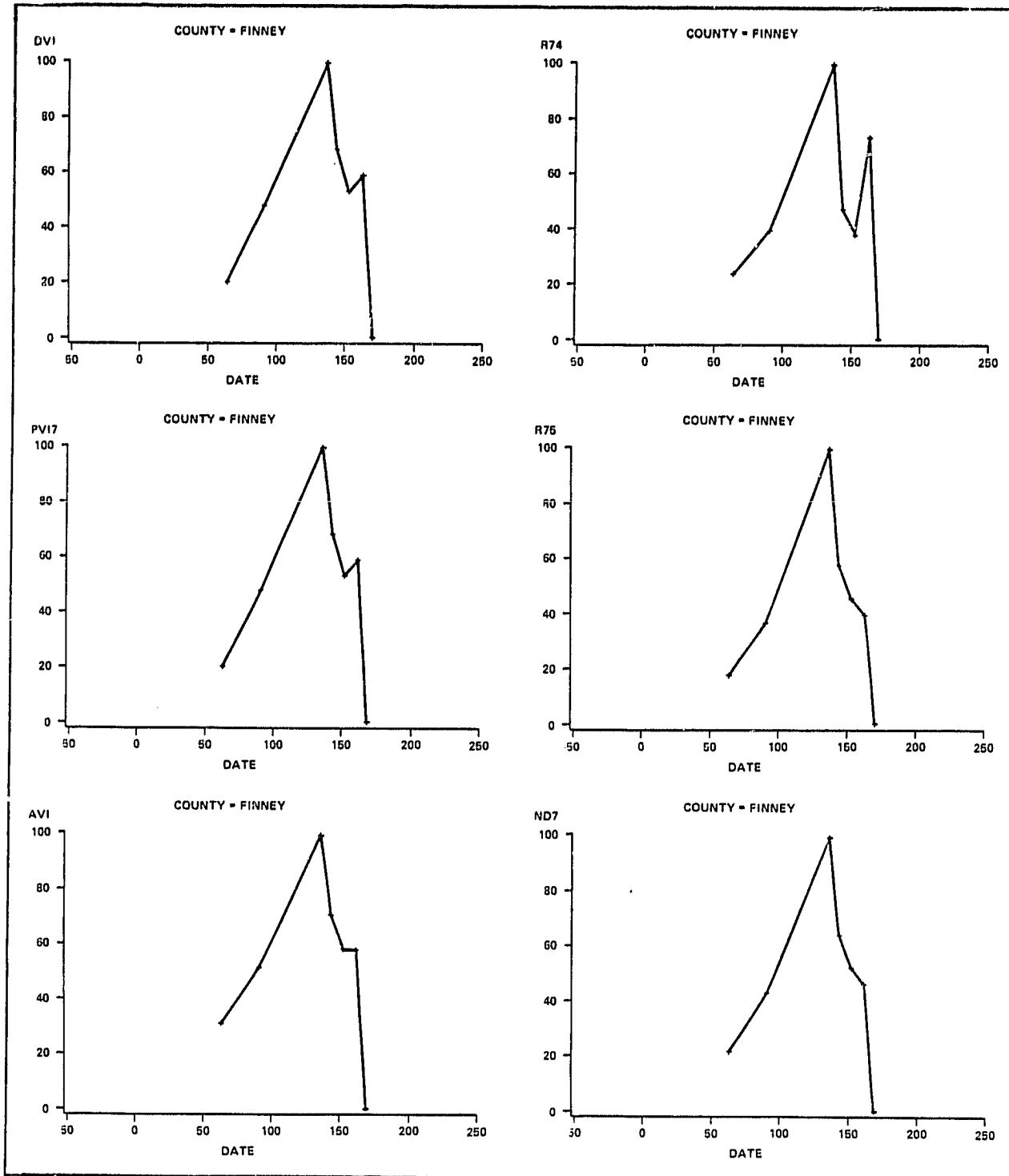
This analysis revealed that some VIs were more closely related than their bivariate correlations had indicated. In some cases, the relationships appear to be close but nonlinear; in others, the correlations break down outside the period of spring greenup to harvest.

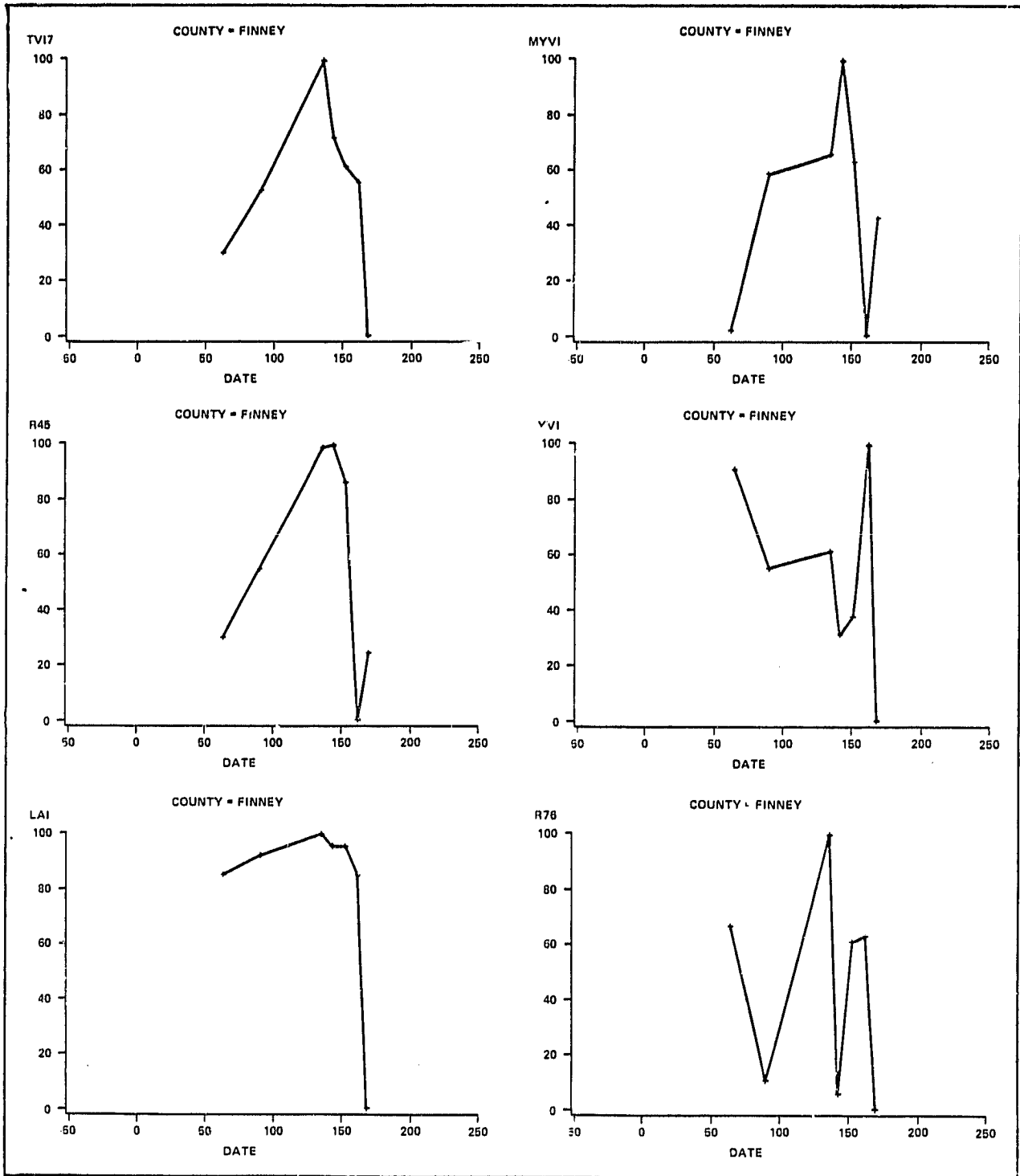
The graphs presented in this appendix are for the four sites with good acquisition histories (Yolo, Finney, Keith, and Grant counties). The trajectories are based on the field data described in Appendix A.

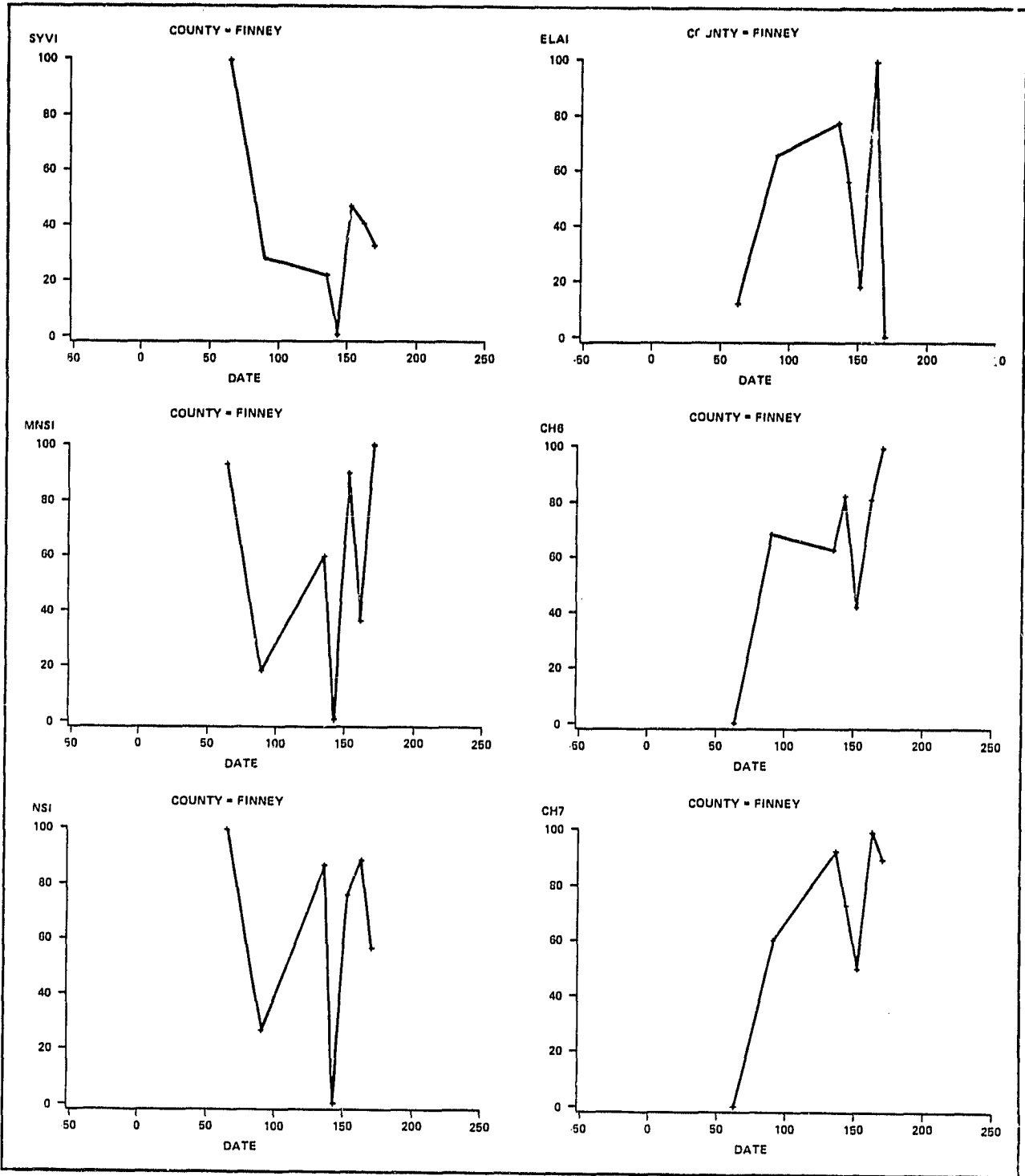


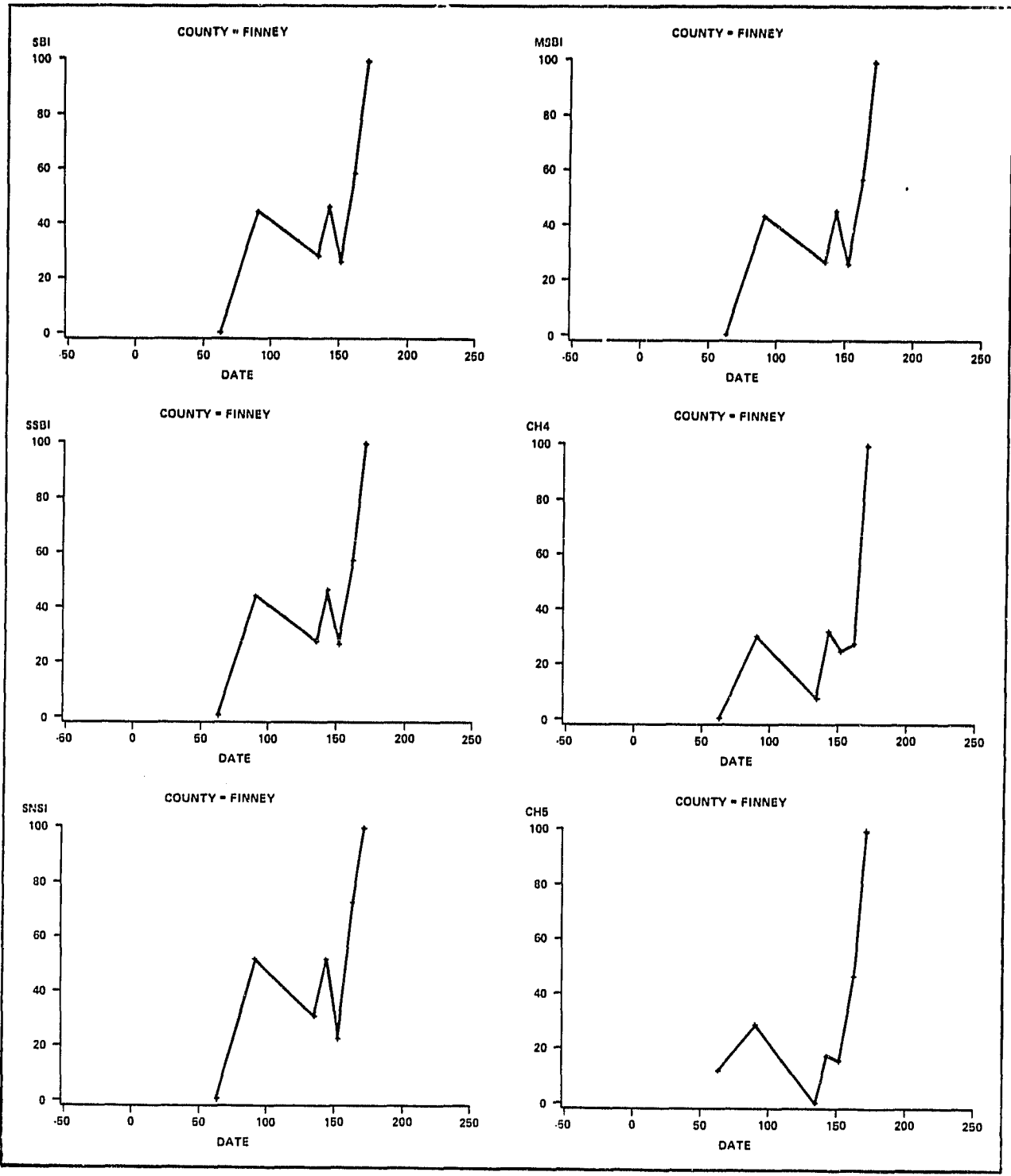


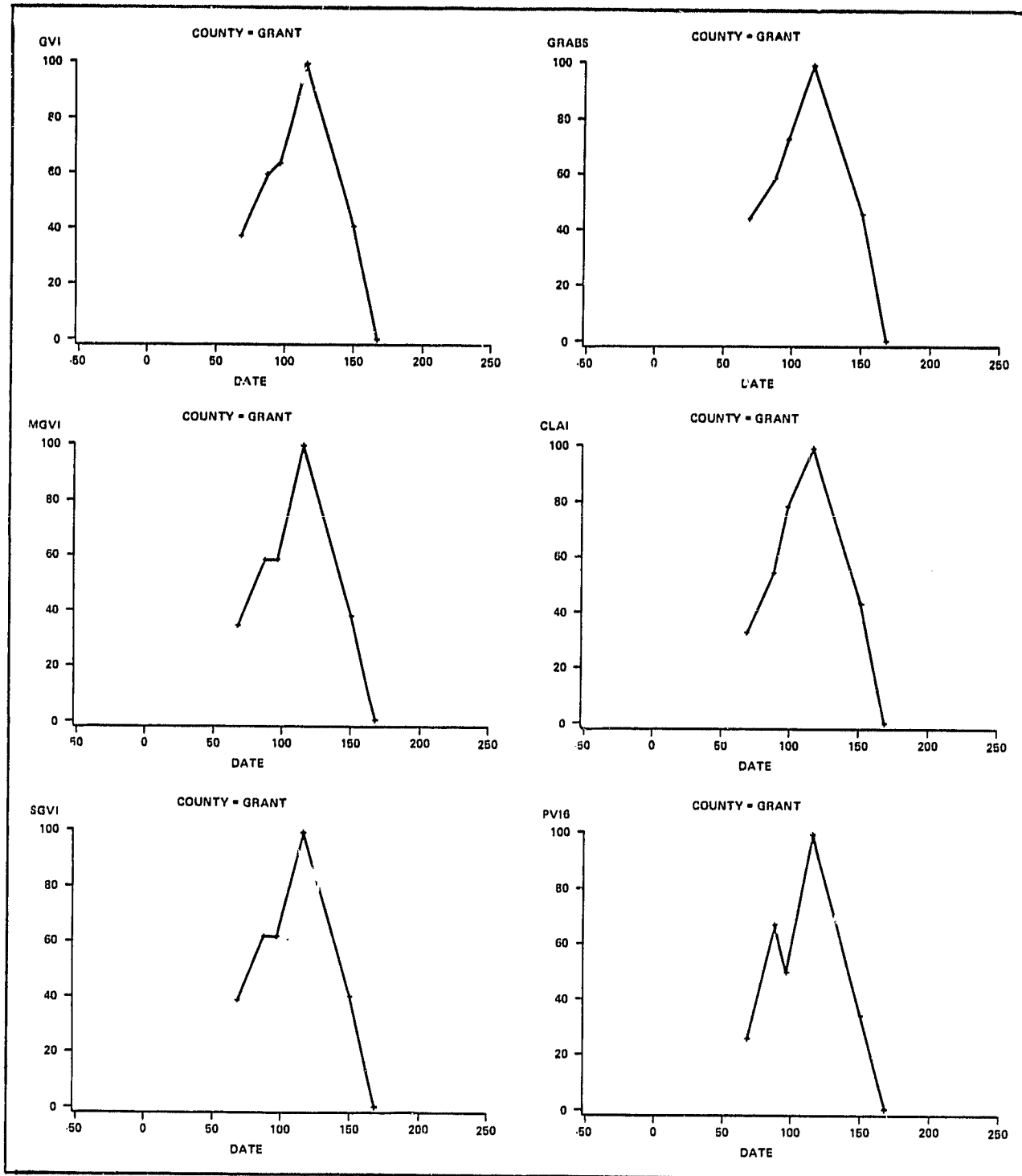


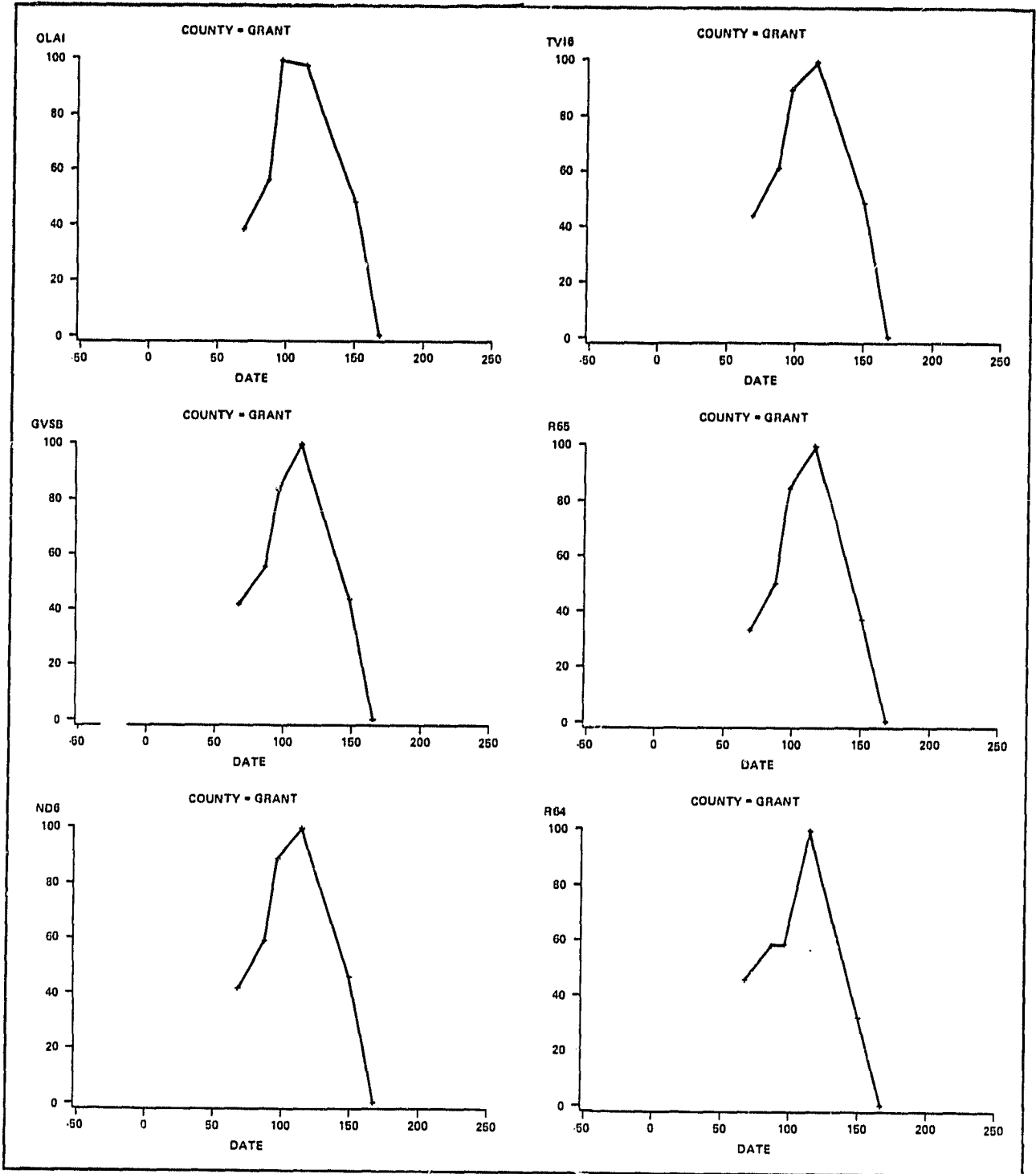


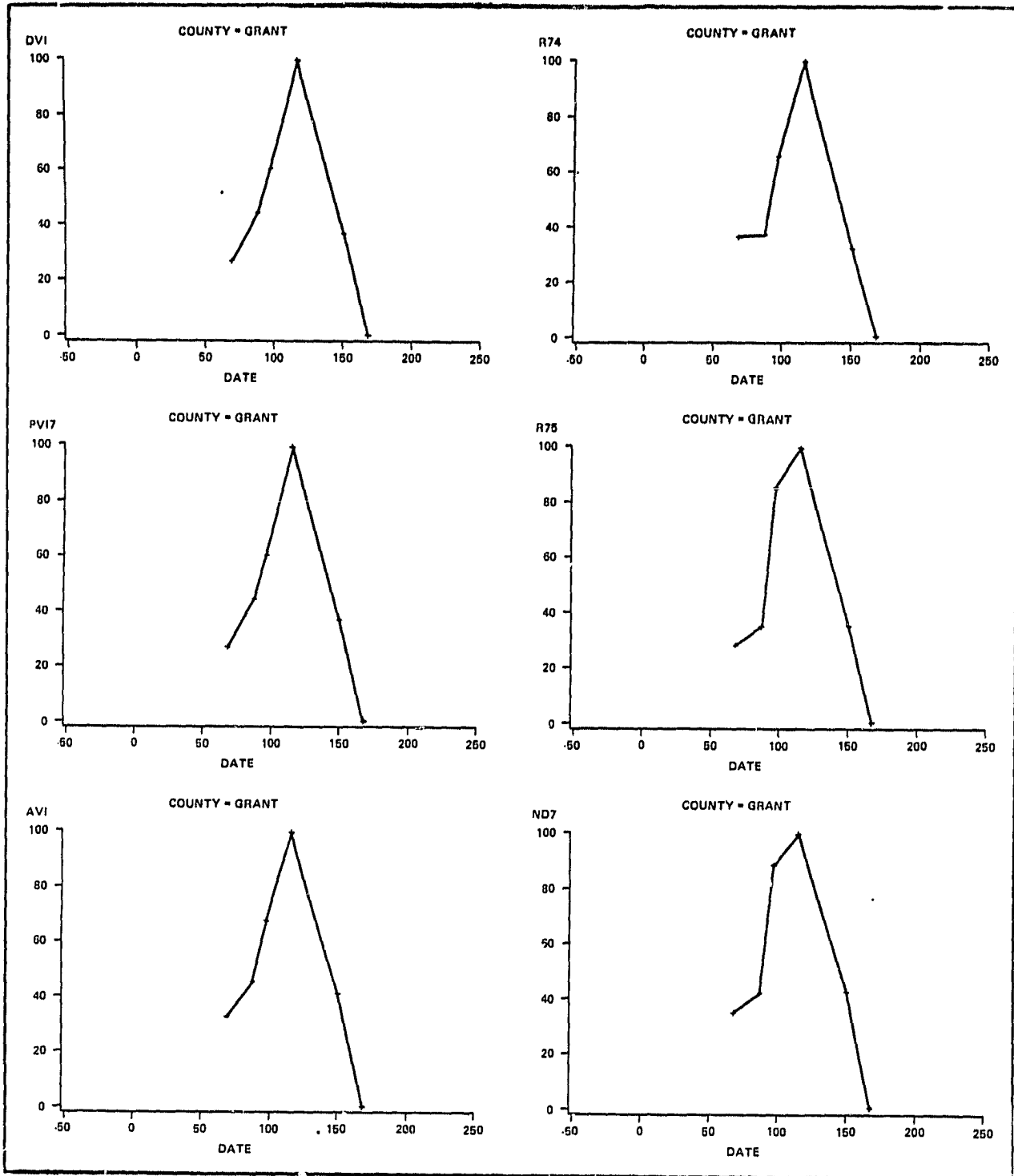


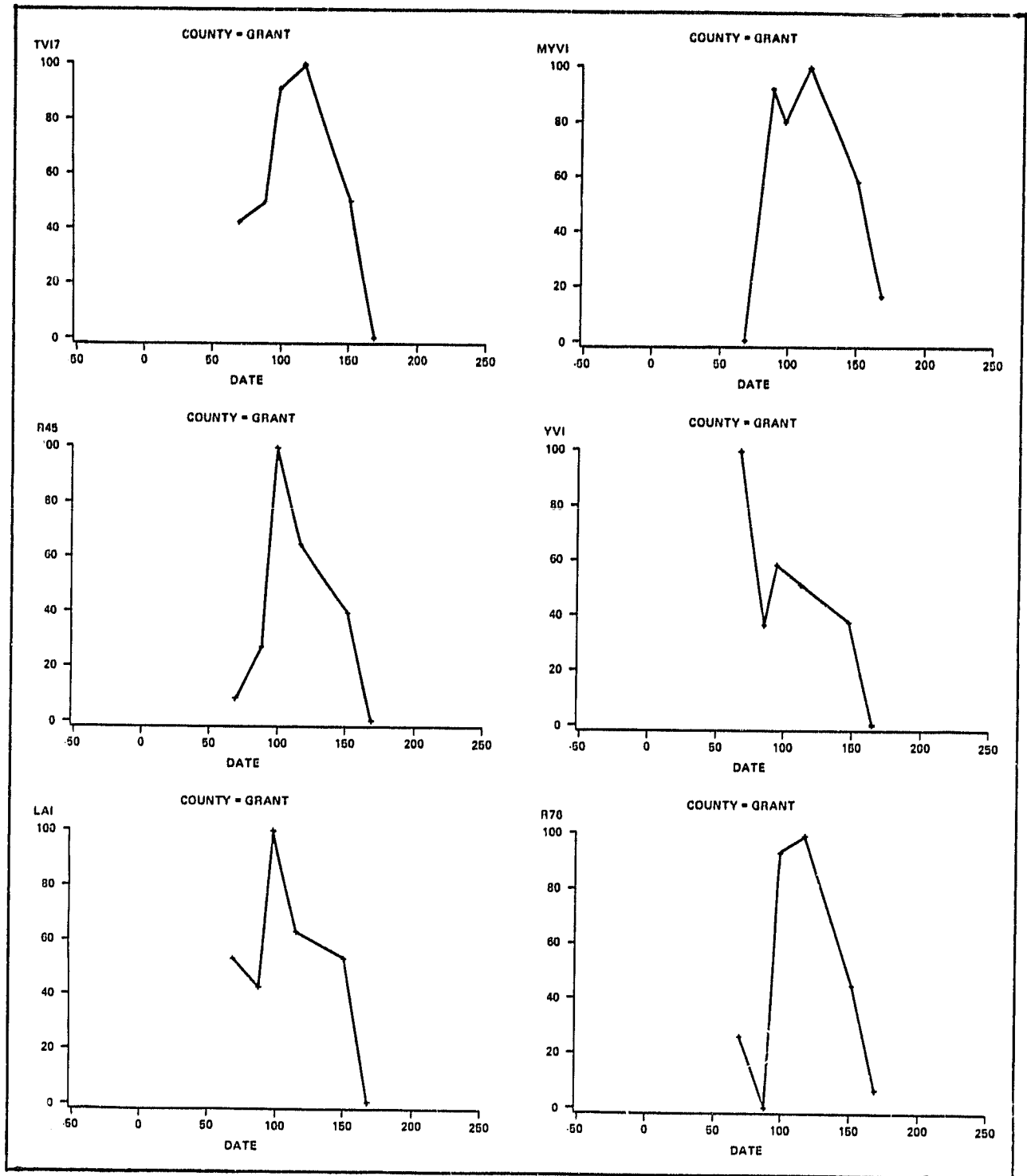




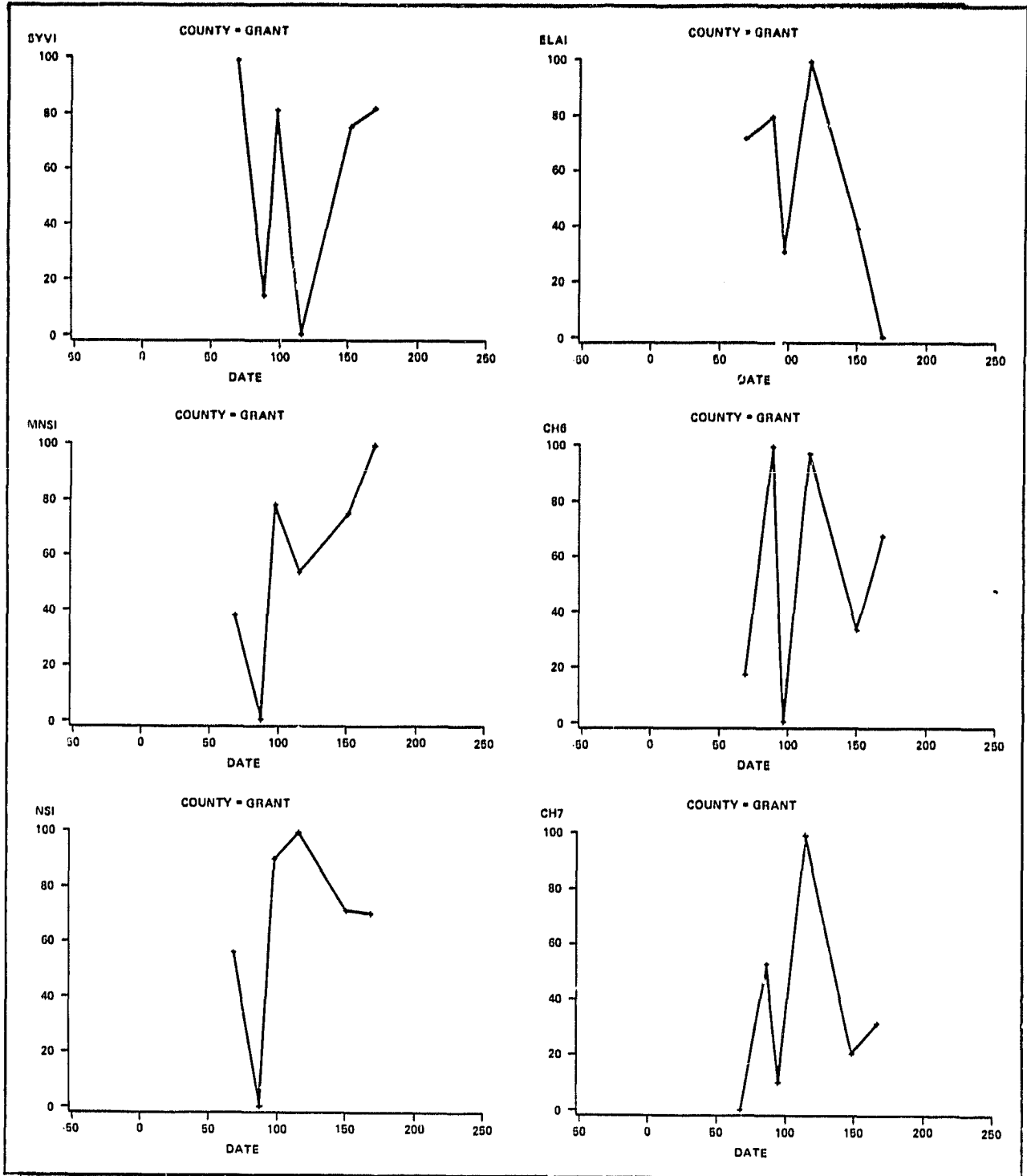


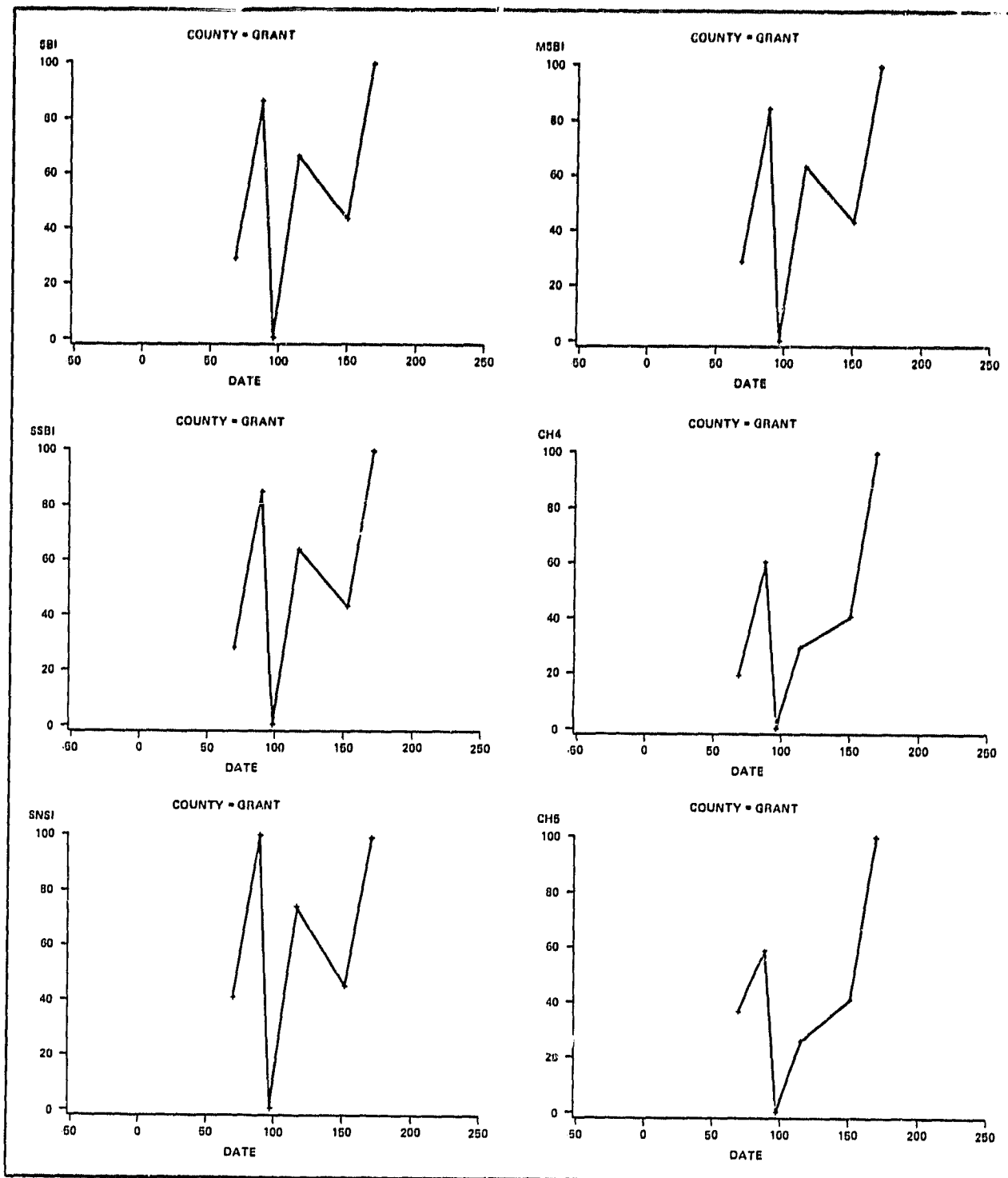


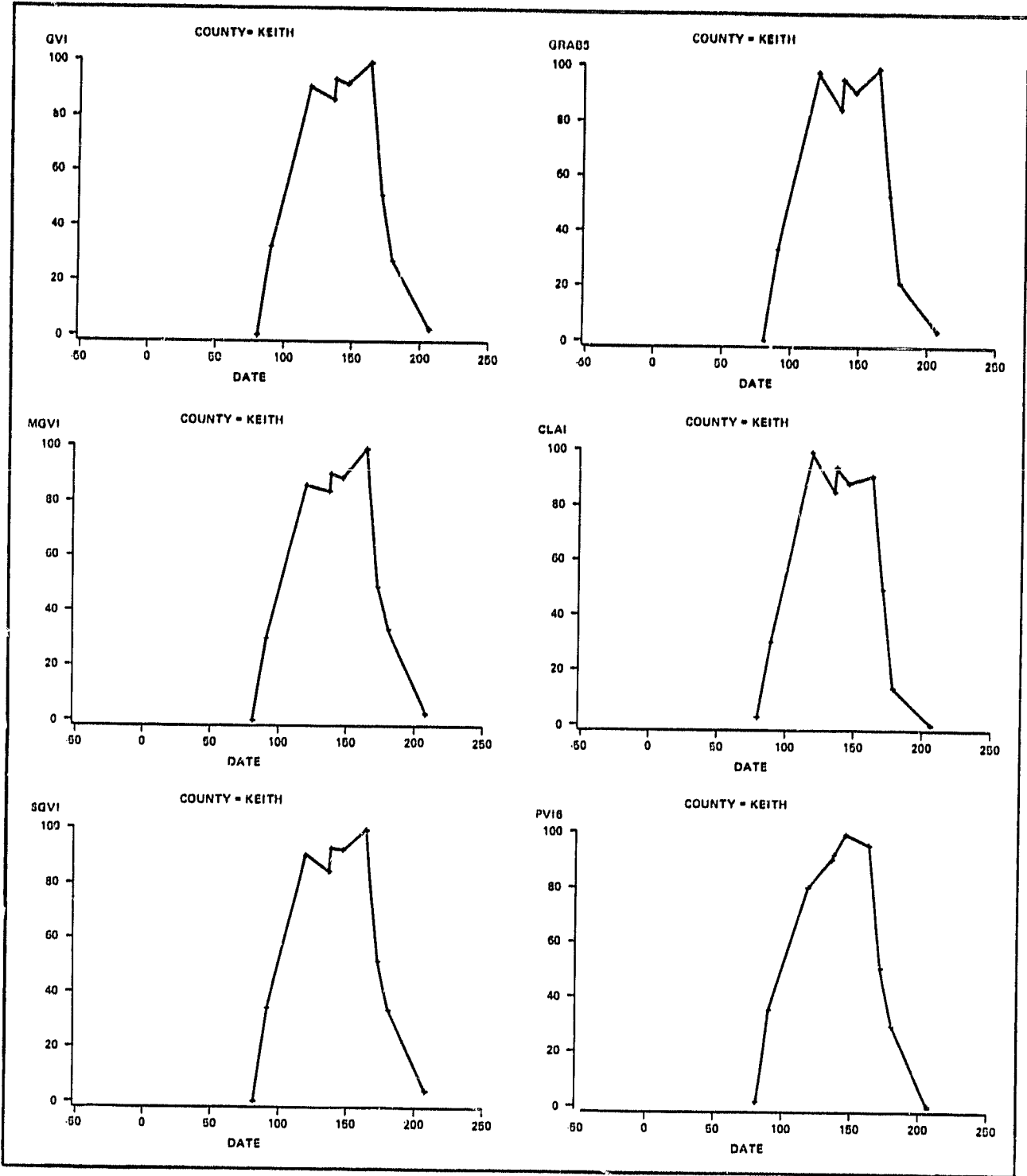


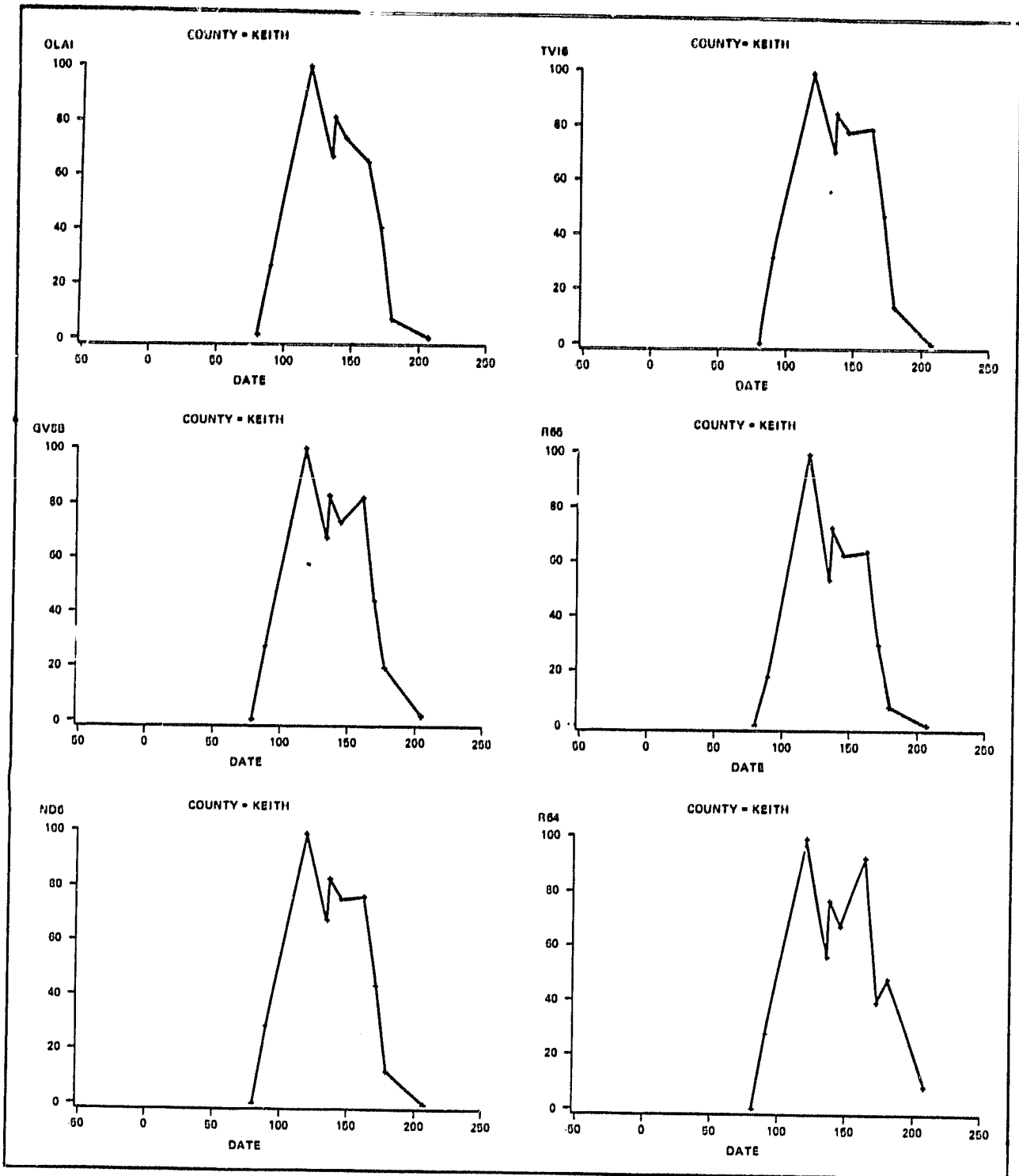


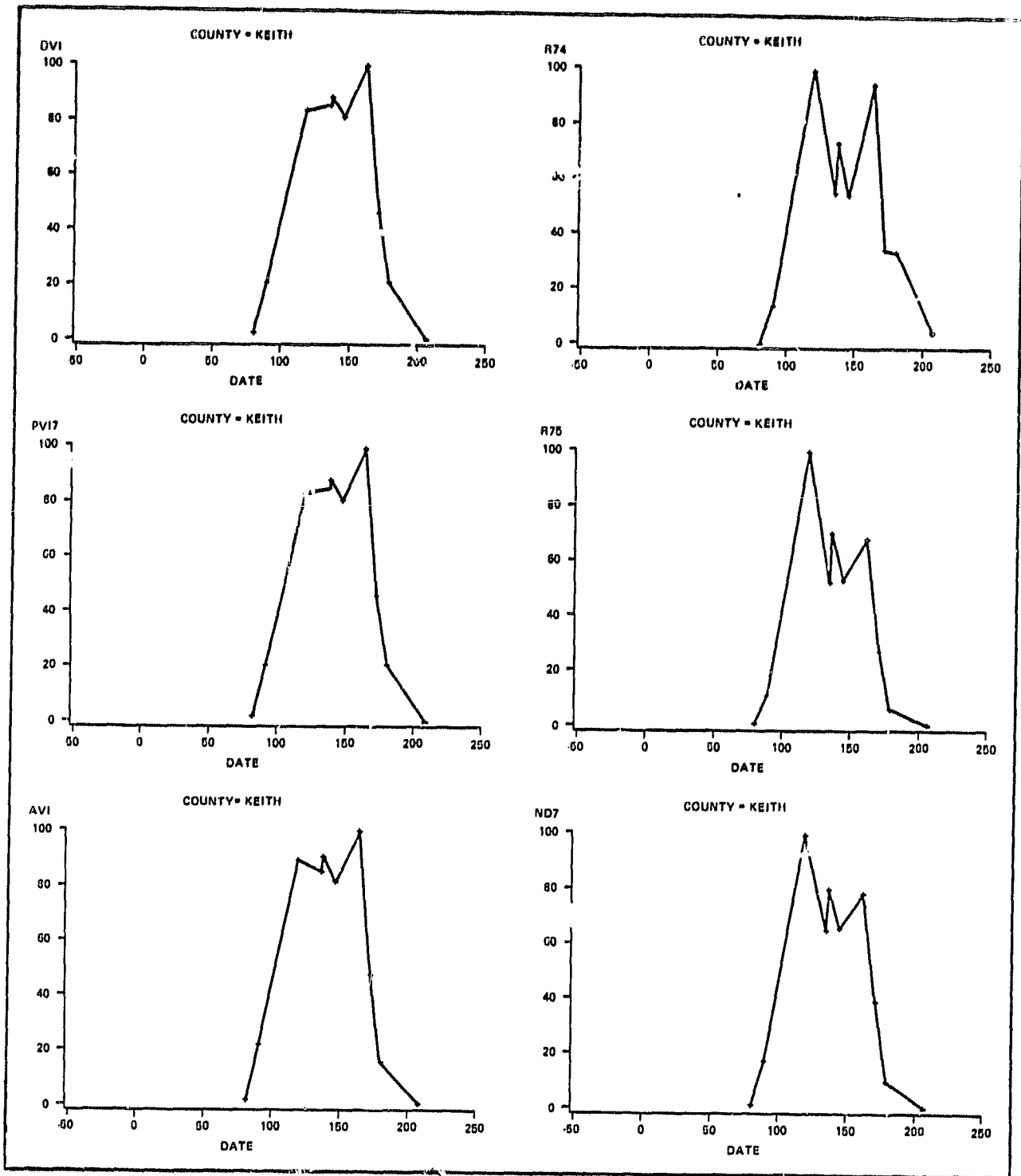


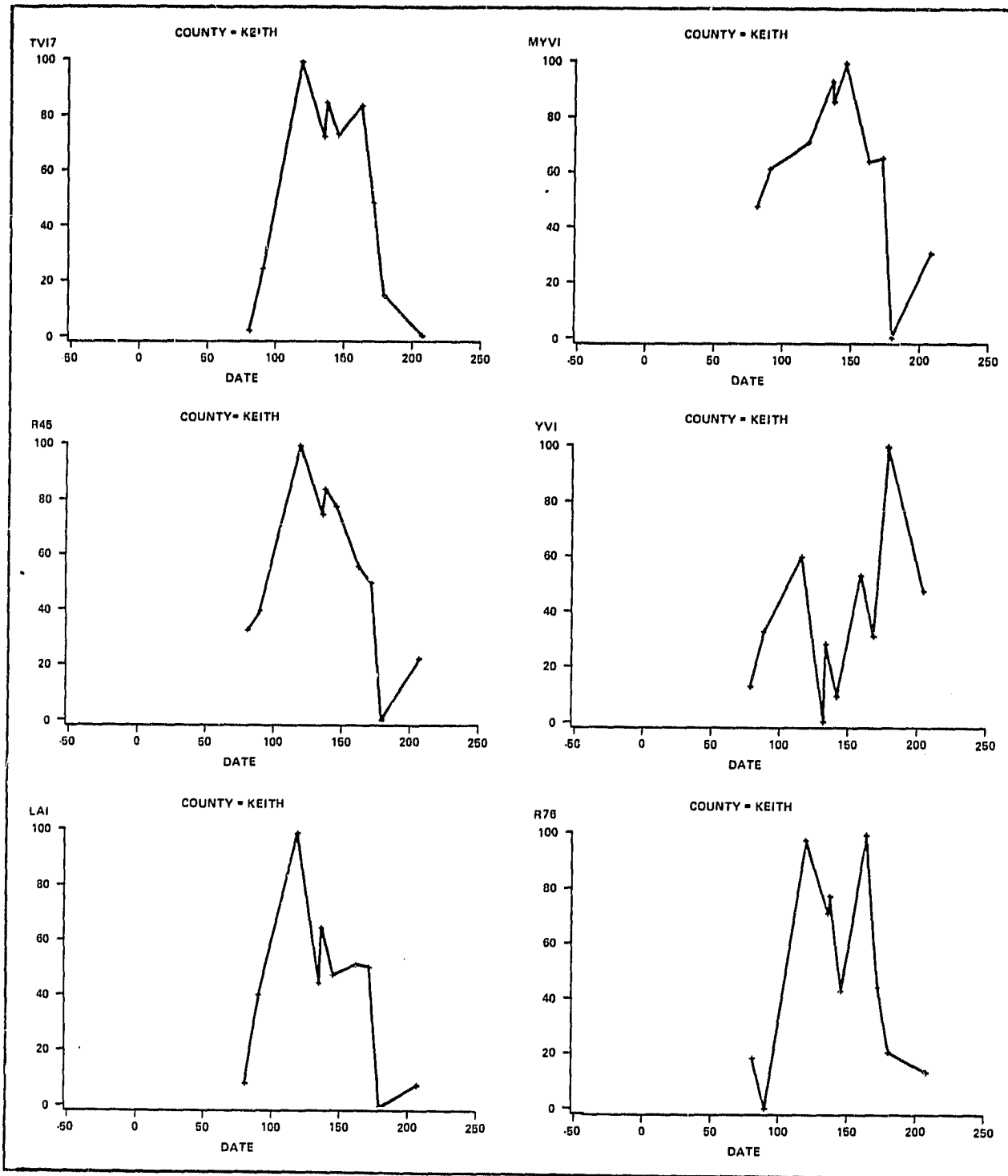


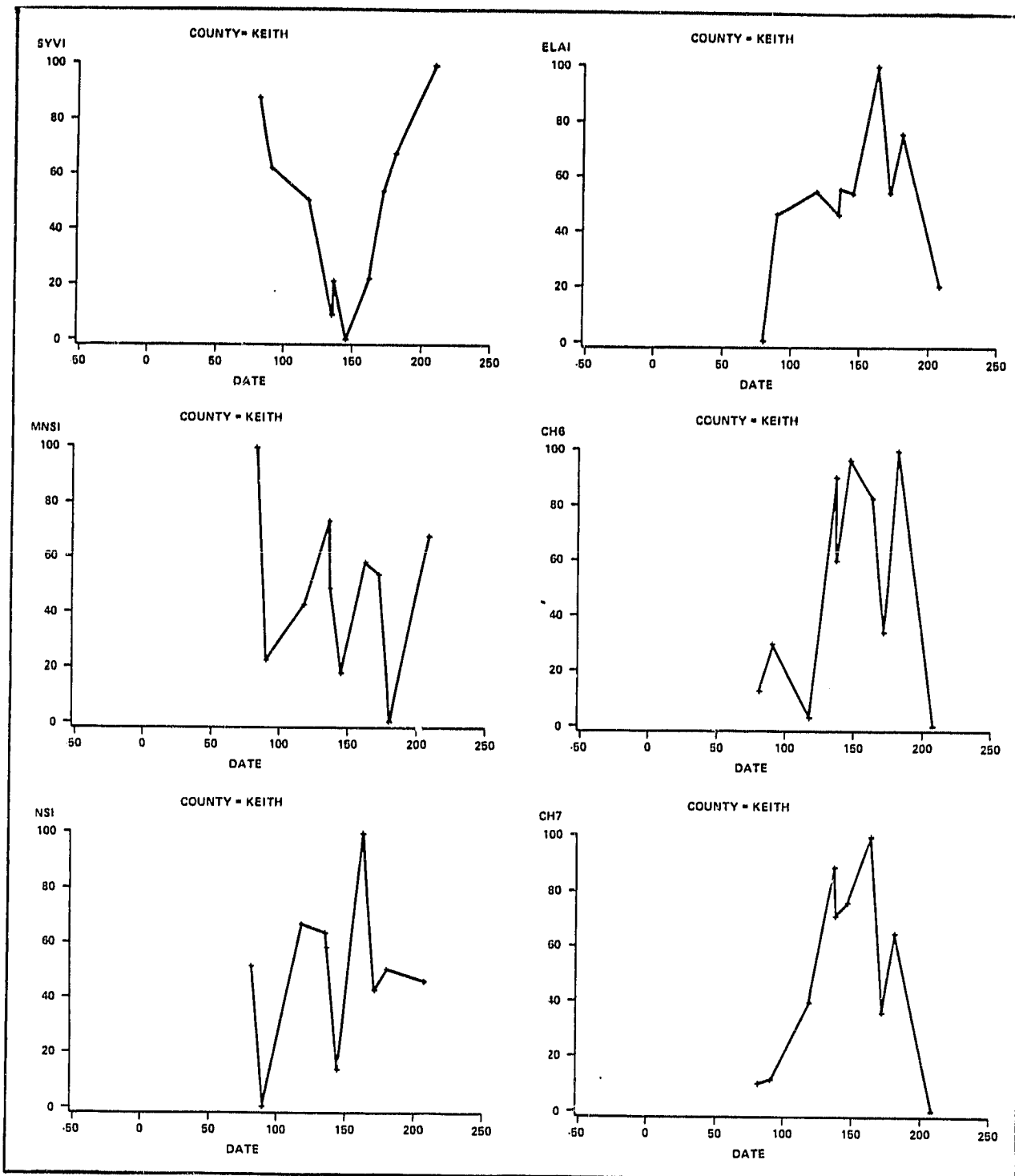


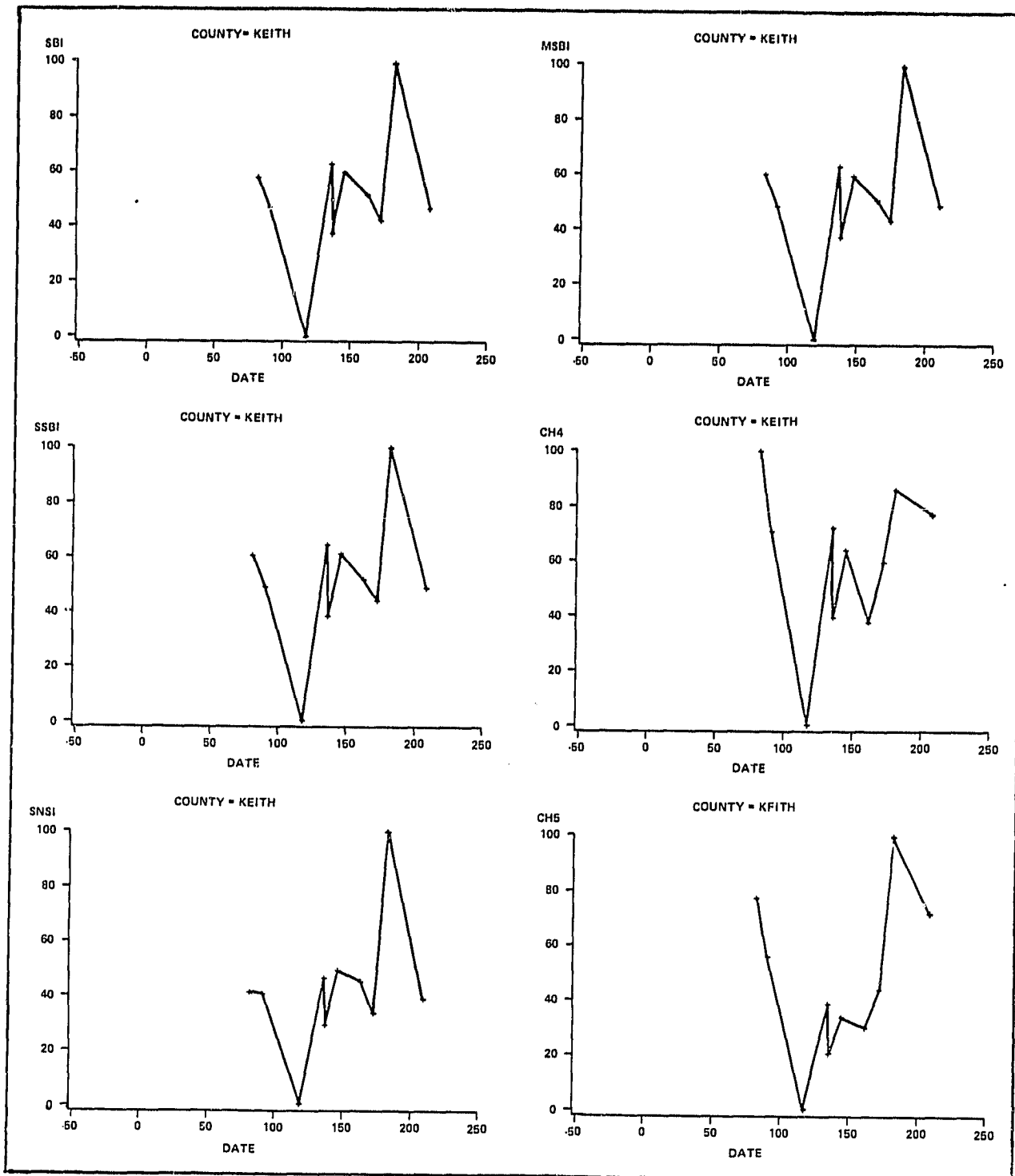




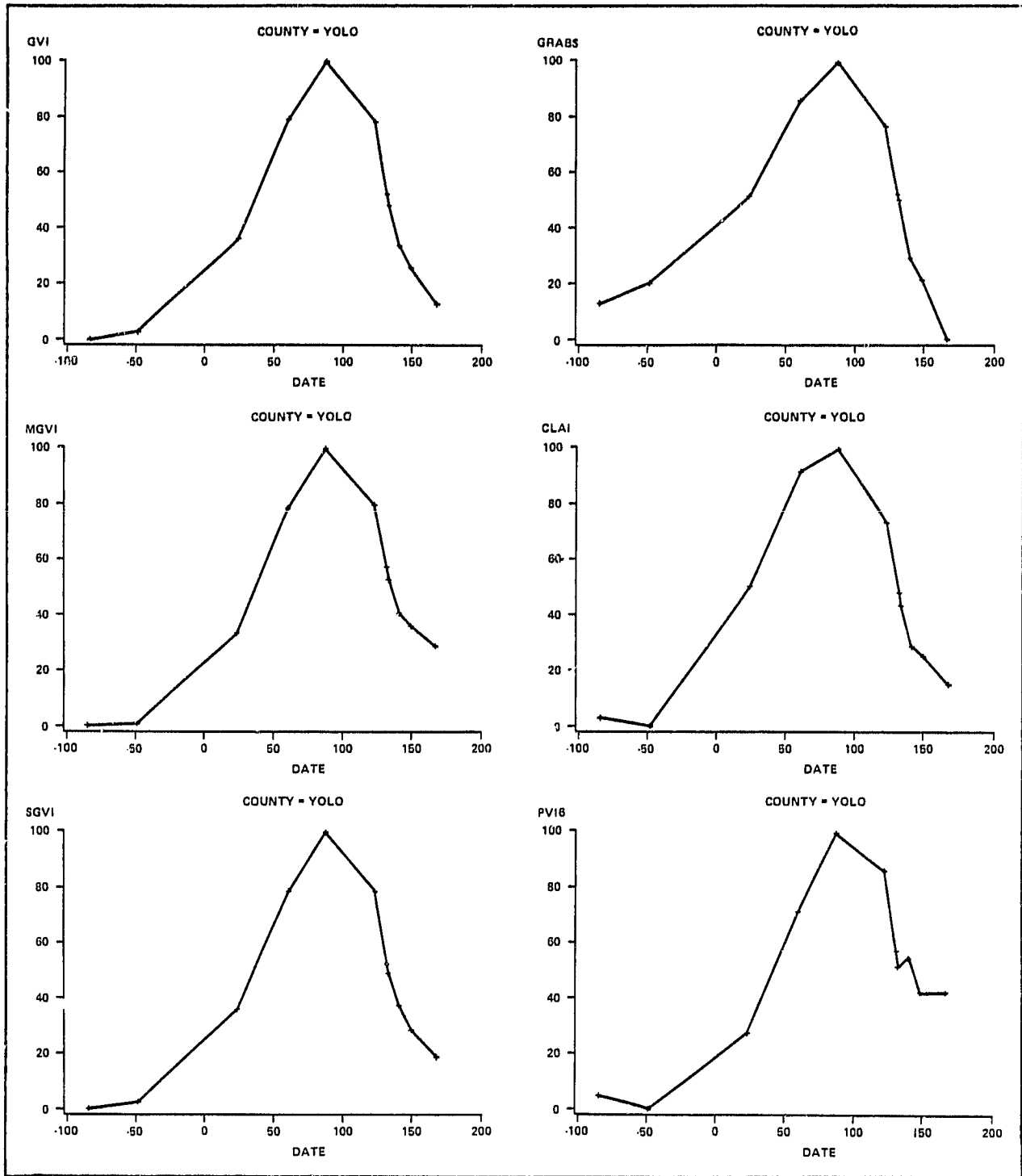


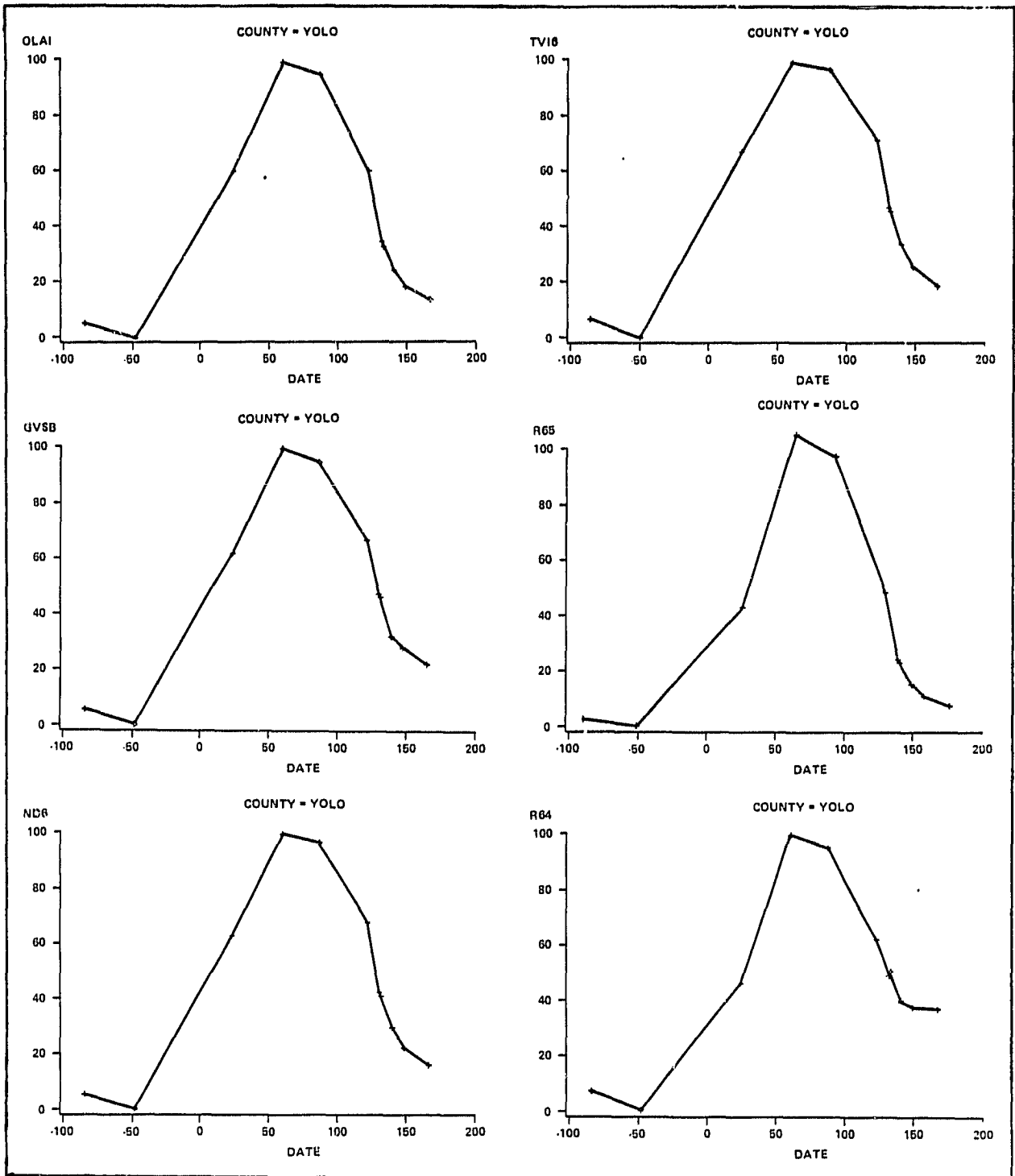


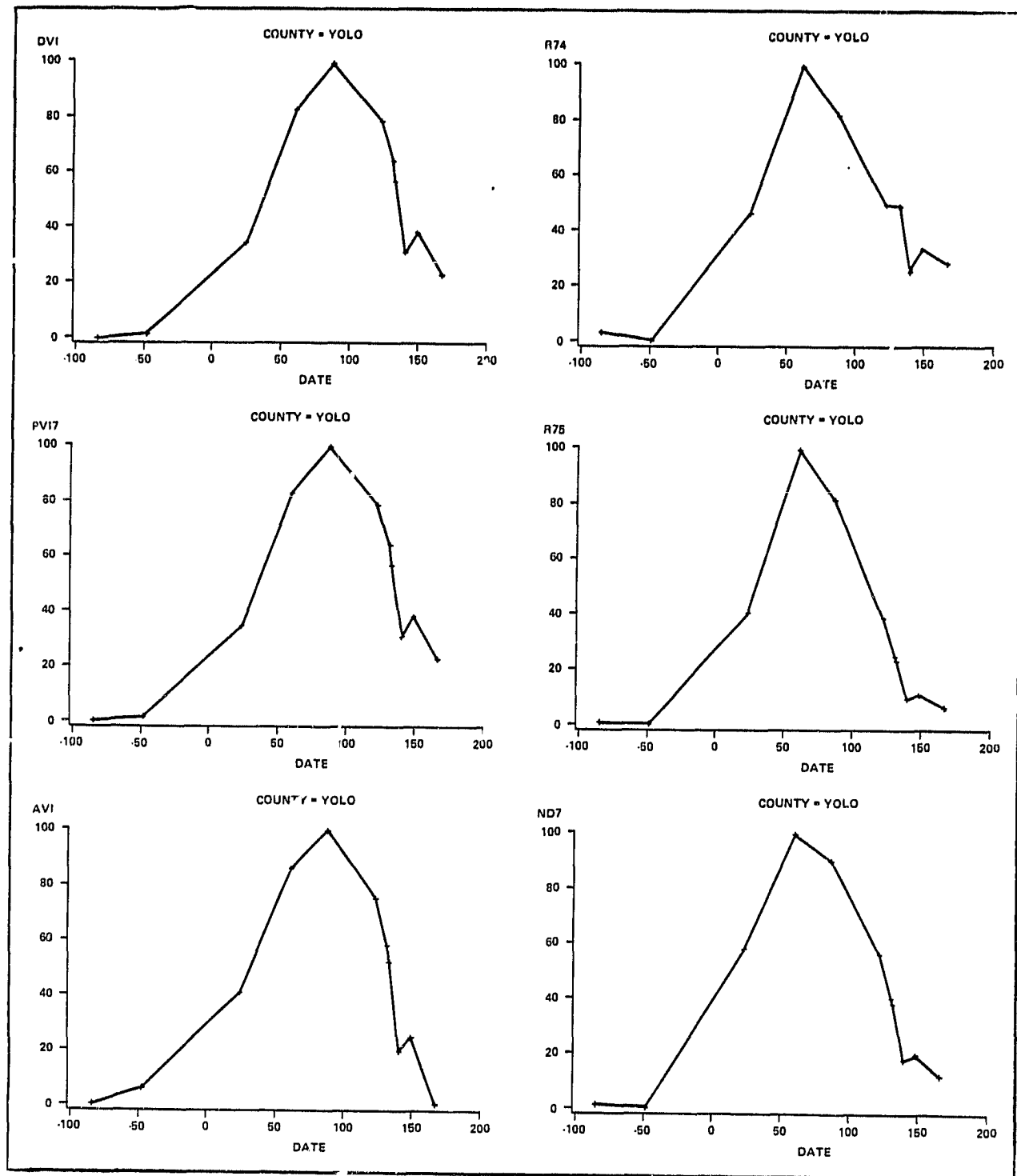


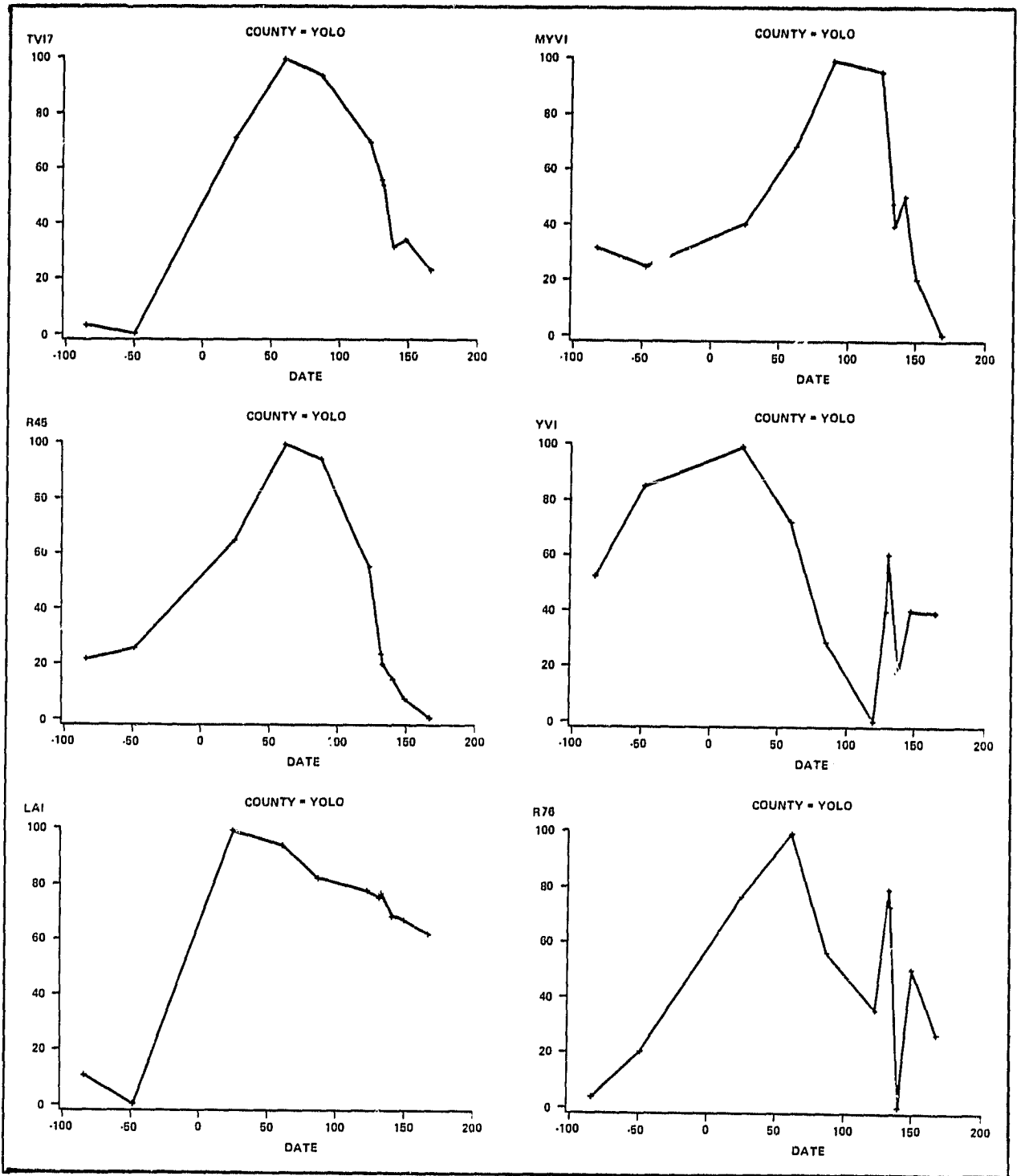


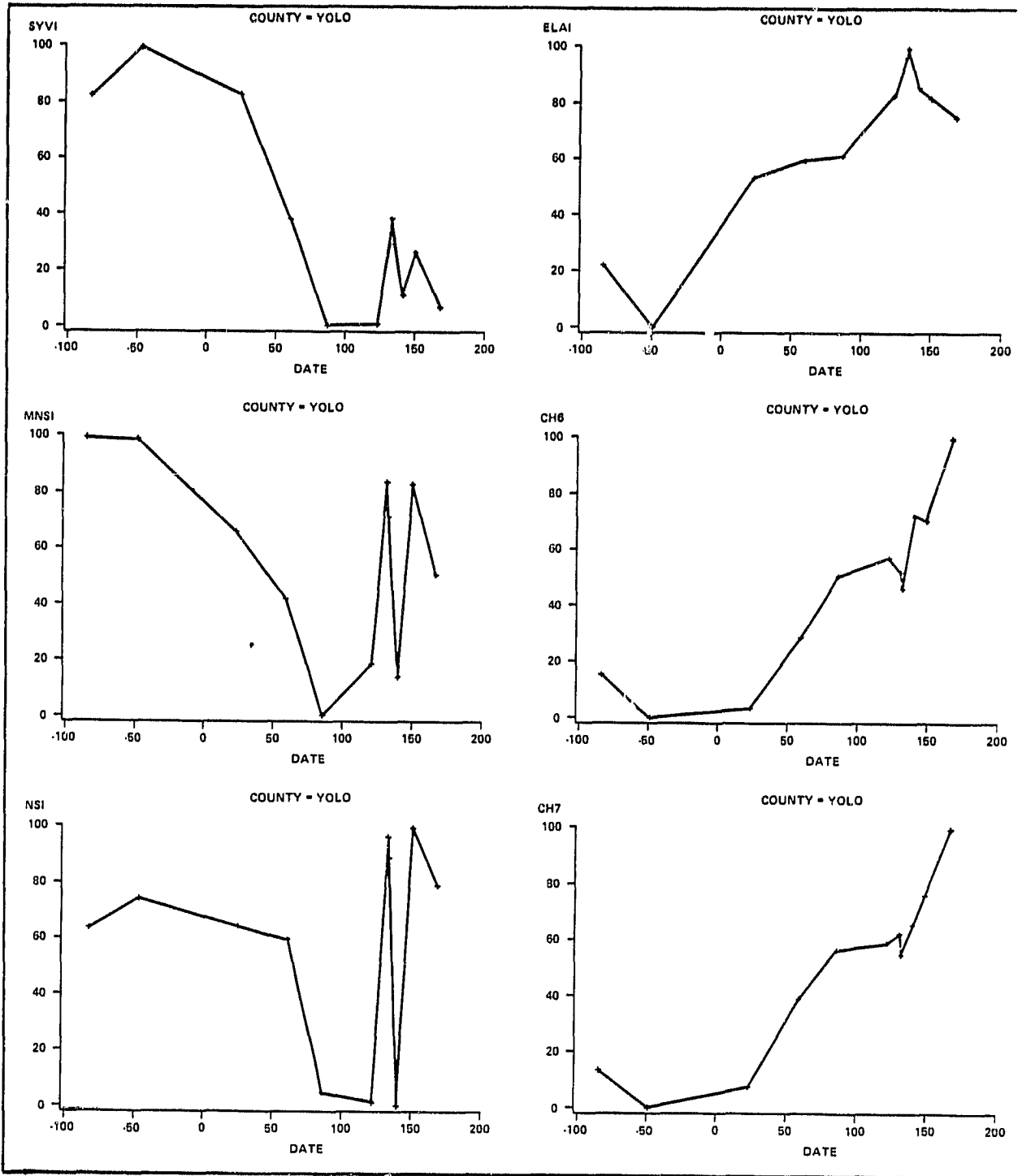


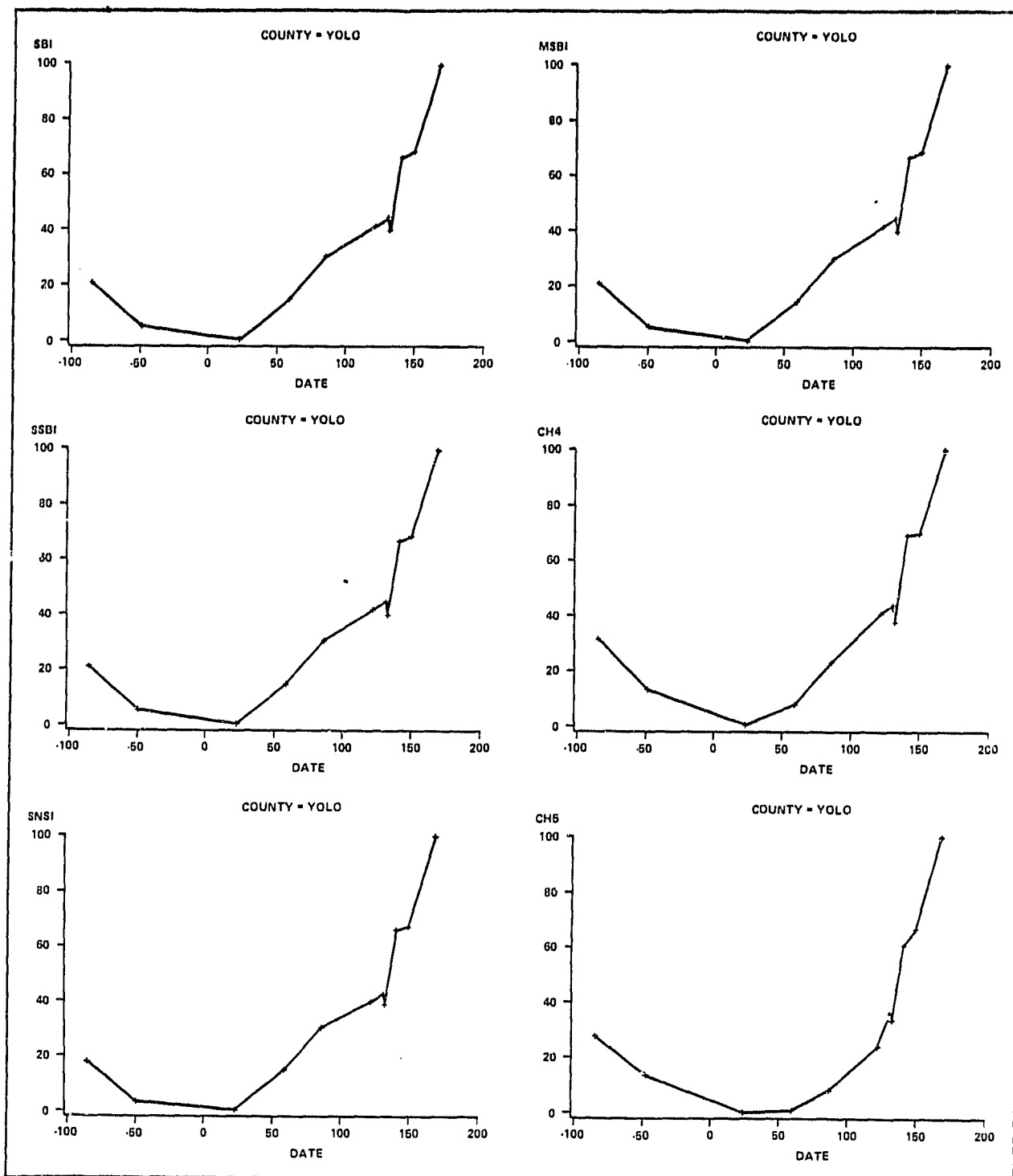






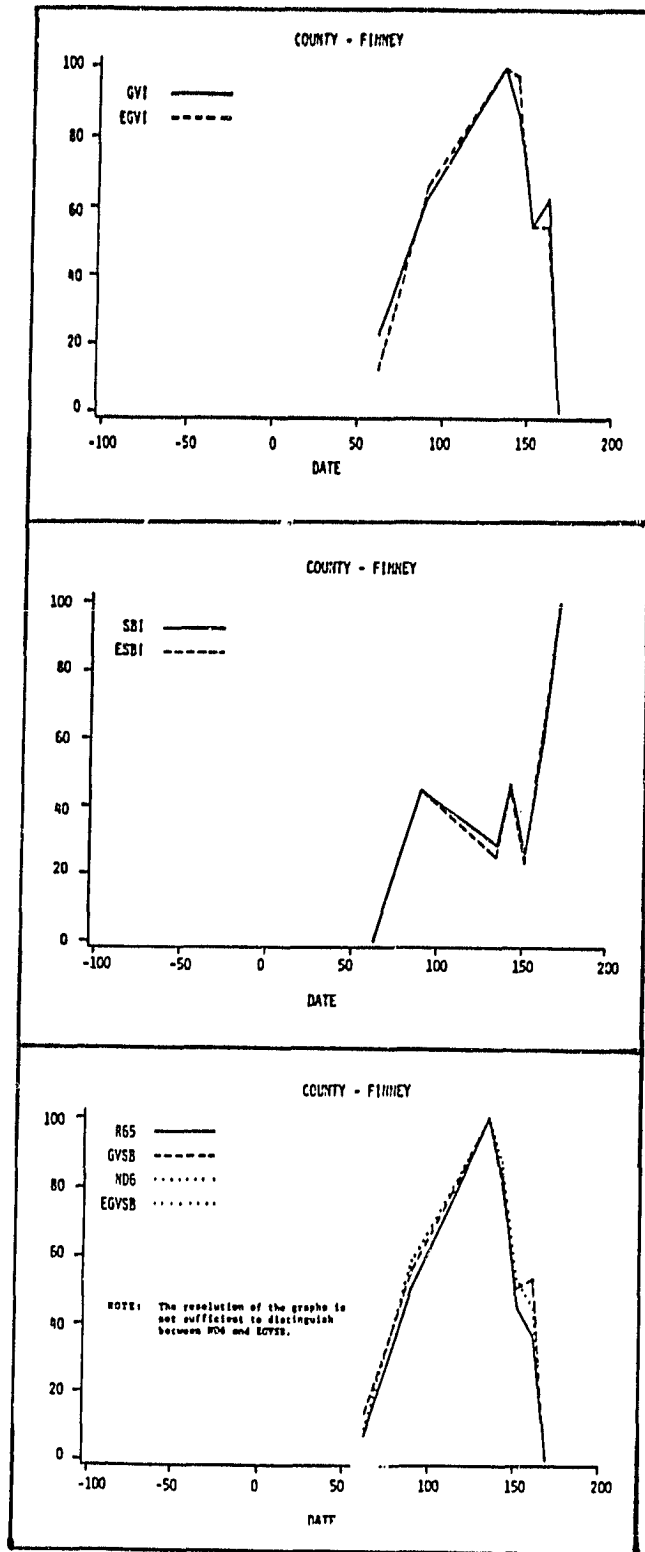






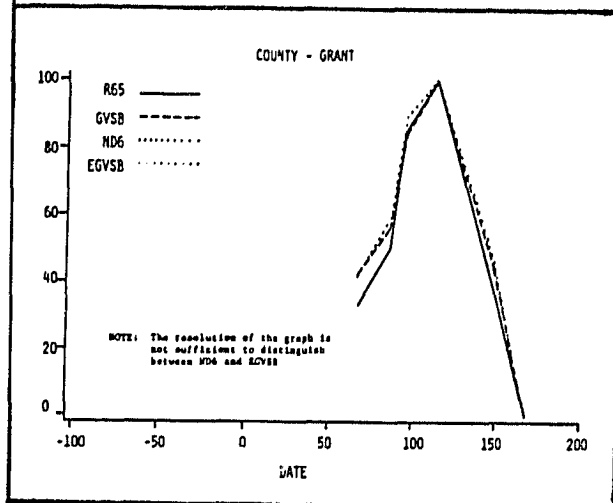
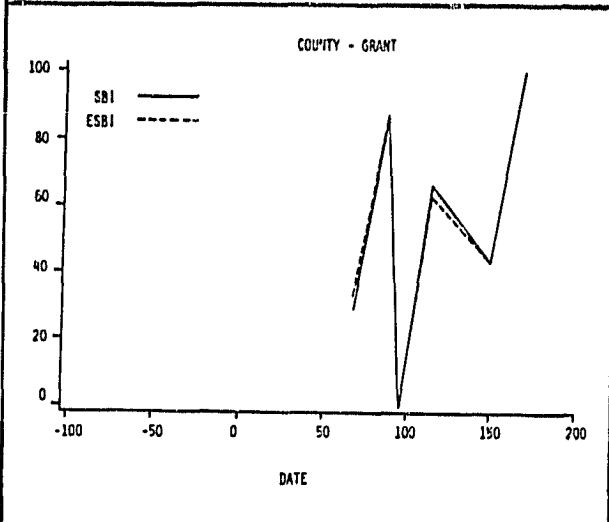
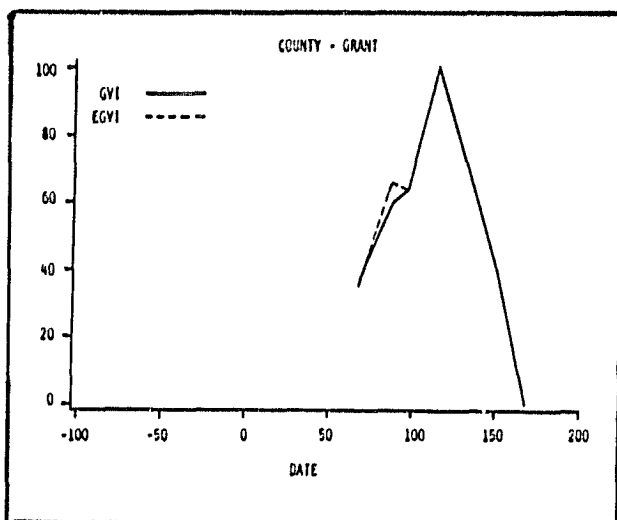
APPENDIX E

VEGETATION INDICES EQUIVALENTS  
AND APPROXIMATIONS ILLUSTRATED  
WITH TRAJECTORY PLOTS





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OF POOR QUALITY



ORIGINAL PAGE IS  
OF POOR QUALITY

