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Title: Comparison of Soil and Vegetation Map Delineation Shapes and Areal Correspondence

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Map delineations of soil and vegetation for a 14,000 acre (5,800 hectare) site in the Oregon Coast Range were compared. Research objectives were to ascertain the types of information that could be extracted from delineation comparisions and to develop a methodology suited to this purpose. The latter objective was achieved in a preliminary sutdy involving a small number of soil-vegetation complexes. Data on shape similarity and areal correspondence were collected using a digital planimeter. The methodology developed was then applied to three data sets: all delineations of two soil mapping units which differed only in dissection, and delineations from a random sample of other mapping units. Nonparametric statistical procedures were employed to analyze the data in terms of soil mapping units and in terms of physiographic position. Little association was found between soil and vegetation delineations overall. However, vegetation and soil delineation shapes, as measured using an elongation ratio, appear to be more similar in the uplands than in the lowlands. Greater upland contrasts in factors significant to both soils and vegetation may contribute to this trend. Areal correspondence was

evaluated with the intersection/union ratio for vegetation and soil polygons. Ranks of vegetation communities according to their areal correspondence with the soil body were generally inconsistent. The dissected soil showed the greatest amount of consistency in areal correspondence between upland and lowland complexes. This raises the possibility that dissection may be a more important determinant of community distributions than is physiographic position. Finally, shape similarity and areal correspondence trends were associated in the uplands but not in the lowlands. The more consistent shape comparisons in the uplands may contribute to this dichotomy of results.

Comparison of Soil and Vegetation Map Delineation Shapes and Areal Correspondence

by

Janet Leone Bilton

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Typed by Jane Tuor for Janet Leone Bilton

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COMPARISON OF SOIL AND VEGETATION MAP DELINEATION SHAPES AND AREAL CORRESPONDENCE

I. INTRODUCTION

Soil survey descriptions usually include the types of vegetation associated with each mapping unit. These qualitative discussions are based on the field observations of the surveyor, who then attempts to summarize the most typical situation in a sentence or two. These summaries, while informative, leave unanswered several questions that might be raised by researchers or resource managers about soil-vegetation relationships. Knowledge about the degree of overlap between particular types of vegetation communities and soil bodies may be useful in managing specific sites. Perhaps communities stay well within the bounds of one type of soil body but lack a great deal of areal correspondence with another type. Whether these relationships vary with physiographic position might also be of concern. Comparing soil and vegetation map delineations is one means of addressing such questions. Soil-vegetation survey maps provide an appropriate base of reference in this regard, since they depict the geographic distribution of the two features at the same scale.

This research project evaluated the potential for using map comparison techniques to investigate spatial correspondence between vegetation and soil. Objectives of the research were: (1) to ascertain what types of information can be extracted from comparisons of soil and vegetation delineations, and (2) to develop a map analysis procedure suited for this purpose.

Specific questions addressed in the study were as follows:

-What is an effective yet simple shape index for soil and vegetation delineations?

-Can delineations of particular soil mapping units be characterized by their shape index?

-Is there a correlation between the shape indices of vegetation polygons and the soil polygon they overlap?

-How much areal correspondence exists between particular soil and plant community types?

-Do any of the above relationships vary according to physiographic position?

Answers to these questions can assist the study of soil-vegetation mapping unit relationships on a polygon-by-polygon basis, or can be viewed as a first step in assessing the pattern of such relationships throughout the landscape.

II. BACKGROUND INFORMATION

No geographical study can be fully understood without consideration of site characteristics and the maps representing the site. Relevant information on these concerns is therefore presented below. Additionally, the dual objectives of the study required a review of literature pertaining to both map analysis and the spatial correspondence of vegetation and soils. Such background knowledge provides a framework for consideration of the methods developed and the results achieved.

A. The Site

Soil-vegetation maps of the Munson Falls Tree Farm, which is owned by Publishers Paper Company of Oregon City, Oregon, were used for this study. The tree farm, at 45° 22' N latitude and 123° 45' W longitude, comprises 14,350 acres (5,807 ha) on the west slope of the Coast Range (Meurisse and Youngberg, 1971).

Physical characteristics of the site, which is described in fuller detail by Meurisse and Youngberg (1971), exhibit an east-west dichotomy. Lowland areas to the west grade into Coast Range uplands in the east, with a range in elevation from 250 to 3,100 feet (76 to 945 m). Most of the tree farm is situated in the fog-belt coastal zone, but the eastern portion extends to the crest of the Coast Range. Winters are wet and cool, whereas summers are dry and warm. Gentle seasonal rains and fog drip account for most of the precipitation. Uneven dissected landforms, sharp ridges, and steep slopes characterize the topography, the latter two features being especially common in the east. Surface geology is predominantly composed of basalt flows, breccia, tuffs, and intrusives, but lowland areas contain tuffaceous shale and siltstone as well. Thus, soils are derived from basalt-gabbro, shale, or alluvial parent materials.

Soils derived from shale and siltstone have surface textures of silt loam or loam and subsoils of clay to silty clay loam. These soils are very strongly acid. Coarse fragments are sparse except in weakly-developed soils. Soils derived from volcanic rocks have loam or silt loam surfaces and subsoils of loam to silty clay loam. Stoniness varies inversely with depth.

Vegetation is transitional between the Western Hemlock Zone to the east and the Sitka Spruce Zone to the west. Western hemlock, Douglas-fir, and western red cedar are common forest species. Locally abundant red alder indicates disturbance by fire or logging operations. Oxalis, sword fern, salmonberry, and thimbleberry are common understory plants. The higher elevations are within the Tillamook Burn area, in which three fires between 1933 and 1945 devastated much of the standing stock (Bailey and Hines, 1971). However, Tillamook Burn communities do not differ greatly from those developed after a single burn in the Coast Range (Bailey and Poulton, 1968).

B. Materials

A soil-vegetation survey of the Munson Falls Tree Farm was conducted in 1970-71 by R.T. Meurisse and C.T. Youngberg, both at the time with the Department of Soil Science at Oregon State University. The soil survey was designed to meet the requirements of the National Cooperative Soil Survey. Soil mapping units were differentiated according to soil series, landform, and slope class. These mapping units and their map symbols are given in Table 1. The vegetation maps contain delineations based on understory communities and on density, species dominance, and age class of the canopy. To compile the maps, tentative delineations were made on aerial photographs and were verified with field transects and observations.[1] Map symbols used for vegetation mapping are presented in Table 2. Detailed descriptions of the vegetation and soils, as well as discussions of their management implications, are found in the survey report (Meurisse and Youngberg, 1971).

The aerial photographs used for mapping, as well as the survey report and the final maps produced, were available as source materials for this research. The aerial photographs are panchromatic, nine-inch format prints at a scale of 1:12,000. Overlap and sidelap are sufficient for stereoscopic viewing. Soil delineations and tree boundaries are drawn directly on the photos, whereas vegetation delineations are shown on clear acetate overlays. The soil and vegetation maps are on separate diazos, and also have a 1:12,000 scale.

C. Map Analysis

Overview

An understanding of the characteristics and limitations of soil and vegetation maps is needed to place map interpretation results in the proper context. Mapping criteria such as the placement of delineation boundaries

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[1] R.T.Meurisse, personal communication, 1982.

TABLE 1. Soils Mapped on the Munson Falls Tree Farm
(after Meurisse and Youngberg, 1971)

Series	Parent Material	Proportionate Extent %	Map Symbol	Mapping Unit
Brenner	Alluvium	.38	11-a-5	Brenner silt loam, bottom, 0-5%
Knappa	Alluvium	.17	12-a-5	Knappa silt loam, bottom, 0-5%
Gauldy	Alluvium	.74	13-a-5	Gauldy loam, bottom, 0-5%
Astoria	Shale	15.04	21-M-75	Astoria silt loam, 60-90% smooth slope
			21-R-15	Astoria silt loam, 0-30% ridge
			21-U-15	Astoria silt loam, 0-30% uneven slope
			21-U-45	Astoria silt loam, 30-60% uneven slope
			21-V-15	Astoria silt loam, 0-30% uneven dissected slope
			21-V-45	Astoria silt loam, 30-60% uneven dissected slope
Trask	Shale	.01	22-U-45	Trask shaly loam, 30-60% uneven slope
Hembre	Basalt-Gabbro	35.13	31-M-45	Hembre silt loam, 30-60% smooth slope
			31-M-75	Hembre silt loam, 60-90% smooth slope
			31-R-15	Hembre silt loam, 0-30% ridge
			31-U-15	Hembre silt loam, 0-30% uneven slope
			31-U-45	Hembre silt loam, 30-60% uneven slope
			31-U-75	Hembre silt loam, 60-90% uneven slope
			31-V-45	Hembre silt loam, 30-60% uneven dissected slope
			31-V-75	Hembre silt loam, 60-90% uneven dissected slope
			31-X-15	Hembre silt loam, 0-30% bench
Klickitat	Basalt-Gabbro	36.51	32-b-45	Klickitat gravelly loam, 30-60% spur
			32-M-45	Klickitat gravelly loam, 30-60% smooth slope
			32-M-75	Klickitat gravelly loam, 60-90% smooth slope
			32-R-15	Klickitat gravelly loam, 0-30% ridge
			32-R-45	Klickitat gravelly loam, 30-60% ridge
			32-U-15	Klickitat gravelly loam, 0-30% uneven slope
			32-U-45	Klickitat gravelly loam, 30-60% uneven slope
			32-U-75	Klickitat gravelly loam, 60-90% uneven slope
			32-V-45	Klickitat gravelly loam, 30-60% uneven dissected slope
			32-V-75	Klickitat gravelly loam, 60-90% uneven dissected slope
Kilchis	Basalt-Gabbro	11.54	33-M-45	Kilchis stony loam, 30-60% smooth slope
			33-M-75	Kilchis stony loam, 60-90% smooth slope
			33-R-15	Kilchis stony loam, 0-30% ridge
			33-R-45	Kilchis stony loam, 30-60% ridge
			33-V-45	Kilchis stony loam, 30-60% uneven dissected slope
			33-V-75	Kilchis stony loam, 60-90% uneven dissected slope
Rockland		.47	R	Rockland

TABLE 2. Vegetation Map Legend
(after Meurissc and Youngberg, 1971)

EXAMPLE

Cover Density Class → Dominant Species ↓ ← Subdominant Species

← Age Class

$$\frac{\text{1 H Hd 2}}{\text{SB-SF(H)}}$$

Understory Community → SB-SF(H) ← Understory Regeneration

SYMBOLS

Cover Density Class

% Cover	Class Symbol
5-20	1
20-40	3
40-60	5
60-80	7
80-100	9

Canopy Cover

Conifers	Symbol	Hardwoods	Symbol
Douglas-fir	D	red alder	Hd
Noble fir	F		
Sitka spruce	S		
Western hemlock	H		
Western red cedar	C		

Tree Age Class

Tree Age (yrs.)	Class Symbol
2-20	1
20-40	2
40-60	3
60-100	4
over 100	5

Understory Plant Communities

Plant Community	
Thimbleberry-Star flower	TB-ST
Bracken-Lotus	BR-LO
Blue huckleberry-Salmonberry	RH-SB
Vine maple-Sword fern	VM-SF
Sword fern	SF
Salmonberry-Sword fern	SB-SF
Sword fern-Oxalis	SF-O

Special Symbols

Symbol	Definition
C&B$_1$	Cut and burned, 0-5 years ago
CO$_1$	Cut over and not burned, 0-5 years ago
NS	Non-stocked
Ag	Agricultural land
BR	More than 5% bracken fern - associated with an established community or without

and the percentage of inclusions allowable are affected by survey objectives. In many cases the objective is merely to enable managers to predict conditions at sites without visiting them, rather than to draw definitive boundaries around soil bodies (Bie and Beckett, 1971) or vegetation communities. All boundaries drawn on soil and vegetation maps do not have equivalent ecological importance (Tjallingii, 1974) since they represent transitions of varying abruptness (Fridland, 1972; Küchler, 1967). Nor is the homogeneity of mapping unit delineations constant and predictable; map inclusions vary in total extent and distribution throughout delineations.

Other map limitations stem from imperfect survey techniques. Surveyors differ in their ability to subdivide the landscape into mapping units of consistent soil patterns (Bie and Beckett, 1971), suggesting the existence of subtle variations in mapping criteria within a surveyed area or between different surveys of the same area. The error in delineating soil series and types on maps has been estimated to range between 15 and 50 percent (Pavlik and Hole, 1977). Compounding the problems when different soil maps are compared are variations in soil characteristics, classification schemes, degree of mapping detail, and potential uses of the maps (Hole, 1953). Analogous situations hold for vegetation maps.

Despite these limitations, a wealth of information is potentially extractable from soil or vegetation map analysis. Studies employing soil maps have focused on individual delineations and on entire soilscape patterns. For example, Hole (1953) quantified the shape of soil bodies by calculating the ratio of soil perimeter to perimeter of a circle having the same area. Soils with narrow and irregular shapes had the highest values for these shape index numbers, and typically occurred in highly dissected landscapes. Analysis of size and pattern complexity of soil bodies showed that well-drained, unglaciated soil types exhibited the greatest range in these characteristics (Hole, 1953).

Fridland (1972) has compiled soil map analysis techniques,[2] including measures of size distribution, shape symmetry and dissection, boundary distinctiveness, and neighboring soil contrasts. Investigations using such techniques have revealed, for example, that large soil bodies tend to have more tortuous boundaries; tortuosity also varies for different soil groups, e.g. bog soils _vs_. those developed in uneven terrain (Fridland, 1972).

Habermann and Hole (1980) analyzed the contrast in sizes of soil bodies in different landscapes, and found landscape age, dissection, and relief to be important influences. Valentine (1981) compared soil maps of the same area compiled at different levels of generalization and found a 16 to 19 percent areal departure between delineations of associations and their constituent mapping units. Arnold (1978) evaluated the randomness of mapping unit distributions using statistical techniques. One approach involved representing polypedons by dots, noting the patterns of dots within quadrats, and comparing these patterns with probability distributions. Another method of analysis utilized simplicial maps, in which distribution of and distances to neighboring polygons could be assessed. Both methods showed non-random patterns of mapping units in a New York State soil survey. Pavlik and Hole (1977) used multivariate discriminant analysis to investigate soil patterns in landscapes with and without drumlins in southeastern Wisconsin. They discovered, for example, a higher density of soil bodies in the drumlin

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[2] The delineations he considers are of elemental soil areals (ESAs), which are conceptually similar to polypedons.

landscape.

Prior studies involving comparisons of soil and vegetation maps have been motivated by a variety of objectives. Theoretical ecologists have used vegetation maps to demonstrate spatial relationships between soil and vegetation (Daubenmire, 1968). Küchler (1967) reports that Klaus Meisel investigated the coincidence of specific soil and vegetation types and concluded that a soil map alone cannot reveal the distribution of vegetation types, since the distribution is a function of changes in qualities which are not necessarily depicted on soil maps. Singh (1973) superimposed small-scale maps of climate, soil, and vegetation for Uttar Pradesh and found a striking coincidence between their boundaries. His interpretation was that climate is a fundamental force shaping the other two. Tjallingii (1974) compared soil and vegetation maps to evaluate ecological diversity in the Utrecht region of the Netherlands. As the climate and relief of the area were essentially uniform, soil maps were used to assess potential ecosystem diversity, in contrast to the actual diversity represented on vegetation maps. Drawbacks to the map comparison approach include the variable ecological significance of soil delineation boundaries, potential "pre-fabricated correlations" resulting from surveying vegetation and soils in tandem, and inclusions in either type of mapping unit delineation (Tjallingii, 1974).

Techniques

Several methods of extracting data from soil and vegetation maps have been alluded to in the overview of previous studies. Past attempts to express shape and areal correspondence are particularly relevant to the development of the research methodology.

Simple but consistent quantitative expression of two-dimensional shapes has not yet been achieved. No one-to-one correspondence can be found between the set of all plane shapes and the set of real numbers (Lee and Sallee, 1970). Despite these limitations, the methods that do exist for quantifying shape have proven workable in many geographical studies. Three basic approaches to shape measurement exist (Stoddart, 1965): calculation of form ratios utilizing various shape dimensions; comparison of actual shapes with standard geometric shapes; and direct measurement of shapes, which generate values independent of shape magnitude and orientation. Form ratios, also called figure attribute indices, generally measure shape compactness (Muehrcke, 1978). Among the better known form ratios (Stoddart, 1965) are Horton's Form Factor (F = Area/Length of longest axis); Miller's Circularity Ratio (C = Area of drainage basin/Area of circle having the same perimeter); and Schumm's Elongation Ratio (R_e = Diameter of circle having the same area/Length of longest axis). Another form ratio divides length of longest axis by the length of the longest perpendicular axis (Hammond and McCullagh, 1974). Compaction can also be measured by a best-fit comparison with a standard shape; specifically, the ratio between area and the area of the smallest inscribing circle is calculated (Hammond and McCullagh, 1974). Two other examples of best-fit regular geometric figures are the Ellipticity Index (I_e = Length of longest axis/2b, where b = Area x $[\pi\frac{1}{2}(\text{Length of longest axis})]^{-1}$) and the symmetric difference method proposed by Lee and Sallee (1970). Index numbers in the latter case are computed as $1 - [\text{area } (K \cap L/\text{area } (KUL)] = \tau_1$, where K is the unknown shape and L the standard.

Direct shape measurements require more computational effort than the other two methods. Examples of such measurements are the Boyce-Clark and the Bunge methods (Boyce and Clark, 1964). To compute a Boyce-Clark index value, the shape's center of gravity must be located. This serves as a node from which radials are drawn to the perimeter. The shape index is

$$I = \sum_{i=1}^{n} \left| \left(\frac{r_i}{n} \times 100 \right) - \frac{100}{n} \right|$$

where r_i = length of the i^{th} radial and n = number of radials (Boyce and Clark, 1964). The method is simple and becomes more precise as n increases, but is limited by a need for consistency in selecting nodes and positioning radials (Cerny, 1975). In the method advanced by Bunge, an equal-sided polygon is superimposed on a shape such that its vertices lie on the shape's perimeter. Distances between every vertex, every other vertex, every third vertex etc. are squared and summed to generate an index value (Boyce and Clark, 1964).

New concepts in the description of shape are being formulated in the fields of biomathematics and pattern recognition. Bookstein (1978), who describes recent advances in biological shape measurement, notes that Euclidean shape indices such as those described above are too dependent on the use of pre-designated landmarks (e.g., where the longest axis intercepts the perimeter). Functions which describe shape in coordinate-free numerical form are seen to hold more promise. One such function, a skeleton, reduces a plane shape to a line by imagining the borders of the shape to be contracted at an equal rate (Bookstein, 1978). Working in the field of automated pattern recognition, Freeman (1978) also reduces a plane shape to a line, but accomplishes this by constructing a normalized plot. Distance between the shape's centroid and boundary is plotted as a function of distance along the boundary from an origin, which is defined as the intersection of the maximum radial with the boundary. The applicability of these concepts in routine geographical analyses remains to be seen.

Methods of evaluating the areal association between two spatially distributed phenomena are more straightforward than shape measurements, and are well-described by Muehrcke (1978). For large study areas, a common approach is to superimpose a dot or grid overlay on the map and tabulate the number of times each combination of phenomena is encountered. Another approach, the coefficient of areal correspondence, is conceptually similar to the best-fit regular geometric figure method of shape measurement. If A is defined as the area of, in this case, a soil delineation and B is the area of the vegetation delineation, the coefficient is computed as: $C_1 = (A \cap B)/(A \cup B)$. This may be computed using the shapes directly or by using quadrats (Muehrcke, 1978).

D. Vegetation and Soil Correspondence

Opinions vary on the importance of soils in determining vegetational distributions. Many ecologists insist that climate is the dominant factor determining distributions of vegetation, while others have noted the affinity of particular plant species or communities for certain substrate types. This disparity in viewpoints is at least partially attributable to differences in scale of observation. Different impressions are gained depending on whether biomes and soil orders or subspecies and phases of series are being examined. Other factors contributing to the divergence in opinions are the variable responses of plants to their environment, the possibility that soil and vegetation distributions both respond to some external factors, and the diverse backgrounds of researchers addressing the question.

Two types of studies - those of vegetative indicators, and soil-vegetation surveys - supply much of the information available on spatial relationships between the soil and plant covers. Representative findings of such studies indicate the complexity of the relationships. In addition, ecologists frequently examine the correlation between soils and vegetation within specific areas. The results from a site proximal to the Munson Falls Tree Farm suggest the types of relations that might be evident from map comparisons.

The correlation between a plant or plant community and its physical substrate is sufficiently high in some instances to warrant using the vegetation as an indicator of substrate conditions. Geobotany, as this field of endeavor is termed (Brooks, 1972), can involve regional lithology, groundwater distribution, or mineralogy as well as the soil cover. The occurrence of particular vegetation types can be used to identify specific soil properties or taxonomic units (Rodman, 1965). For example, a distinctive flora including Jeffrey pine and buckbrush is indicative of serpentinitic soils in southwestern Oregon. Macronutrient deficiencies and micronutrient toxicity are largely responsible for the characteristic plant cover (Oregon State Univ., Dept. of Soils, 1970). Changes in parent material, relief, moisture regime, and temperature can also induce distinctive changes in the vegetation cover, from which the transitions in substrate conditions can be deduced (Leont'eva, 1965). In arid environments, communities can indicate soil moisture, texture, and salinity (Shantz and Piemeisel, 1940). Plant indicators, particularly those in the understory, have been used to estimate site productivity (Hodgkins, 1970) and slope instability (Pole and Satterlund, 1978). Less work has been done on mapping soil taxa from inspection of the plant cover. "Ecological compensation," the occurrence of similar vegetation in different habitats, and "ecological replaceability," meaning the occurrence of different vegetation in similar habitats (Vinogrodov, 1965), may be two reasons why indicators of soil taxa have not been investigated more fully.

The results of soil-vegetation surveys are even more applicable than indicator relationships to the research questions at hand. Soil information in conjunction with vegetation surveys allows the forest manager to predict the location and nature of management problems, or at least where management practices should be varied (Corliss and Dyrness, 1965). It can also aid the manager interested in growing a particular tree species on a certain site (Byrne _et al_., 1965), and perhaps improve the accuracy of the timber inventory (Orr, 1965).

Soil-vegetation surveys reveal variations in the degree of correlation between the two features. Several causal factors have been implicated. Lemieux (1965) saw relationships between plant community types and parent material mineralogy, but not texture; available moisture was also an important factor. Excessive soil moisture during periods critical for plant growth and establishment was implicated in species composition differences between two bottomland soils in Georgia (May and Blackmarr, 1965). Byrne _et al_. (1965) found differences in successional rates between two soil series in the southern Appalachian Plateau. Again, moisture differences as influenced by texture and solum thickness were thought to be critical. Driscoll (1964) found a direct correlation between four vegetation associations in central Oregon and mapping units of weakly-developed soils, as long as the soil definitions included the nature of the regolith. Stevens (1965) could associate vegetation with soils at the series level in southeastern Alaska, but concluded that geographic location, physiography, and climate were the major influences affecting the distribution of vegetation. Delineations of vegetation communities resulted in the delineations of most soil boundaries in the California Vegetation-Soil Survey (Küchler, 1967).

The soil-vegetation survey of the Alsea area in the Oregon Coast Range (Corliss and Dyrness, 1965) is particularly instructive since it served as a model for the Munson Falls survey. A tight correlation between soils and vegetation communities was generally lacking. It was noted, for instance, that communities characterized by understories of vine maple-salal and vine maple-sword fern often occurred on the same soil mapping unit. Each soil-vegetation complex had different management implications (Corliss and Dyrness, 1965). Meurisse and Youngberg (1971) noted some specific soil-vegetation relationships in the Munson Falls survey itself. For instance, the vine maple-sword fern communities almost exactly follow the boundaries of the Astoria series in the southern part of the tree farm. Thus, in this survey as in the others referenced, some patterns of spatial association between soils and vegetation were identifiable.

Ecologists have studied soil and vegetation relationships in a 360 acre deer enclosure in the Cedar Creek drainage northwest of the Munson Falls Tree Farm (Bailey and Poulton, 1968; Bailey and Hines, 1971). Many of the plant communities and soil types present are similar to those in the tree farm. Point samples of soil were taken within each vegetation community delineated and the co-occurrence frequencies of soil and vegetation were tabulated (Bailey and Hines, 1971). Red alder-thimbleberry and vine maple-sword fern communities were frequently underlain by Astoria soils, whereas bracken fern-pink trefoil communities were associated with Hembre soils. However, thimbleberry-star flower communities were mainly found on steep middle or upper slopes above 1,200 feet, regardless of soil types present (Bailey and Hines, 1971). Community distributions were also evaluated in terms of aspect, slope position, elevation, and percent slope. The greatest distinctions between communities arose with elevational differences (Bailey and Poulton, 1968). Map comparisons like those conducted with the Munson Falls Tree Farm maps, can elucidate the areal correspondence of such factors (in this case, of soil and vegetation) on a delineation-by-delineation basis.

III. PROCEDURAL EXPERIMENTATION AND DATA COLLECTION

One objective of the research project was establishing a map analysis procedure suitable for accomplishing the other objective, that of extracting information about soil-vegetation correspondences. A preliminary study was therefore designed to test data collection techniques on a small number of soil and vegetation delineations. Various avenues of procedure were explored and were adopted, modified, or discarded as seemed appropriate. This experimentation resulted in the methodology that was subsequently employed in collecting data for several soil-vegetation complexes.[3]

Data collection methods were influenced by the analytical resources available, particularly the instrument employed for measurement acquisition: the Graf/Pen Sonic Digitizer (GP-Series 6/40, Science Accessories Corporation). Changes in the position of a cursor are detected by an L-frame acoustic sensor assembly bordering the active work area. Length or area readings are digitally displayed on a control unit. The operator controls the rate at which points are digitized and whether English or metric units are employed.

A. Preliminary Study

All data collection efforts involved the following basic tasks:

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[3] The term "complex", as used throughout this thesis, refers to a single soil delineation plus all vegetation delineations that overlap any part of the soil delineation.

-tracing each soil delineation[4] to be investigated on a separate sheet of paper;

-superimposing tracings of all vegetation polygons that overlapped the soil polygon;

-acquiring areal and linear measurements with the digital planimeter; and

-calculating shape indices and measures of areal correspondence.

These tasks required that exact procedures be defined to ensure consistency, repeatability, and objectivity in the data collection process. The first step was to select the soil delineations to be analyzed in the preliminary study. The mapping units chosen were Gauldy loam, bottom, 0-5% slopes (map symbol 13-a-5) and Klickitat gravelly loam, 30-60% ridge slopes (map symbol 32-R-45). Figure 1 depicts a Gauldy delineation and its overlapping vegetation; a Klickitat soil-vegetation complex is shown in Figure 2. Six delineations of 13-a-5 and ten of 32-R-45 were found on maps of the Munson Falls Tree Farm. All of these delineations had elongated shapes, even though the mapping units had different landscape positions. Thus data collected on soil shapes in the preliminary study could be analyzed along with other data collected later (see Chapter IV) to investigate the differences between the shapes of these alluvial and ridge soils.

Specific procedural problems addressed in the preliminary study and their solutions are discussed in the sections that follow.

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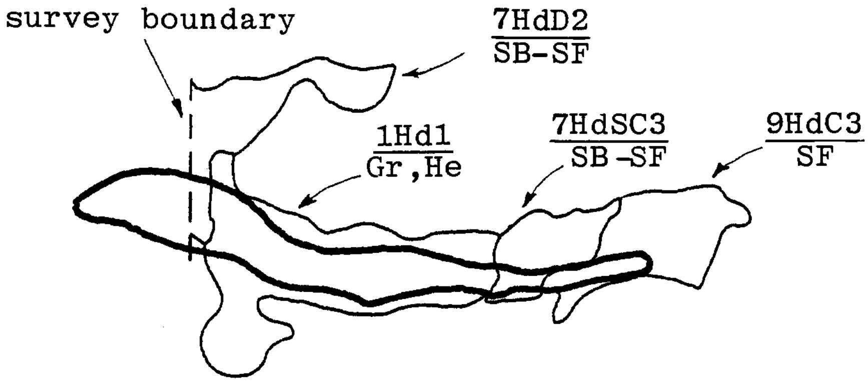
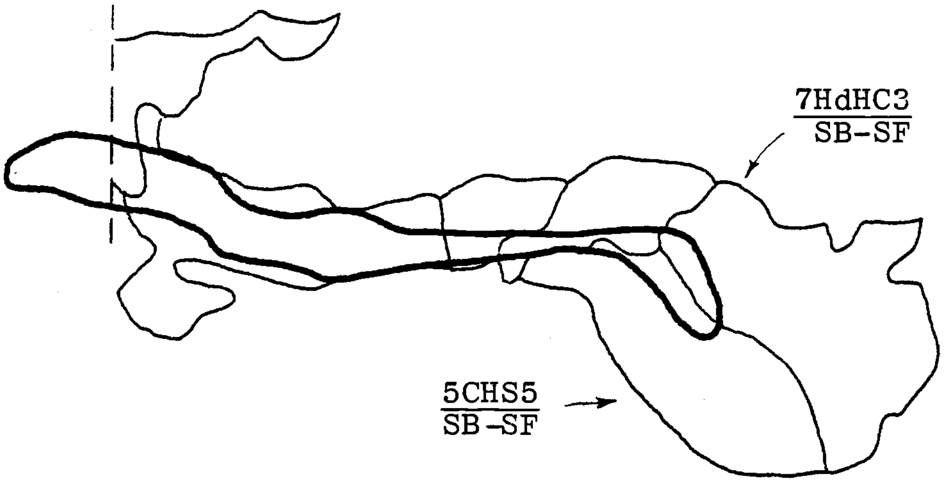
[4] The terms "delineation" and "polygon" will be used interchangeably.

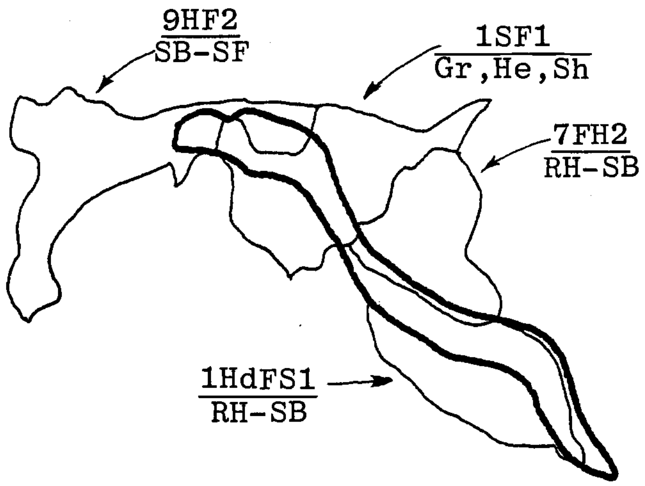


a. Complex traced from aerial photos

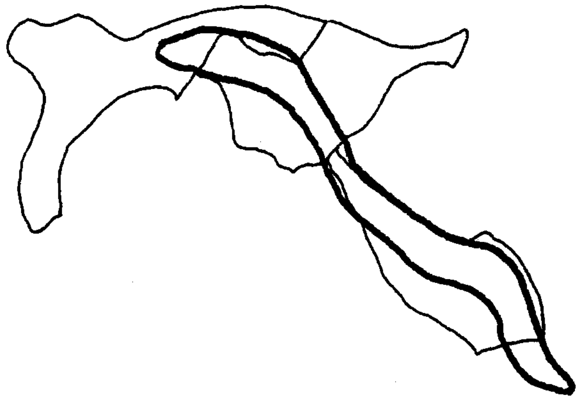


b. Complex traced from maps

Figure 1. Example of 13-a-5 soil-vegetation complex: Complex #4.



a. Complex traced from aerial photos



b. Complex traced from maps

Figure 2. Example of 32-R-45 soil-vegetation complex. Complex #1.

Base Reference for Delineations

A fundamental procedural decision was whether to trace delineations from the aerial photographs or from the diazo maps. Delineation boundaries were probably drawn with more precision on the photographs, where terrain features were clearly visible. However, the maps had the advantage of providing a planimetric base. Both sources also had their disadvantages. Scale, and thus measurement accuracy, varied with landscape relief on the photographs. In addition, many delineations extended over two or more photos, which complicated the tracing process. The primary disadvantage of the maps was the generalization of polygon boundaries that occurred during map compilation (see Figures 1 and 2).

Each delineation was traced from both sources to allow an evaluation of differences in measurements and in computed indices. A cursory evaluation of differences in measurements from the two sources indicated that areal measurements differed by eleven percent, whereas length measurements differed by nine percent (Table 3). The tendency of both types of measurements to be ten percent larger on the maps indicated that differences between the sources were consistent in direction and not overly large. Such differences may be attributable to scale distortions on the aerial photos and to small deviations in tracing and digitizing.

Other types of discrepancies that arose between the two sources caused some interpretive problems. Differences in shapes of delineations sometimes resulted from indistinct or multiple lines drawn on the air photos, as in the case of Gauldy complex #4 (see Figure 1), or from lines mistakenly included on or omitted from the maps. These

TABLE 3. Comparison of Photo and Map Measurements For Four 13-a-5 Complexes

		AREA (cm^2)		PERIMETER (cm)	
Complex	Polygon	Photo-Map	% Photo Measurement	Photo-Map	% Photo Measurement
1	13-a-5 entire	-.0648	7.13	-.79	8.68
	13-a-5 truncated	-.0935	14.13	-.56	7.32
	7SHd4/SB-SF	-.0142	5.60	-.17	5.44
	5HdS2/SB-SF[a]	-	-	-	-
	7HdS2/SB-SF	-.1923	31.65	-2.46	39.08
2	13-a-5 entire	.0563	10.50	.17	3.02
	13-a-5 truncated	.0473	18.60	.15	4.93
	5HdD1/Sh,He,Gr[a]	-	-	-	-
	1DHd1/Sh,He	-.0226	22.47	-.22	15.38
	7HdH1/SB-SF	-.0594	7.06	.09	1.88
3	13-a-5 entire	-.1183	2.93	-.18	1.51
	13-a-5 truncated	.2746	9.42	1.68	15.79
	Gr,He,Sh Ag	.2086	7.10	-1.02	10.02
	7Hd2,3/SB,SF	1.1483	28.76	.80	5.78
4	13-a-5 entire[b]	-	-	-	-
	13-a-5 truncated[b]	-	-	-	-
	7HdD2/SB-SF	.0074	.36	-.41	4.36
	1Hd1/Gr,He	-.5198	10.42	-1.60	11.92
	7HdSC3/SB-SF	-.0524	4.11	.38	7.63
	9HdC3/SF	-.0696	3.30	.45	5.76
AVERAGE			11.48		9.28

[a] insufficient areal overlap on maps

[b] discrepancy in shape between the two sources

discrepancies were reconciled whenever possible by relying on the air photos as the primary source of information. The two sources seldom differed in the degree of overlap between specific soil and vegetation polygons. Such differences, where they did occur (for instance compare Figure 2a and 2b), resulted from minor errors in map compilation, in tracing procedures, or from a combination of the two.

Truncated Delineations

Delineations truncated by the limits of the surveyed area presented a dilemma. Optimally the study would have relied only on delineations that were present on the maps in their entirety. However, this would have necessitated omitting a significant acreage comprised of partial delineations. It was decided, therefore, to include such delineations in the analysis.

The best method of dealing with truncated polygons then remained to be determined. Options included treating an artificial boundary segment as part of the polygon boundary, or attempting to draw more natural boundaries for the delineations using photo interpretation. Both methods were tried on the same delineations to facilitate a choice.

Experimental procedures for drafting natural boundaries differed slightly for soil and vegetation polygons. In both cases the first step was to view stereoscopically several photos of the tree farm and thereby gain familiarity with typical boundary placement with respect to terrain and vegetation cover transitions. For truncated soil polygons, boundaries were then drawn in reference to slope, aspect, or geomorphic transitions that indicated pedogenetic differences.

Vegetation polygons presented a different situation because they were drawn on detachable photo overlays. Adjoining photos were viewed in stereo with one of the vegetation photo overlays removed. Vegetation boundaries were "completed" for the polygons that were partially represented on the overlay in place. These drafted boundaries were later compared with the entire delineation as seen when the overlays were adjoined. Differences in measurements and index values were then analyzed for the mapped, the "truncated," and the interpreted polygon. Selected comparisons of some of the measurements obtained are presented in Table 4. While the photo interpreted boundaries did not always correspond closely with the boundaries actually mapped, more often than not they did represent an improvement over the "truncated" polygons. Thus it was concluded that interpreted boundaries could be drafted on truncated soil and vegetation polygons to approximate the shapes of the delineations as they might have been mapped by the surveyors.

Minimal Polygon Overlap

A consistent basis was needed for deciding which vegetation delineations to include in the analysis. Some delineations overlapped a polygon of 13-a-5 or 32-R-45 only to a very minor extent, such that the cartographic and ecological significance of the relationship was questionable. Consequently a criterion for including vegetation delineations in the data set was established such that the area of overlap (or area of intersection) had to constitute more than ten percent of either the soil or the vegetation delineation. This value was chosen after considering several trade-offs. If the value set for the minimal percentage was too large, many vegetation

TABLE 4. Evaluation of Photo-Interpreted vs "Truncated" Vegetation Polygons

VEGETATION UNIT	Area (cm^2)	Long Axis (cm)	Elongation Ratio[a]	% Change In Elongation Ratio
-PHOTOS 3-22/3-23				
● 9H2/SF				
As mapped	2.1907	3.50	.4772	
As interpreted	2.1045	3.23	.5068	6.2
"Truncated"	1.7023	2.35	.6265	31.3
● 7H1/RH-SB				
As mapped	6.4929	6.42	.4479	
As interpreted	4.3787	4.60	.5133	14.6
"Truncated"	2.0764	2.91	.5588	24.8
● 1HHd1/SB-SF^{CO}1				
As mapped	4.7341	3.46	.7096	
As interpreted	.8505	1.85	.5625	-20.7
"Truncated"	.3276	.79	.8175	15.2
● 3H1/RH-SB				
As mapped	2.7423	2.72	.6870	
As interpreted	5.2800	4.49	.5775	-15.9
"Truncated"	1.7277	1.97	.7529	9.6
-PHOTOS 3-22/3-21				
● 5HF1/TB-ST				
As mapped	4.6722	5.56	.4387	
As interpreted	3.7744	3.74	.5861	33.6
"Truncated"	1.9060	2.23	.6986	59.2
● 1D1/TB-ST				
As mapped	7.2681	6.61	.4602	
As interpreted	7.2668	5.87	.5182	12.6
"Truncated"	4.6066	5.26	.4604	.04
● 1D1/RH-SB				
As mapped	14.1677	6.63	.6406	
As interpreted	6.1138	4.36	.6399	-.1
"Truncated"	3.1244	2.98	.6693	4.5
-PHOTOS 1-21/1-22				
● 1SH1/SB-SF				
As mapped	3.8381	3.92	.5639	
As interpreted	3.5079	3.80	.5562	-1.4
"Truncated"	2.2688	3.57	.4761	-15.6
-PHOTOS 1-21/1-20				
● 7HS2/SB-SF				
As mapped	5.3866	5.12	.5115	
As interpreted	1.8974	1.88	.8268	61.64
"Truncated"	1.1320	1.62	.7411	44.9
● 1D1/SB-SF^{CO}1				
As mapped	7.1887	3.99	.7582	
As interpreted	7.2158	4.19	.7234	-4.6
"Truncated"	6.2907	3.98	.7111	-6.2
● 5HSHd2,1/SB-SF				
As mapped	6.9806	5.59	.5333	
As interpreted	4.7661	5.08	.4849	-9.1
"Truncated"	1.2602	4.29	.2953	-44.6

[a] Diameter of a circle having the same area/Length of longest axis

polygons would be excluded from consideration; but if the value chosen was too small, several vegetation polygons with negligible correspondence to the soil body would be included in the analysis to little avail. Examination of several soil-vegetation complexes revealed that ten percent was a reasonable cut-off between sufficient and insufficient overlap.

Parameters Measured

The preliminary study provided an opportunity to acquire, manipulate, and retain or omit several types of cartometric data. Among the parameters investigated were: area, perimeter, length and orientation of long axis, length of perpendicular long axis, area and perimeter of union, and area and perimeter of intersection.

Area, perimeter, and length of long axis were important perimeters to measure because of their utilization in the most common shape indices. Similarly, the simplest index of areal correspondence is the ratio between area of union and area of intersection; thus, omission of any of these measurements from the data set was never seriously considered.

Other measurements acquired on a trial basis were subsequently abandoned either because they were not particularly instructive or because they were part of computations beyond the scope of the research. For instance, it was initially postulated that orientation of long axis would be a useful measurement to acquire, since a comparison of soil and vegetation long axes could indicate whether a directional trend exists in these landscape features. This approach was discarded, however, because several of the delineations lacked a unique long axis. A delineation may have two or more long axes of essentially equal lengths but different orientations, and no basis exists for choosing the orientation of one over that of the other. Attempts were also made to measure the length of the longest axis perpendicular to the long axis. This value can be used in computing the measure of compaction described by Hammond and McCullagh (1974). The added complexity of this approach, combined with the problem of non-unique long axes, led to its abandonment.

Some measurements of perimeters of union and intersection were collected with the thought that the ratio of these values might yield information to supplement the coefficient of areal correspondence. Perimeter values, however, reflect not only the size but the complexity of the shape being studied. Areas of union tend to have highly complex outlines, often with enclaves (or islands) of non-applicable terrain, and therefore have large perimeter values. Since the complexity of such shapes was not of direct concern, it was decided not to continue measuring union and intersection perimeter beyond the preliminary study.

Choice of Shape Index

One objective of the preliminary study was to select the shape index that best described the shapes of soil and vegetation polygons. The choice was made from among several of the indices discussed in the previous chapter. Only computationally simple indices were considered, in view of the large number of shapes to be processed. Values for the following indices were generated using the data collected:

-Area of polygon/Area of circle having the same perimeter (Miller's Circularity Ratio);

-Perimeter of polygon/Perimeter of circle having the same area;

-Square root of area/Length of longest axis;

-Square root of area/Perimeter; and

-Diameter of circle having the same area/Length of longest axis (Schumm's Elongation Ratio).

Results using the data from 13-a-5 complexes are shown in Table 5. Several trends are apparent from the rankings of the values within each soil-vegetation complex: the rank of the second index is always the inverse of the first, and the rankings of the first and fourth indices are identical, as are the rankings of the third and fifth. Consequently, the second, third, and fourth shape indices were eliminated from further consideration in favor of the better-known Circularity and Elongation Ratios.

The purpose of calculating a shape index was to assign a numerical value to shapes that could otherwise only be described qualitatively. In this study the interest was not so much in the magnitude of each value as it was in how their rank conveyed information about differences between shapes. Therefore, to choose between the two remaining indices, the shapes in each soil-vegetation complex were visually ranked in terms of similarity to each other. This ranking was then compared with the index value rankings and differences were tabulated (see Table 6). Since the Elongation Ratio corresponded more closely to the visual ranking than did the Circularity Ratio, it was selected as the shape index for subsequent investigations.

Number of Readings

Use of the average of multiple readings would be

TABLE 5. Comparison of Shape Index Values for 13-a-5 Soil-Vegetation Complexes

				-PHOTOS-					-MAPS-		
COMPLEX	DELINEATION	A_U/A_C[a]	P_U/P_C[b]	$\sqrt{A}/L$[c]	$\sqrt{A}/P$[d]	D_{CSA}/L[e]	A_U/A_C	P_U/P_C	$\sqrt{A}/L$	$\sqrt{A}/P$	D_{CSA}/L
1	-interpreted	.1379	2.693	.2196	.1047	.2479	.1251	2.827	.2126	.0998	.2399
	-truncated	.1400	2.672	.2371	.1056	.2676	.1390	2.682	.2290	.1052	.2584
	7SHd4/SB-SF	.3123	1.790	.4426	.1576	.4994	.2968	1.836	.4052	.1537	.4572
	5HdS2/SB-SF	.4416	1.505	.4856	.1874	.5479	NO DATA - INSUFFICIENT AREAL OVERLAP				
	7HdS2/SB-SF	.1931	2.275	.2964	.1240	.3345	.1314	2.758	.2369	.1023	.2674
2	-interpreted	.2074	2.196	.2806	.1285	.3166	.1974	2.250	.2654	.1253	.2995
	-truncated	.3306	1.739	.3682	.1622	.4155	.2978	1.832	.3341	.1539	.3770
	5HdD1/Sh,He,Gr	.6195	1.270	.5781	.2229	.6497	NO DATA - INSUFFICIENT AREAL OVERLAP				
	1DHd1/Sh,He	.6092	1.281	.5284	.2202	.5962	.5604	1.336	.5401	.2112	.6094
	7HdH1/SB-SF	.4976	1.418	.6240	.1990	.7041	.5133	1.396	.6135	.2021	.6923
3	-interpreted	.3553	1.678	.3462	.1682	.3906	.3550	1.678	.3464	.1681	.3909
	-truncated	.3235	1.758	.3442	.1604	.3891	.4132	1.556	.3611	.1813	.4074
	Ge,He,Sh Ag	.3562	1.676	.3826	.1684	.4308	.4087	1.564	.4069	.1803	.4591
	7Hd2,3/SB,SF	.2623	1.952	.3506	.1445	.3947	.3805	1.621	.4294	.1740	.4846
4	-interpreted	.1989	2.242	.2617	.1258	.2954	.1818	2.346	.2596	.1203	.2930
	-truncated	.2068	2.199	.2820	.1283	.3182	.1948	2.266	.2800	.1245	.3159
	7HdD2/SB-SF	.2874	1.865	.4235	.1512	.4778	.2629	1.950	.4024	.1446	.4540
	1Hd1/Gr,He	.3483	1.694	.5397	.1665	.6089	.3070	1.805	.5360	.1563	.6048
	7HdSC3/SB-SF	.6464	1.244	.5483	.2268	.6165	.7887	1.126	.6098	.2505	.6880
	9HdC3/SF	.4344	1.517	.4956	.1859	.5597	.5053	1.407	.4936	.2005	.5570
	7HdHC3/SB-SF	NO DATA - INSUFFICIENT AREAL OVERLAP					.4968	1.419	.6217	.1988	.7015
	5CHS5/SB-SF	NO DATA - INSUFFICIENT AREAL OVERLAP					.5985	1.293	.4996	.2182	.5637
5	-interpreted	.1677	2.442	.2424	.1155	.2735	.1388	2.684	.2255	.1051	.2544
	-truncated	.2949	1.842	.3288	.1532	.3709	.2172	2.146	.2051	.1315	.2314
	7HS3,4/SB-SF	.4793	1.444	.5900	.1953	.6658	.3086	1.800	.3856	.1567	.4350
	9Hd2/SB-SF	.2706	1.922	.3812	.1467	.4301	.5168	1.391	.5649	.2028	.6374
	7Hd1/SB-SF	.5449	1.355	.5327	.2082	.6011	.4633	1.469	.4834	.1920	.5455
6	-interpreted	.0776	3.588	.1804	.0786	.2036	.0791	3.555	.1856	.0793	.2095
	-truncated	.0773	3.596	.1793	.0784	.2023	.0840	3.450	.1858	.0818	.2097
	9Hd2/SB-SF	.1088	3.032	.2717	.0930	.3066	.0895	3.343	.2751	.0844	.3105
	9HS4/SF-O	.7958	1.210	.5886	.2516	.6641	.6180	1.272	.4819	.2218	.5438
	3HHdS2,1/SB-SF	.3500	1.6902	.3887	.1669	.4385	.3321	1.735	.3498	.1626	.3947
	9Hd1/SB-SF	.1538	2.5502	.2260	.1106	.2550	.1607	2.495	.2307	.1131	.2603
	7Hd1/SB-SF	.1361	2.7103	.2160	.1041	.2438	.1248	2.831	.2106	.0996	.2377

[a] Area of polygon/Area of circle having the same perimeter
[b] Perimeter of polygon/Area of circle having the same area
[c] Square root of area/Length of longest axis
[d] Square root of area/Perimeter
[e] Diameter of a circle having the same area/Length of longest axis
[f] Includes boundary outside the surveyed area

TABLE 6. Comparison of Shape Index Rankings With Visual Rankings of Vegetation and Soil Delineations (using maps as base reference)

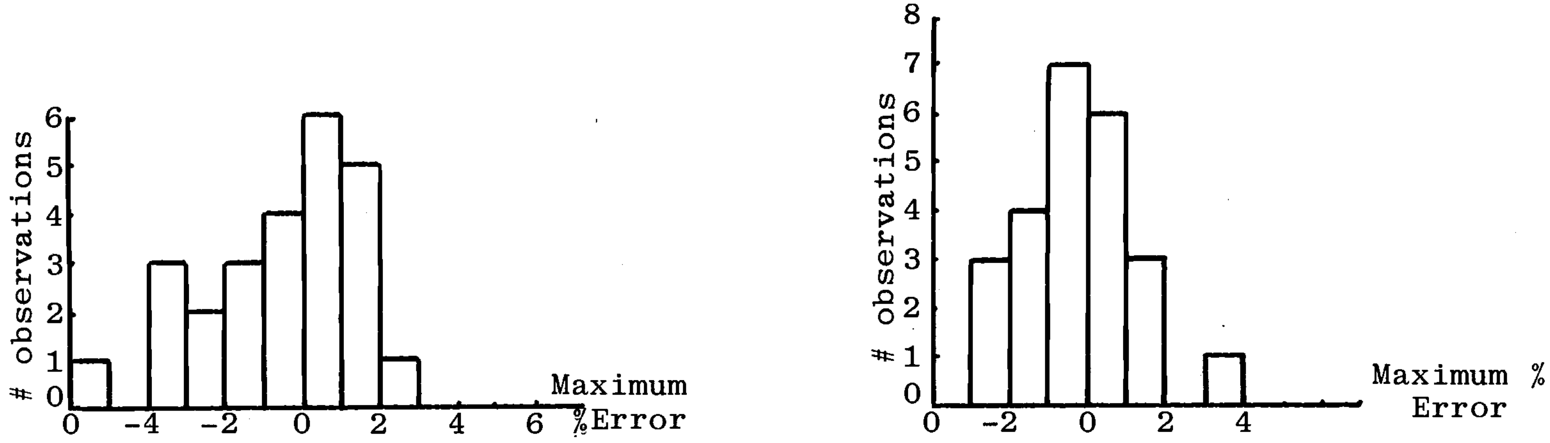
			Σ(Visual rank-index rank)^2	
MAP UNIT	COMPLEX		A_U/A_C	D_{CSA}/L
GAULDY	1		2	0
	2		2	0
	3		8	0
	4		10	16
	5		2	4
	6		10	4
		TOTAL	34	24
KLICKITAT[a]	1		10	8
	2		18	10
	3		12	12
	4		18	6
	5		4	2
	7		12	4
	10		2	2
		TOTAL	76	44

[a] Complexes involving less than four delineations were not visually ranked

warranted if great variability was obtained in readings taken with the digital planimeter. Measurements for the first several soil-vegetation complexes were acquired in triplicate, so that the average and the maximum percent difference of a reading from the average could be computed. The maximum percent error, never larger than six percent, decreased as more experience with the equipment was obtained (see Figure 3). This level of error was considered tolerable in light of the inherent precision of the maps themselves. It was decided, therefore, that acquiring only one reading per measurement would be adequate for the purposes of the investigation.

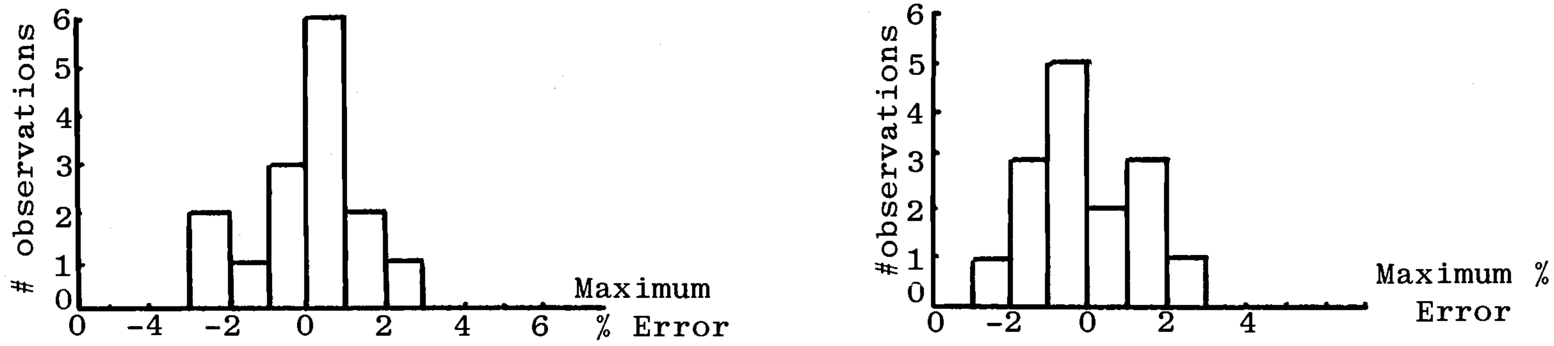
B. Data Collection

Analysis of every one of the more than three hundred soil delineations on the Munson Falls Tree Farm was not feasible. Hence, two mapping units were studied in detail, and others were evaluated in a small sample. The Hembre silt loam, 30-60% uneven slope (31-U-45) and the Hembre silt loam, 30-60% uneven dissected slope (31-V-45) were selected for the detailed analysis. Both phases are extensive throughout the tree farm and are important in terms of timber stand management. They are also relatively pure; mapping unit inclusions (of Klickitat and to a lesser degree Astoria soils) typically comprise less than 15 percent of these delineations (Meurisse and Youngberg, 1971). These two mapping units do exhibit a wide range of characteristics within the definition of Hembre soils. In particular, depth varies with slope position, decreasing upslope and with convexity (Meurisse and Youngberg, 1971). Table 7 presents the important attributes of the two soil phases. The main difference between the



a. Area measurements - first five complexes

b. Perimeter measurements - first five complexes



b. Area measurements-without the first two complexes

d. Perimeter measurements - without the first two complexes

Figure 3. Maximum percent difference in measurement readings from the average reading - 13-a-5 complexes.

TABLE 7. Characteristics of Hembre Silt Loam, 30-60% Uneven Slope, and Hembre Silt Loam, 30-60% Uneven Dissected Slope (from Meurisse and Youngberg, 1971, and Bailey and Poulton, 1968).

Classification:	fine-loamy, mixed, mesic Typic Haplumbrept
Parent Material:	hard basalt and gabbro
Elevation:	200 to 2600 feet (60 to 790 m)
Depth:	deep and very deep
Drainage:	well-drained
Texture:	silt loam
Surface characteristics:	thick, dark reddish brown or dark brown; 0-20% fine gravel and concretions
Subsurface characteristics:	thick, dark reddish brown to dark brown, or yellowish red to strong brown; silty clay loam or clay loam; 0-60% gravel and cobbles
Productivity:	highly productive
Erosion hazard:	moderate
Runoff:	moderate

phases is in degree of dissection. Any disparity observed between the two phases in terms of shape or vegetation associations might be attributable to this difference.

A random sample was taken of the remaining soil delineations on the tree farm. Each delineation was assigned a number which was subject to being selected from a random digit table. Twenty-seven delineations represented a sample size of ten percent.

Figure 4 illustrates the location of all soil-vegetation complexes studied. The margin between lowlands and uplands coincided with a distinct transition in relief as depicted on a topographic map.

The same data collection methodology was employed in both the detailed study and the random sample. First the appropriate soil polygon was located on the map and on the air photos. If truncated by the survey boundary, the perimeter of the delineation was extended stereoscopically to approximate its natural shape. The delineation was traced from the map onto tracing paper with a graphite pencil. In the case of truncated delineations, the mapped portion was traced from the map, and the remaining perimeter was traced from the photos after matching the boundaries as closely as possible. Such polygons were identified with an asterisk.

Tick-marks representing 5,000 foot intervals of the State Plane Coordinate System were traced along with the soil delineations. These helped to identify the location of each soil-vegetation complex. The coordinate grid was further subdivided to 2,500 foot intervals, and the coordinates closest to the center of the soil delineation were recorded, as were the township, range, section, and air photo(s) on which the polygon was located. Superimposing the traced tick-marks with those on the vegetation maps enabled proper registry of the soil and vegetation

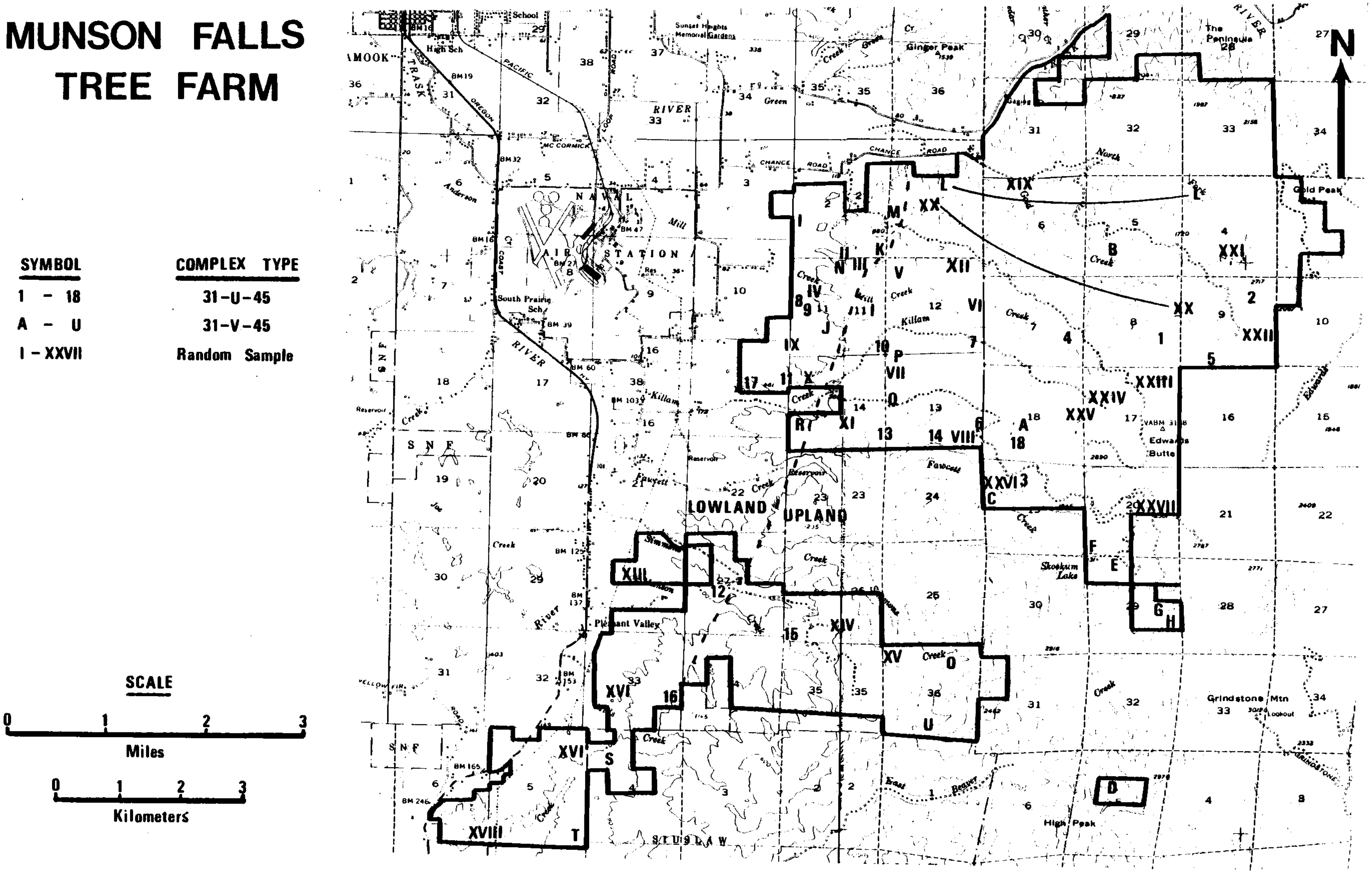


Figure 4. Location of soil-vegetation complexes on the Munson Falls Tree Farm.

polygons. The vegetation delineations were then traced and labeled in red pencil. Boundaries of truncated delineations were extended stereoscopically on the vegetation photo overlays and transferred to the tracing paper. All such delineations were identified with an asterisk. Figures 5, 6, and 7 provide examples of completed soil-vegetation complex tracings.

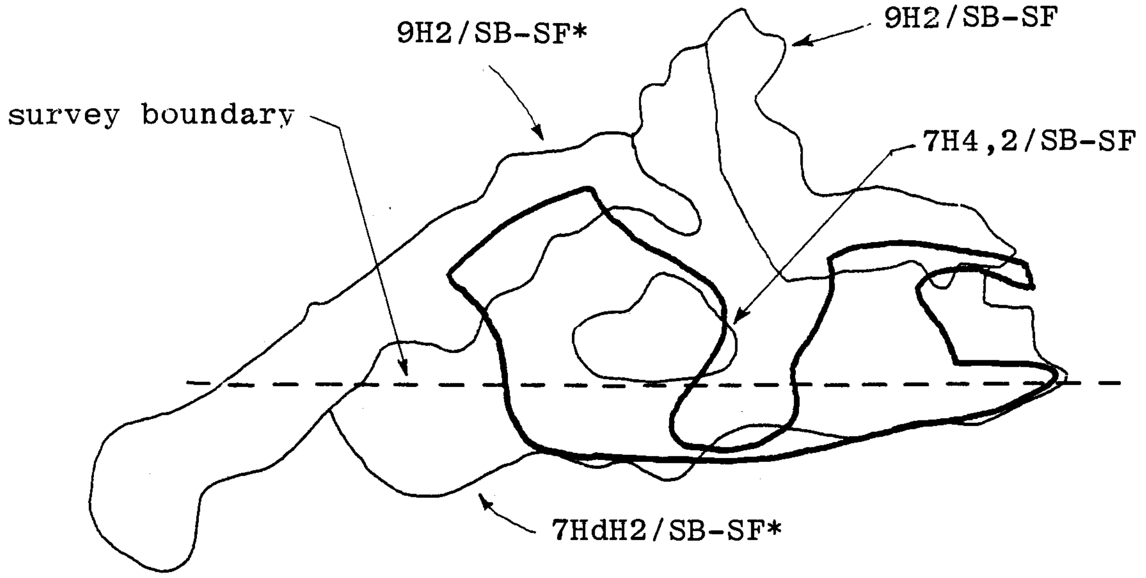
Data sheets were drawn up for each soil-vegetation complex, with soil and vegetation units listed vertically and the measurements to be acquired listed horizontally. A tracing of a soil-vegetation complex was taped onto the active work area of the Graf/Pen Sonic Digitizer. Measurements were collected in centimeters and square centimeters.

The measurements collected and the methods for acquiring them were as follows:

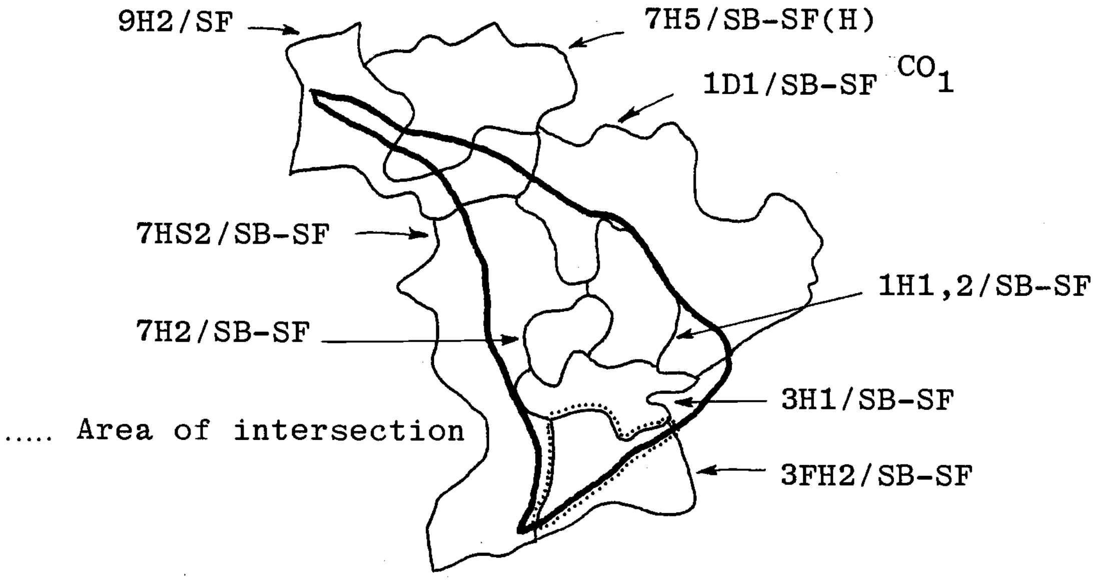
-Area. With the digitizer in the areal mode, the outline of each shape was tracked with the cursor and the areal value was recorded from the digital display. The areas of any enclaves that existed in the shape (see for example 7H4,2/SB-SF in Figure 5a) were subtracted from the first reading to obtain a final value.

-Area of Union. This is defined as the area covered by either the soil or the individual vegetation polygon, or both. Figure 6 illustrates the area of union for one soil-vegetation combination. The cursor was tracked around the indicated boundaries to obtain a reading. In cases where the resultant shape contained enclaves, their areas were subtracted to obtain the final reading.

-Area of Intersection. This is the area covered by the soil and the vegetation, as is shown in Figure 5b. Where the area of intersection occurred as two or more "islands," the area of each island was summed to obtain a final value. If the total area of intersection was less



a. Complex #14.



b. Complex #18.

<u>Figure 5</u>. Examples of 31-U-45 soil-vegetation complexes. See text for further explanation.

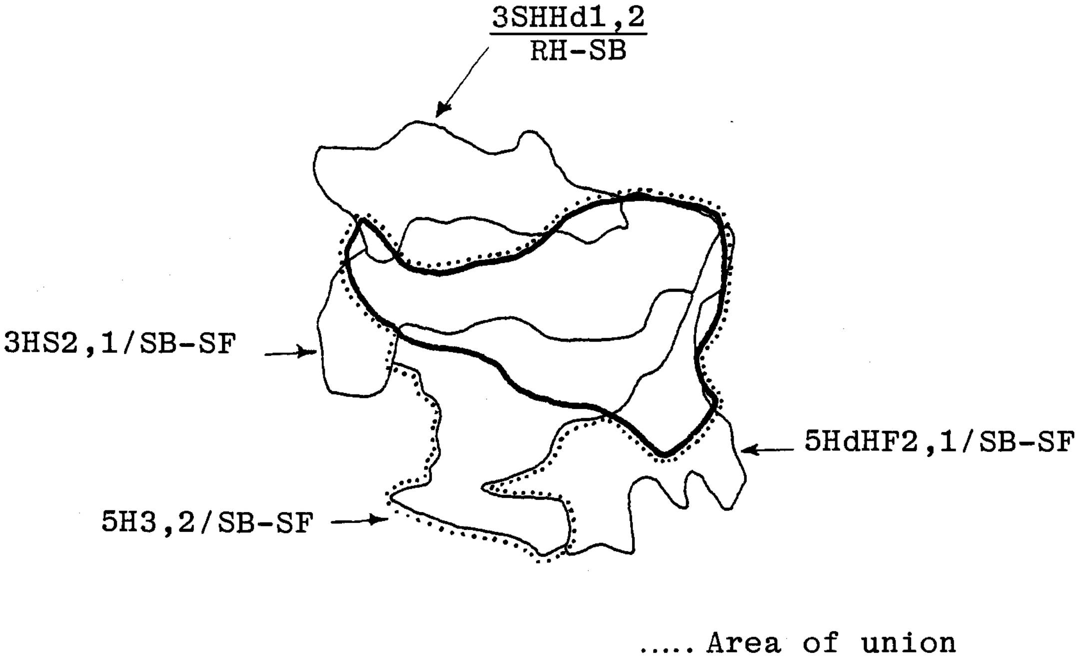


Figure 6. Example of 31-V-45 soil-vegetation complex. Complex "A". See text for further explanation.

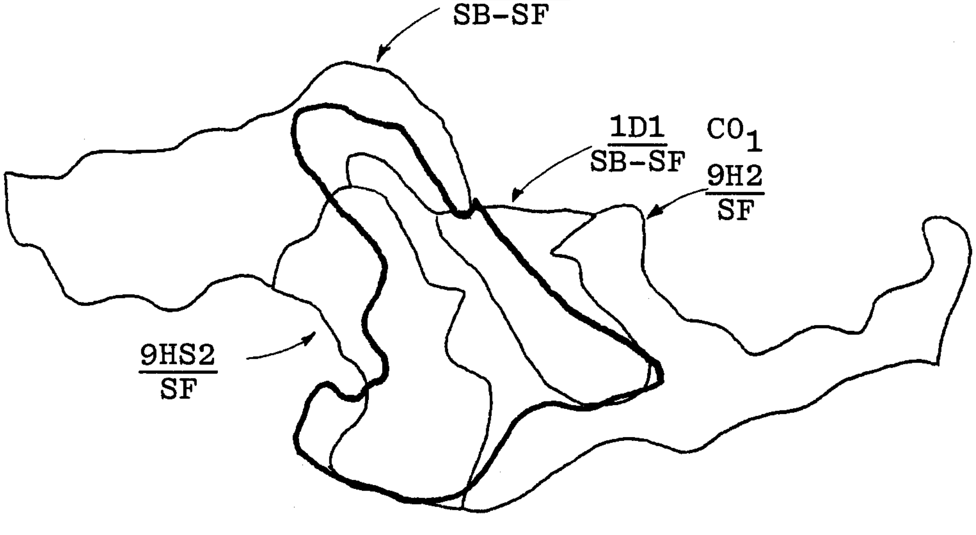


Figure 7. Example of random sample soil-vegetation complex. Complex V; soil mapping unit: 21-U-45.

than ten percent of either the vegetation or the soil area, the vegetation delineation was excluded from further consideration.

-Perimeter. The same boundary digitized for the area reading was tracked agian, but with the digitizer in the length mode.

-Long Axis. This measurement was acquired last to avoid cluttering the sheet with lines before other measurements were taken. In most cases the long axis could be located by visual inspection. For shapes having two or more approximately equal long dimensions, each long axis candidate was measured with a metric ruler, then with the digitizer itself if the ruler measurements were almost identical. Often in such cases the long axis was only 0.01 cm longer than the closest alternative. Once identified, the longest axis was drawn in purple pencil and the length between endpoints was recorded.

The data sheets were checked for accuracy and completeness once the digitizing phase was completed. Discrepancies and omissions were rectified with additional measurements. All measurements were then converted to meters, kilometers, or hectares. The elongation ratio used as a shape index was computed using the formula

$$\frac{2(\text{Area}/\pi)^{\frac{1}{2}}}{\text{Long axis}} ;$$

the numerator gives the diameter of a circle having the same area as the polygon.

Tables A1 through A3 in Appendix I present the cartometric data collected, which were subsequently analyzed to detect trends in the correspondence between vegetation and soil delineations.

IV. DATA ANALYSIS

The data collected were analyzed with three basic aims: to discern trends in the shapes of soil polygons, to compare the elongation ratios of vegetation and soil polygons, and to evaluate areal correspondence relationships between the two types of polygons. Results of the latter two methods were compared to see if they indicated the same type of soil-vegetation relationships.

Simple nonparametric statistical methods, which obviate the need for assumptions of normal distributions (Hollander and Wolfe, 1973), were employed for data analysis. The Kolmogorov-Smirnov test reveals differences of any sort between the distributions of two samples or populations. Spearman's rank correlation coefficient indicates the degree to which the ranks of paired observations are associated. The r_s value can be used as a test statistic to evaluate the null hypothesis that the variables are independent. The chi-square test also measures degree of association, but does so in reference to expected frequencies with which the data fit certain categories of two variables (Daniel, 1978). Statistical test results are presented in Appendix II.

The general procedure in each type of analysis involved two facets: the comparison of trends between soil mapping units, and the comparison within mapping units between lowland and upland delineations. The first mode of analysis allowed an investigation of differences between delineations having different properties. In the second case the influences of elevation, terrain, and associated site variables could be addressed.

A. Soil Delineation Relationships

A basic premise of the research was that a given type of soil may be characterized by delineations having a particular appearance. This premise was evaluated by analyzing the data on size and shape of soil delineations.

Figure 8 illustrates the distributions of soil delineation size for 31-U-45, 31-V-45, and the random sample. Frequencies for lowland and upland delineations are illustrated simultaneously. In all three cases the median delineation size is under 30 ha. Kolmogorov-Smirnov tests show that all three data sets follow essentially the same distribution. No significant difference is evident between the size of lowland and upland delineations except in the 31-V-45 data set. In this instance the uplands contain several comparatively small delineations. Soil bodies larger than 120 ha[5] appear in all three data sets. The perimeters of these large polygons typically exhibit numerous indentations created by smaller polygons of different mapping units. Irregular shapes for large delineations thus result.

Figure 9 illustrates the distribution of values for the elongation ratios for soil polygons, including those investigated in the preliminary study. Possible values for the elongation ratio (ER) range between zero and one. Small values indicate long and narrow shapes, whereas values close to one imply more rounded shapes. Kolmogorov-Smirnov tests on these distributions show that delineations of the Klickitat ridge (32-R-45) and the Gauldy alluvial (13-a-5) soils are more elongate than the Hembre polygons and those of the random sample. However, the ER

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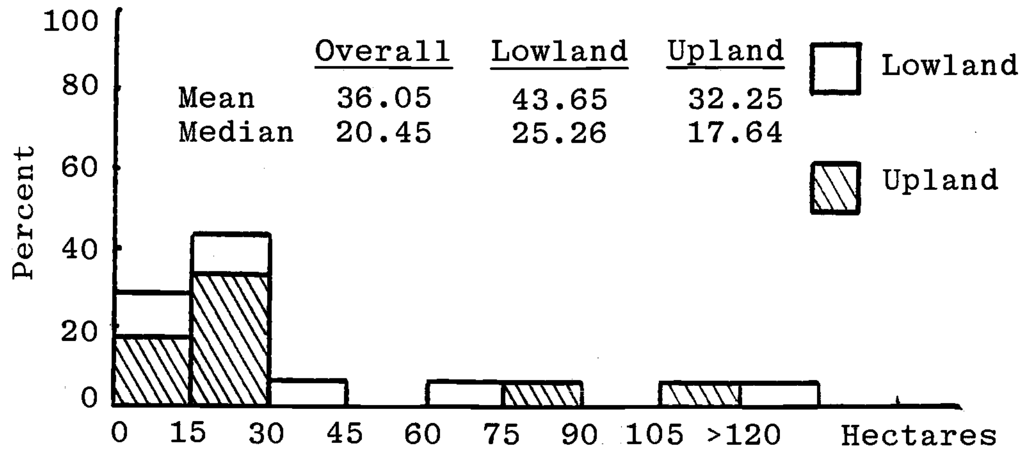
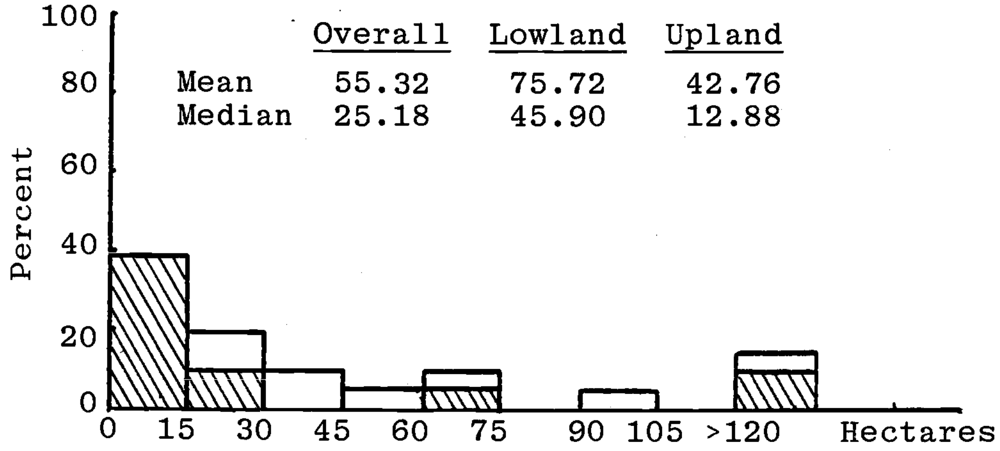
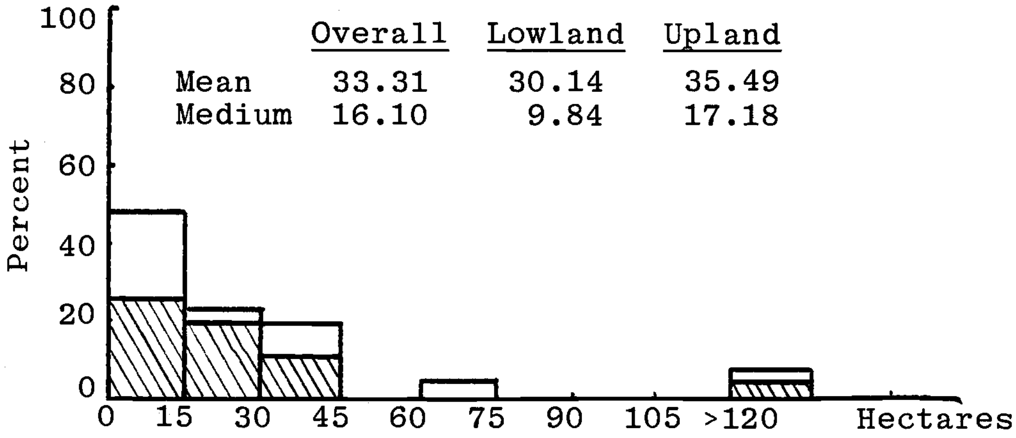
[5] These are analogous to what Fridland (1972) terms background elementary soil areals (ESAs).



a. 31-U-45 polygons

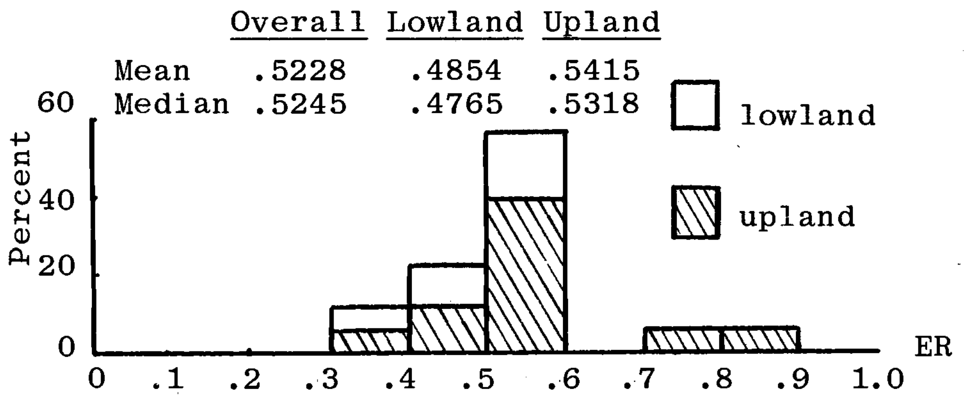


b. 31-V-45 Polygons

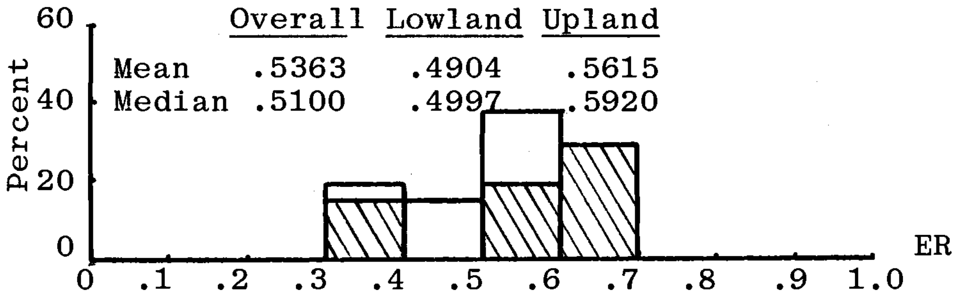


c. Random sample polygons

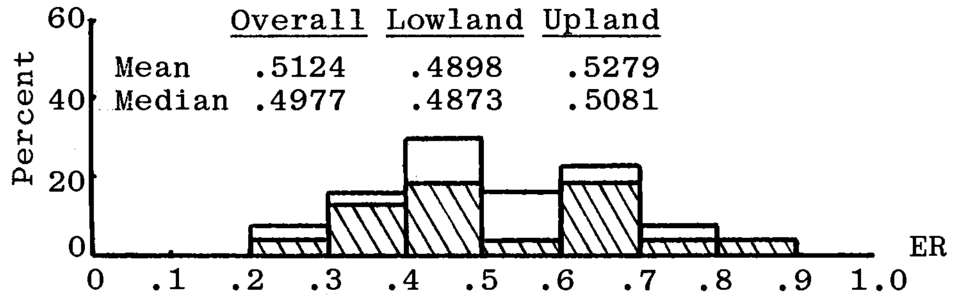
Figure 8. Distribution of soil delineation size.



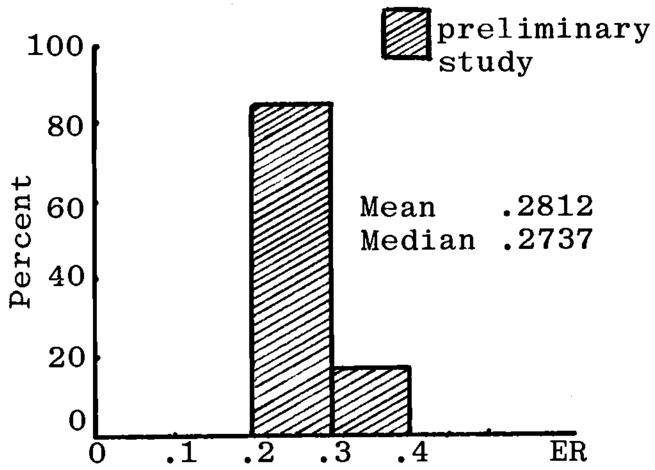
a. 31-U-45 polygons



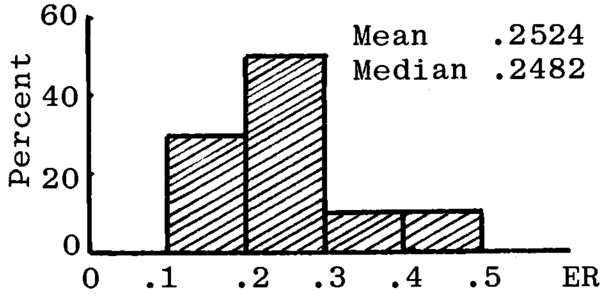
b. 31-V-45 polygons



c. Random sample polygons



d. 13-a-5 polygons



e. 32-R-45 polygons

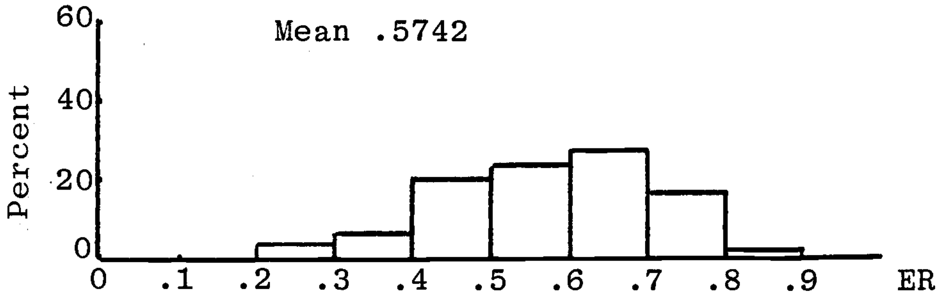
Figure 9. Distribution of soil polygon elongation ratios.

values for the Gauldy and the Klickitat soils are not significantly different from each other. Neither of the Hembre mapping units differ significantly in terms of elongation from the randomly sampled soils. Furthermore, no difference is found between the distributions for the two Hembres. Upland and lowland comparisons within the two mapping units and within the random sample similarly reveal no significant distinction in ER values, although the means and medians indicate higher values in the uplands. Overall, these statistical results confirm the visual impressions gained during the course of data collection, i.e. that mapping units could not be differentiated by the size or shape of their delineations.

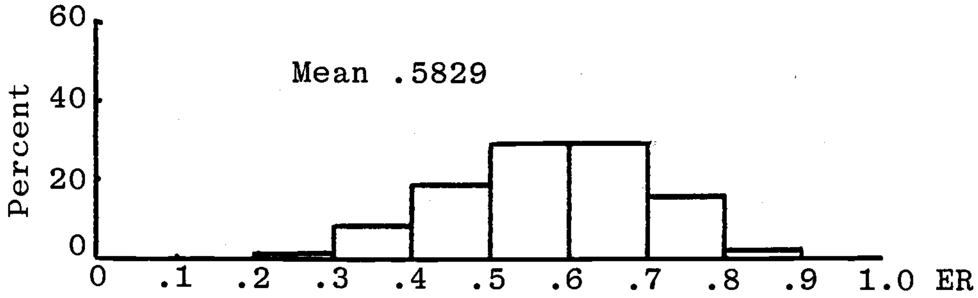
B. Soil-Vegetation Shape Comparisons

One way to assess the relationship between vegetation and soil delineations is to compare their shapes, or in this case, their relative degree of elongation. The distributions of ER values for vegetation polygons are shown in Figure 10. The means of these distributions tend to be higher than those shown in Figure 9, implying that vegetation polygons are generally more rounded than soil polygons.

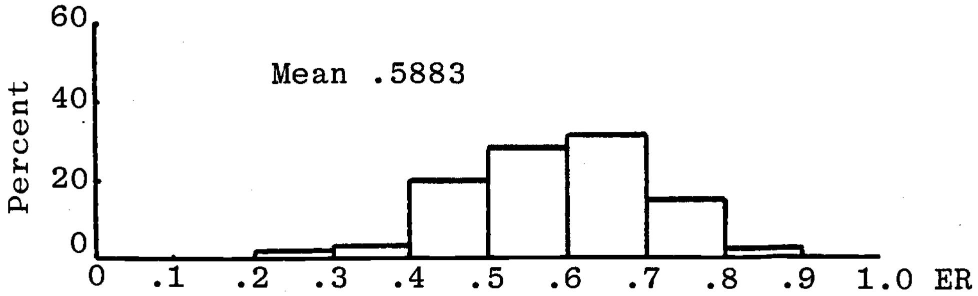
Nevertheless, if a strong relationship exists between a body of soil and the vegetation it supports, a similarity in the shapes of the delineations might be expected. That is, elongated soil polygons would have elongated vegetation delineations overlapping them, and more rounded soil polygons would support vegetation delineations with higher ERs. Because most soil delineations have several vegetation polygons overlapping them, the average of the vegetation ERs serves as the basis of



a. Vegetation polygons in 31-U-45 complexes



b. Vegetation polygons in 31-V-45 complexes



c. Vegetation polygons in random sample complexes

Figure 10. Distribution of vegetation polygon elongation ratios.

comparison with the soil ERs. Spearman's rank correlation coefficient was used to test the idea that the elongation ratios of vegetation delineations and the underlying soil are associated.

Table 8 presents the ER values for the soil delineations and the average ER of their overlapping vegetation delineations. Calculated values of Spearman's rank correlation coefficient range from -.68 for the lowlands in the random sample to +.68 for the 31-U-45 upland complexes. Of the nine r_s values calculated, only these two and the +.56 value for all 31-U-45 complexes prove to be significantly different from zero ($\alpha = .05$). Thus, the shapes of soil polygons and overlapping vegetation polygons tend to be similar in upland 31-U-45 complexes and in 31-U-45 complexes as a whole. Conversely, rounded soil shapes tend to be associated with elongate vegetation shapes, and vice versa, in random sample lowland complexes. Even so, the r_s values suggest weak correlations at best between soil and vegetation polygon shapes in these three cases. Consistent trends are entirely absent in the remaining data sets.

Reasons for the different outcomes in shape correlation are not apparent. The negative correlation for randomly sampled soils in the lowlands implies that rounded soil bodies tend to be overlapped by more elongate vegetation polygons, and that elongate soils are overlapped by rounded vegetation polygons. The first situation is a departure from the norm, in that vegetation polygons generally are more rounded (have higher ERs) than soil polygons (compare Figures 9 and 10). Explanations for this inverse relationship between lowland soil and vegetation shapes are not immediately apparent. The comparatively large r_s value for upland 31-U-45 complexes contributes to the positive correlation for 31-U-45 complexes

TABLE 8. Comparison of Soil Polygon ERs With The Average ER of Overlapping Vegetation Polygons

a. 31-U-45 complexes

Complex	Upland/ Lowland	Soil ER	Average Veg.ER
1	Up	.7652	.5741
2	Up	.8398	.6759
3	Up	.5435	.6151
4	Up	.5334	.6199
5	Up	.5362	.6140
6	Up	.5302	.4852
7	Up	.4021	.4782
8	Low	.4489	.6324
9	Low	.4486	.5170
10	Up	.3231	.4799
11	Low	.5040	.4021
12	Low	.5904	.5402
13	Up	.4401	.5703
14	Up	.5245	.5694
15	Up	.5358	.6315
16	Low	.5375	.6157
17	Low	.3830	.4538
18	Up	.5245	.6555

	r_s
Overall	+.5577
Lowlands	+.3143
Uplands	+.6783

b. 31-V-45 complexes

Complex	Upland/ Lowland	Soil ER	Average Veg.ER
A	Up	.6516	.5385
B	Up	.5090	.5479
C	Up	.5920	.5368
D	Up	.6698	.6653
E	Up	.5602	.5010
F	Up	.6913	.5133
G	Up	.6544	.6212
H	Up	.6969	.6360
I	Low	.5985	.4465
J	Low	.4924	.5925
K	Low	.3379	.5494
L	Up	.3905	.5792
M	Low	.5580	.5707
N	Low	.4742	.5102
O	Up	.5084	.6171
P	Up	.3963	.5608
Q	Up	.3816	.5587
R	Low	.4455	.5872
S	Low	.5070	.6456
T	Low	.5100	.5696
U	Up	.6367	.6822

	r_s
Overall	+.0864
Lowlands	-.1429
Uplands	+.1813

c. Random sample complexes

Complex	Upland/ Lowland	Soil ER	Average Veg.ER
I	Low	.3768	.5875
II	Low	.2545	.6344
III	Low	.4316	.6241
IV	Low	.5275	.4795
V	Up	.6330	.5577
VI	Up	.3819	.6131
VII	Up	.7177	.4041
VIII	Up	.4679	.5298
IX	Low	.5045	.5211
X	Low	.4696	.5577
XI	Low	.6257	.4629
XII	Up	.2405	.5848
XIII	Low	.7028	.5699
XIV	Up	.4977	.5856
XV	Up	.4057	.5211
XVI	Low	.4515	.6325
XVII	Low	.4873	.6232
XVIII	Low	.5560	.6281
XIX	Up	.3798	.6305
XX	Up	.4175	.5625
XXI	Up	.6884	.6422
XXII	Up	.6340	.6034
XXIII	Up	.6284	.6589
XXIV	Up	.3636	.5924
XXV	Up	.6570	.5808
XXVI	Up	.8182	.5627
XXVII	Up	.5144	.6079

	r_s
Overall	-.2208
Lowlands	-.6773
Uplands	-.1324

as a whole. Why a positive correlation occurs in this instance but not in other categories is unclear. The lack of dissection does not appear to be a factor. The random sample data include both dissected and undissected delineations; thus, if dissection were an influence in ER similarity, the sample r_s values would be intermediate between those for 31-U-45 complexes and 31-V-45 complexes, instead of exhibiting the lowest values of the three data sets.

The positive correlation found for the upland 31-U-45 complexes is consistent with another apparent difference among the data sets: the trend for r_s values to be more positive in the uplands than in the lowlands. Further analyses are required to determine whether the observed trends, which are not statistically significant, are merely coincidence. Physiographic contrasts might offer an explananation for the observations. The lowlands are typified by relatively uniform conditions; that is, sharp transitions in microclimate, slope, and moisture regime are generally lacking. Such conditions may allow vegetation associations in the lowlands to become established in relation to subtle microsite variations or local disturbance history - in either case, conditions not directly related to the soil substrate. In the uplands, however, boundaries of soil delineations frequently coincide with important topographic transitions, such as ridgetops, aspect changes, and slope variations. These same transitions that have affected soil development may also influence the boundaries of plant communities. The shapes of soil and vegetation delineations may therefore be more similar in the uplands because the two features are responding to the same environmental influences.

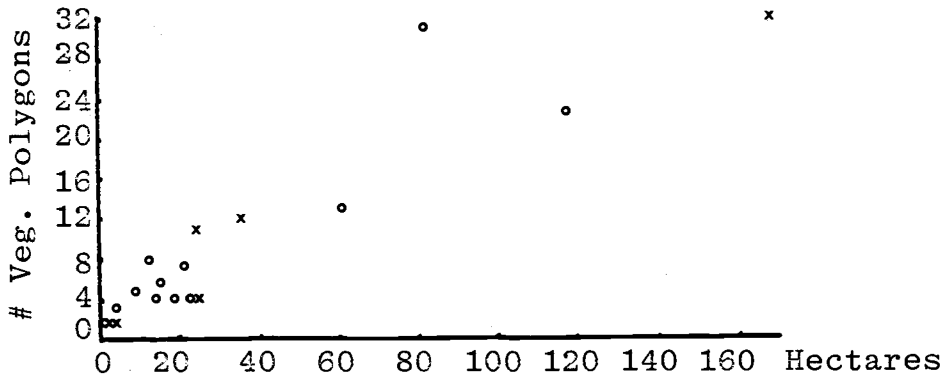
The elongation ratio correspondences between particular vegetation community types and the soil substrate has not yet been addressed. This is touched upon in Section D, in which the results of ER studies and areal correspondence analyses are compared.

C. Areal Relationships and Areal Correspondence

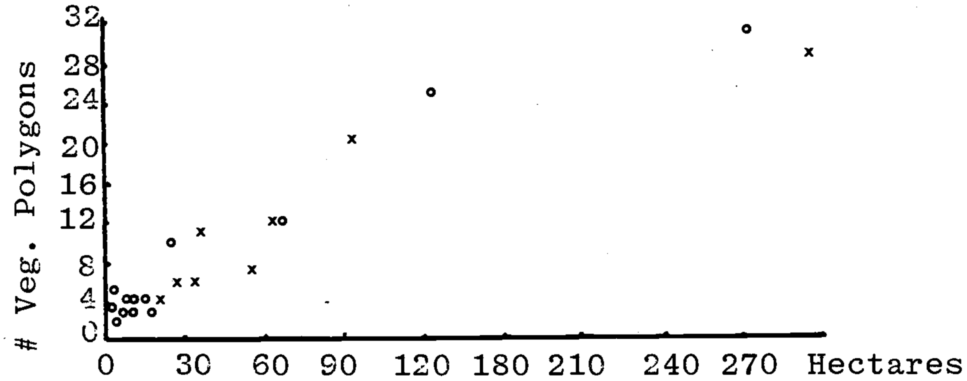
Comparison of polygon shapes is but one means of studying the spatial association of two factors. Another approach to the problem examines the degree of areal overlap between the two types of polygons. For this study three facets of the areal approach are employed. First, the number of vegetation delineations found on each soil polygon is compared to the size of the soil polygon. If soil mapping unit characteristics exert an important influence on the distribution of vegetation, a constant number of vegetation delineations would overlap soil delineations of any size. Large polypedons would support areally large vegetation communities, and vice versa. Second, the total extent of overlap between given vegetation communities and soil delineations is examined. A ranking of these values indicates the relative dominance of community types on the soil mapping units. Third, the amount of areal correspondence is evaluated. This compares the area of soil and vegetation overlap with the area covered by either, i.e. the area of intersection with the area of union. Areal overlap and areal correspondence do not necessarily agree. For example, a vegetation community could overlap a large proportion of a soil delineation, but if the vegetation also had a large extent beyond the soil boundary, the two would have a low areal correspondence. Areal correspondence provides a good indication of soil-vegetation interdependency at the delineation level.

Numbers of vegetation polygons overlapping soil delineations of various sizes are plotted in Figure 11. In all three cases the degree of correlation is high (see Appendix II), suggesting that larger polypedons do support more vegetation communities than smaller polypedons. The independence of soil and vegetation delineation size is thus implied. The calculations also demonstrate that lowland and upland soil-vegetation complexes do not behave very differently in this regard, although the correlation is somewhat higher in the lowlands. One anomalous complex (#15) is seen in Figure 11a. The complex has thirty-one vegetation polygons although the area of the soil is only 81 ha. In contrast, the soil delineation in complex #16 is twice this size (168 ha) and has 32 overlapping vegetation polygons. The anomaly is due to the boundary tortuosity of the smaller soil polygon. As a background delineation from which others have been "carved out," the smaller polygon has a perimeter just 12 percent shorter than the perimeter of the larger polygon. This proportionately long perimeter leads to a greater number of overlapping vegetation polygons than would be expected from considering delineation size alone.

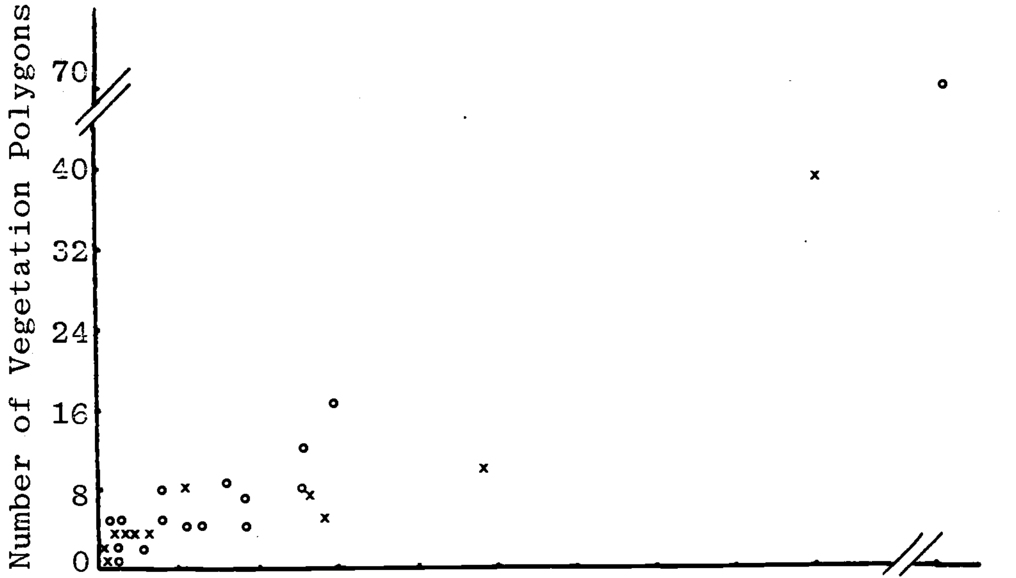
Examination of differences in vegetational areal overlap and in areal correspondence requires that technical groupings be made. Vegetation classes were defined using density, canopy composition, age class, and understory as criteria (see Table 2). The result was a vast number of vegetation mapping units, many of which were represented by only one or two delineations. At first vegetation mapping units having the same species composition and dominance in the canopy and the same understory were grouped; in effect, this amounted to ignoring density and age class information. Even with this degree of generalization,



a. 31-U-45 complexes



b. 31-V-45 complexes



c. Random sample complexes

Figure 11. Number of vegetation polygons in a complex vs. soil delineation size. x = lowland complex; o = upland complex.

109 classes resulted. Forty-four classes were finally achieved by considering the dominant canopy species, whether subdominants were present, and the understory community. The first two criteria give the most fundamental information about canopy composition, whereas the understory communities are indicative of site conditions, particularly of effective moisture (Meurisse and Youngberg, 1971). Thus in Tables 9 and 10, the understory communities are shown in order of increasing effective moisture, with miscellaneous classes shown last. Further details on the composition and characteristics of the understory communities can be found in Meurisse and Youngberg (1971).

The relative extent of different community types on 31-U-45, 31-V-45, and the randomly sampled soils is indicated in Table 9. The figures shown are derived by totaling all area of intersection values for each community category. This sum is then divided by the total number of hectares comprising the soil mapping unit overall, in the uplands, or in the lowlands as appropriate. The most extensive community type in almost all cases consists of hemlock with subdominants and a salmonberry-sword fern understory (H&/SB-SF). Other common vegetation communities are hemlock-dominant, spruce-dominant, alder-dominant, and alder with subdominants, all over salmonberry-sword fern (H/SB-SF, S/SB-SF, Hd/SB-SF, Hd&/SB-SF); hemlock with a sword fern understory (H/SF); hemlock with subdominants over a vine maple-sword fern community (H&/VM-SF); and hemlock with subdominants and a blue huckleberry-salmonberry understory (H&/RH-SB).

The preponderance of salmonberry-sword fern communities agrees with the observations of the survey report. Alder stands are especially likely to be associated with this understory community, which, along with TB-ST and

TABLE 9. Percentages of Areal Overlap Between Vegetation Communities and Soil Delineations

COMMUNITY TYPE	Percent of Areal Overlap[a]								
	31-U-45			31-V-45			Random Sample		
	Lowland	Upland	Overall	Lowland	Upland	Overall	Lowland	Upland	Overall
D/TB-ST	-	-	-	-	-	-	-	1.38	.87
H/TB-ST	-	.35	.21	-	-	-	-	1.14	.72
H&/TB-ST[b]	-	.83	.50	-	.69	.33	-	-	-
Hd&/TB-ST	-	1.56	.93	-	.99	.47	-	.78	.49
D/BR-LO	-	-	-	-	-	-	-	4.89	1.80
DHd/BR-LO	-	-	-	-	-	-	-	.78	.49
HdD/BR-LO	-	-	-	-	-	-	-	1.00	.63
D/RH-SB	-	.52	.31	-	-	-	-	-	-
DH/RH-SB	-	-	-	-	-	-	-	.25	.16
F/RH-SB	-	-	-	-	-	-	-	.21	.13
F&/RH-SB	-	-	-	-	-	-	-	1.91	1.21
S&/RH-SB	-	1.65	.98	-	.13	.06	-	.59	.37
H/RH-SB	3.67	4.24	4.01	-	-	-	-	2.76	1.74
H&/RH-SB	3.34	4.38	3.96	-	1.08	.52	-	5.43	3.43
Hd&/RH-SB	-	-	-	-	.40	.19	-	1.50	.95
DH/VM-SF	-	-	-	.26	-	.13	-	-	-
H/VM-SF	-	-	-	-	.20	.10	5.08	-	1.87
H&/VM-SF	3.28	2.35	2.73	3.81	-	1.99	28.77	-	10.61
Hd/VM-SF	.83	-	.34	-	-	-	.47	-	.17
Hd&/VM-SF	3.82	-	1.54	1.37	.33	.87	1.35	-	.50
NS/VM-SF	-	-	-	-	-	-	1.22	-	.45
DH/SF	-	-	-	-	-	-	.31	-	.11
S/SF	1.58	-	.64	-	-	-	-	-	-
H/SF	2.11	9.60	6.58	2.07	3.00	2.51	2.28	6.18	4.74
H&/SF	8.37	2.51	4.83	.92	.50	.72	-	2.22	1.40
D/SB-SF	-	.47	.28	.75	-	.39	.52	2.39	1.70
D&/SB-SF	3.72	-	1.50	2.87	-	1.49	-	.27	.17
FH/SB-SF	-	.70	.42	-	-	-	-	-	-
S/SB-SF	6.45	4.90	5.52	6.87	4.91	5.93	1.45	.58	.90
S&/SB-SF	-	4.89	2.92	1.39	-	.73	-	3.49	2.20
H/SB-SF	5.96	8.67	7.58	2.91	4.19	3.52	-	9.21	5.82
H&/SB-SF	11.69	26.60	20.58	21.97	33.06	27.28	11.92	31.25	24.12
C&/SB-SF	-	-	-	-	.47	.22	.11	-	.04
Hd/SB-SF	6.40	7.38	6.98	6.28	13.17	9.58	8.14	5.30	6.34
Hd&/SB-SF	10.08	8.17	8.94	11.35	22.36	16.62	8.93	5.96	7.05
CO_1/SB-SF	.83	-	.34	-	.18	.09	-	1.88	1.19
DH/SF-O	-	-	-	-	1.29	.62	3.02	-	1.11
H/SF-O	3.13	2.65	2.84	.95	-	.49	.27	.20	.23
H&/SF-O	3.47	2.13	2.67	.58	1.08	.82	1.69	-	.62
NS/SF-O	-	.34	.20	-	-	-	-	.61	.39
D(&)/Sh-He(&)[c]	-	-	-	1.52	-	.79	1.38	-	.51
S(&)/Sh-He(&)	1.26	-	.51	3.03	-	1.58	.74	.18	.39
Hd(&)/Sh-He	-	-	-	1.52	-	.79	1.29	-	.48
Gr,He,Sh	-	-	-	-	-	-	1.14	.29	.60

[a] For each vegetation community/soil category combination, percent of areal overlap = Σ area of intersection/Σ soil area

[b] &=presence of subdominants

[c] (&)=subdominants may or may not be present

TABLE 10. Indices of Areal Correspondence Between Vegetation and Soil Delineations

COMMUNITY TYPE	Index of Areal Correspondence[a]								
	31-U-45			31-V-45			Random Sample		
	Lowland	Upland	Overall	Lowland	Upland	Overall	Lowland	Upland	Overall
D/TB-ST	-	-	-	-	-	-	-	.0319	.0319
H/TB-ST	-	.0165	.0165	-	-	-	-	.1682	.1682
H&/TB-ST	-	.0399	.0399	-	.3503	.3503	-	-	-
Hd&/TB-ST	-	.2432	.2432	-	.1096	.1096	-	.0157	.0157
D/BR-LO	-	-	-	-	-	-	-	.1343	.1343
DHd/BR-LO	-	-	-	-	-	-	-	.1087	.1087
HdF/BR-LO	-	-	-	-	-	-	-	.1412	.1412
D/RH-SB	-	.0574	.0574	-	-	-	-	-	-
DH/RH-SB	-	-	-	-	-	-	-	.0990	.0990
F/RH-SB	-	-	-	-	-	-	-	.0878	.0878
F&/RH-SB	-	-	-	-	-	-	-	.3252	.3252
S&/RH-SB	-	.0786	.0786	-	.0385	.0385	-	.0714	.0714
H/RH-SB	.0569	.3352	.2424	-	-	-	-	.1366	.1366
H&/RH-SB	.0507	.0798	.0756	-	.5473	.5473	-	.1599	.1599
Hd&/RH-SB	-	-	-	-	.0090	.0090	-	.0579	.0579
DH/VM-SF	-	-	-	.0058	-	.0058	-	-	-
H/VM-SF	-	-	-	-	.0165	.0165	.1693	-	.1693
H&/VM-SF	.1678	.0383	.1160	.1927	-	.1927	.3093	-	.3093
Hd/VM-SF	.2927	-	.2927	-	-	-	.0348	-	.0348
Hd&/VM-SF	.2468	-	.2468	.1756	.0260	.1008	.1045	-	.1045
NS/VM-SF	-	-	-	-	-	-	.1827	-	.1827
DH/SF	-	-	-	-	-	-	.0820	-	.0820
S/SF	.1587	-	.1587	-	-	-	-	-	-
H/SF	.0373	.1293	.0948	.0903	.1187	.1080	.1705	.2496	.2179
H&/SF	.0719	.1750	.0734	.1037	.0400	.0612	-	.1041	.1041
D/SB-SF	-	.0903	.0903	.0278	-	.0278	.0126	.2156	.1649
D&/SB-SF	.0614	-	.0614	.0579	-	.0579	-	.0405	.0405
FH/SB-SF	-	.1449	.1449	-	-	-	-	-	-
S/SB-SF	.1531	.1565	.1548	.2669	.2253	.2565	.2361	.0401	.1707
S&/SB-SF	-	.1143	.1143	.0315	-	.0315	-	.1371	.1371
H/SB-SF	.0921	.2240	.2075	.1150	.1749	.1549	-	.2007	.2007
H&/SB-SF	.1704	.4008	.3240	.2669	.2956	.2830	.1684	.2241	.2002
C&/SB-SF	-	-	-	-	.0172	.0172	.0184	-	.0184
Hd/SB-SF	.1525	.0642	.0894	.0739	.1395	.1002	.1156	.1172	.1168
Hd&/SB-SF	.0866	.1648	.1257	.1142	.1769	.1581	.1329	.0756	.1016
CO_1/SB-SF	.0581	-	.0581	-	.0467	.0467	-	.0375	.0375
DH/SF-O	-	-	-	-	.5298	.5298	.0735	-	.0735
H/SF-O	.0485	.0829	.0657	.0575	-	.0575	.0065	.0041	.0053
H&/SF-O	.0428	.0696	.0495	.0266	.0939	.0689	.0806	-	.0806
NS/SF-O	-	.0505	.0505	-	-	-	-	.0123	.0123
D(&)/SH-He(&)	-	-	-	.0345	-	.0345	.0335	-	.0335
S(&)/Sh-He(&)	.1074	-	.1074	.0525	-	.0525	.1314	.0216	.0948
Hd(&)/Sh-He	-	-	-	.0345	-	.0345	.0687	-	.0687
Gr,He,Sh	-	-	-	-	-	-	.0409	.0777	.0532

[a] For each vegetation community/soil category combination, index of areal correspondence = Σ(area of intersection/area of union)/number of soil delineations where overlap occurs.

BR-LO understories, indicate past disturbance (Meurisse and Youngberg, 1971). In contrast, sword fern communities can be considered climax, and were reported to be not widely distributed. Vine maple-sword fern communities are largely associated with lowland Astoria soils, as indicated in the survey report. Upland Hembre soils are mentioned as a preferred site for blue huckleberry-salmonberry communities (Meurisse and Youngberg, 1971), and this is borne out in soil-vegetation map comparisons.

Great variations are seen in the areal overlap of less extensive community types. Some types are present exclusively in the uplands or the lowlands. This is especially apparent for communities associated with effective moisture extremes. Communities that do best on drier sites are often absent from the lowland soils; the opposite situation also occurs. In addition, fourteen community types are absent from one Hembre unit but are present on the other, and eight are found only on the randomly sampled soils. Among these eight are the sparsely distributed bracken-lotus communities, which are restricted to disturbed upland sites (Meurisse and Youngberg, 1971). Aside from this, no clear trends are discernible in the presence or absence of community types on soil mapping units.

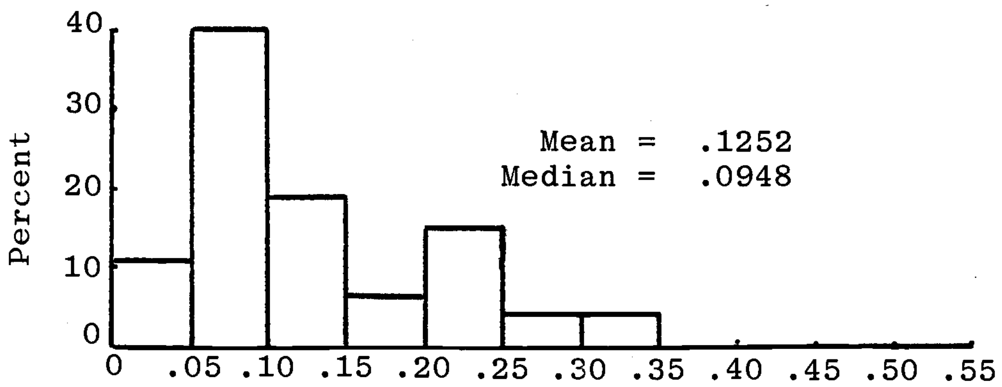
Calculations of areal correspondence (AC) ratios indicate how well individual soil and vegetation polygons coincide. Table 10 presents values representing the degree of areal correspondence between vegetation communities and soils of particular types. The values are obtained by summing the intersection/union ratios for each vegetation-soil combination and dividing this sum by the number of soil delineations involved. This last step negates an upward bias for the more widespread community types. Thus a maximum value of one would be obtained if one community type coincided perfectly with one soil delineation, or if several community type delineations each perfectly coincided with their respective soil delineations.

The values obtained are well below the maximum value. Both of the highest values are found on upland 31-V-45 delineations: .55 for hemlock with subdominants and blue huckleberry-salmonberry, and .53 for Douglas-fir and hemlock with a sword fern-oxalis understory. In both cases, one relatively small soil delineation is overlapped by two or three vegetation polygons fitting the appropriate community type category. The small sizes of the vegetation and soil polygons result in a relatively low value for area of union and thus a correspondingly high intersection/union ratio. Soil delineation size, as well as number of soil delineations, should therefore be taken into account when evaluating areal correspondence between soil and vegetation.

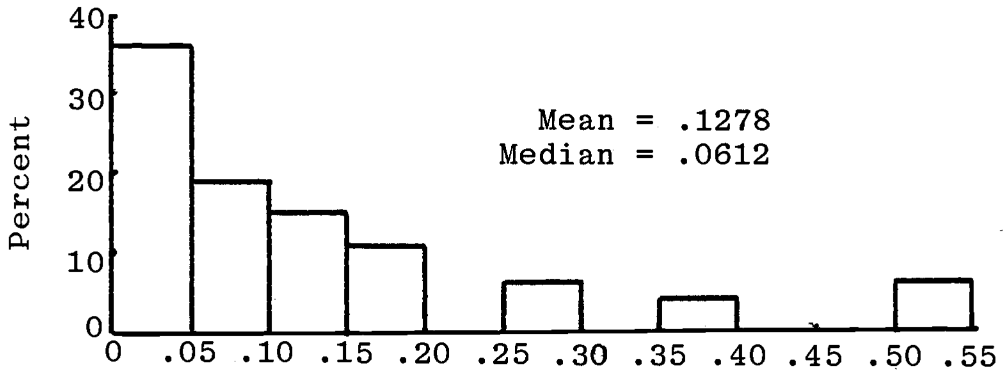
The tabulations also indicate that the most extensive vegetation communities are fairly important in terms of areal correspondence, but are not necessarily the most important. That is, the ranks of vegetation communities in Table 9 are similar to, but not identical with, the ranks of communities in Table 10. Results of tests comparing the ranks are presented in Appendix II. The values presented in Table 10 can sometimes be misleading. For instance, the table shows some fairly high AC values for vine maple-sword fern communities on Hembre delineations, even though such communities are reportedly closely associated with Astoria soils (Meurisse and Youngberg, 1971). The explanation once again lies with the small size of the soil delineations involved. High AC values result on small soil polygons because the area of union is diminished relative to the area of intersection. Further research may reveal an effective method of compensating for soil size differences in generating AC summary tabulations.

Distributions of areal correspondence data are illustrated in Figures 12 and 13. Kolomogorov-Smirnov tests, which were used to evaluate the similarity of these distributions, show no significant differences in any of the comparisions ($\alpha= .10$). Thus the Hembre units investigated show no difference in areal correspondence with vegetation as opposed to each other or to the sample of all soil delineations. Nor do upland soils behave differently from lowland soils in this regard.

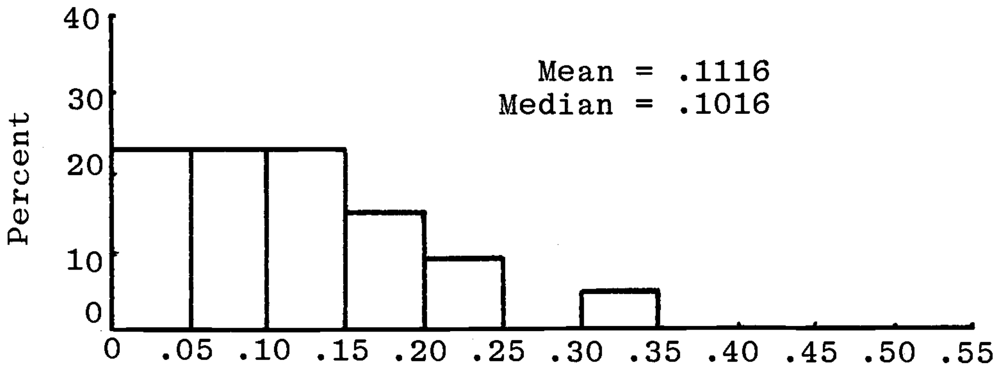
The second analysis involves a comparison of the AC of particular vegetation communities on different types of soil delineations. Spearman's rank correlation coefficient was employed, again using pairings of soil mapping units and of uplands vs. lowlands. Only those communities found in both soil categories in the pairings are evaluated. Table 11 presents the paired comparisions of AC values. A weak correlation is observed only in the comparison of 31-V-45 vs. random sample complexes, and possibly in the comparison of 31-V-45 lowlands vs.uplands ($.05<\alpha<.10$). It is curious that the ranks are more similar between 31-V-45 and the random sample complexes than between 31-U-45 and 31-V-45. Why the dissected Hembre unit shows the greatest similarity between uplands and lowlands is also an open question. It may suggest that dissection is a more important influence on areal correspondence with vegetation than is physiographic position. An examination of vegetation communities having the greatest differences in rank indicates that these generally are the less common types, e.g. thimbleberry-star flower and vine maple-sword fern communities. In contrast, the more extensive community types, particularly those with a salmonberry-sword fern understory,



a. 31-U-45 complexes

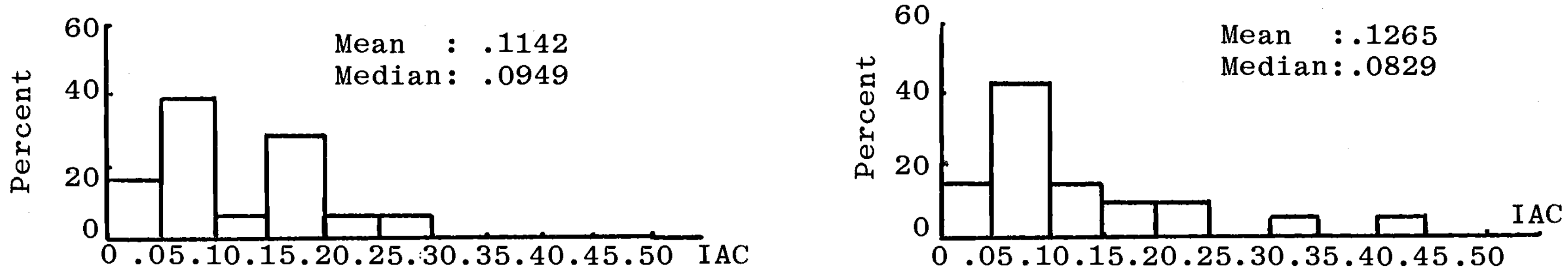


b. 31-V-45 complexes



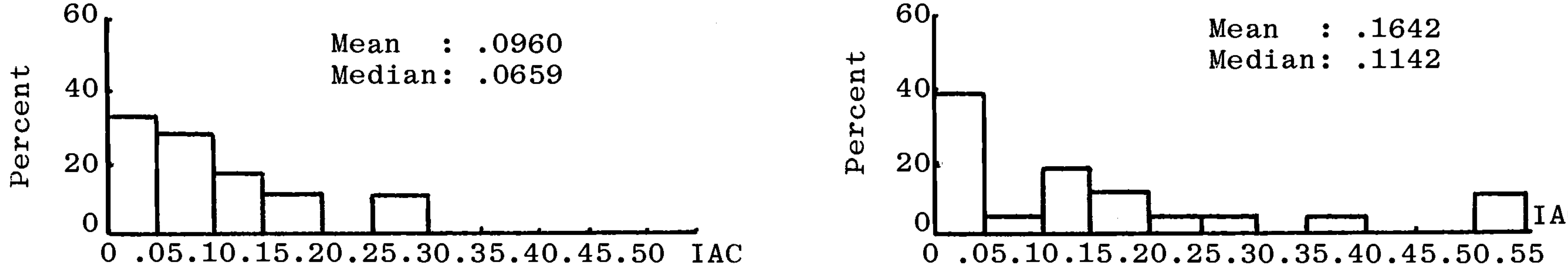
c. Random sample complexes

<u>Figure 12</u>. Distribution of index of areal correspondence: soil mapping unit comparisons.



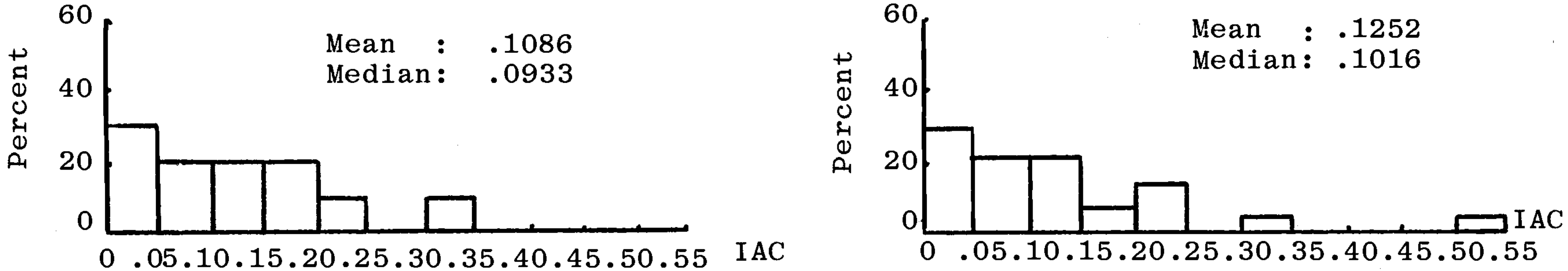
a. 31-U-45 lowland complexes

b. 31-U-45 upland complexes



c. 31-V-45 lowlands complexes

d. 31-V-45 upland complexes



e. Random smaple lowland complexes

f. Random sample upland complexes

Figure 13. Distribution of index of areal correspondence: upland vs lowland comparisons.

IAC=Index of Areal Correspondence

TABLE 11. Comparisons of Vegetation AC Values on Different Soils

a. 31-U-45 vs 31-V-45

Community Type	31-U-45 AC	31-V-45 AC
H&/SB-SF	.3240	.2830
Hd&/VM-SF	.2468	.1008
Hd&/TB-ST	.3432	.1096
H/SB-SF	.2075	.1549
S/SB-SF	.1548	.2565
Hd&/SB-SF	.1257	.1581
H&/VM-SF	.1160	.1927
S&/SB-SF	.1143	.0315
S(&)/Sh-He(&)	.1074	.0525
H/SF	.0948	.1080
D/SB-SF	.0903	.0278
Hd/SB-SF	.0894	.1002
S&/RH-SB	.0786	.0385
H&/RH-SB	.0756	.5473
H&/SF	.0734	.0612
H/SF-O	.0657	.0575
D&/SB-SF	.0614	.0579
CO_1/SB-SF	.0581	.0467
H&/SF-O	.0495	.0689
H&/TB-ST	.0399	.3503

$r_s = +.2902$

b. 31-U-45 vs Random Sample

Community Type	31-V-45 AC	Sample AC
H&/SB-SF	.3240	.2002
Hd/VM-SF	.2927	.0348
Hd&/VM-SF	.2468	.1045
Hd&/TB-ST	.2432	.0157
H/RH-SB	.2424	.1366
H/SB-SF	.2075	.2007
S/SB-SF	.1548	.1707
Hd&/SB-SF	.1257	.1016
H&/VM-SF	.1160	.1927
S&/SB-SF	.1143	.0315
S(&)/Sh-He(&)	.1074	.0948
H/SF	.0948	.2179
D/SB-SF	.0903	.1649
Hd/SB-SF	.0894	.1168
S&/RH-SB	.0786	.0714
H&/RH-SB	.0756	.1599
H&/SF	.0734	.1041
H/SF-O	.0657	.0053
D&/SB-SF	.0614	.0405
CO_1/SB-SF	.0581	.0375
NS/SF-O	.0505	.0123
H&/SF-O	.0495	.0806
H/TB-ST	.0165	.1682

$r_s = +.2559$

c. 31-V-45 vs Random Sample

Community Type	31-V-45 AC	Sample AC
H&/RH-SB	.5473	.1599
DH/SF-O	.5298	.0735
H&/SB-SF	.2830	.2002
S/SB-SF	.2565	.1707
H&/VM-SF	.1927	.3093
Hd&/SB-SF	.1581	.1016
H/SB-SF	.1549	.2007
Hd&/TB-ST	.1096	.0157
H/SF	.1080	.2179
Hd&/VM-SF	.1008	.1045
Hd/SB-SF	.1002	.1168
H&/SF-O	.0689	.0806
H&/SF	.0612	.1041
D&/SB-SF	.0579	.0405
H/SF-O	.0575	.0053
S(&)/Sh-He(&)	.0525	.0948
CO_1/SB-SF	.0467	.0375
S&/RH-SB	.0385	.0714
D(&)/Sh-He(&)	.0345	.0335
Hd(&)/Sh-He	.0345	.0687
S&/SB-SF	.0315	.1371
D/SB-SF	.0278	.1649
C&/SB-SF	.0172	.0184
H/VM-SF	.0165	.1693
Hd&/RH-SB	.0090	.0579

$r_s = +.4044$

d. 31-U-45 Lowlands vs. Uplands

Community Type	Lowland AC	Upland AC
H&/SB-SF	.1704	.4008
H&/VM-SF	.1678	.0383
S/SB-SF	.1531	.1565
Hd/SB-SF	.1525	.0642
H/SB-SF	.0921	.2240
Hd&/SB-SF	.0866	.1648
H&/SF	.0719	.0750
H/RH-SB	.0569	.3352
H&/RH-SB	.0507	.0798
H/SF-O	.0485	.0829
H&/SF-O	.0428	.0696
H/SF	.0373	.1293

$r_s = +.1329$

e. 31-V-45 Lowlands vs Uplands

Community Type	Lowland AC	Upland AC
H&/SB-SF	.2669	.2956
S/SB-SF	.2669	.2253
Hd&/VM-SF	.1756	.0260
H/SB-SF	.1150	.1749
Hd&/SB-SF	.1142	.1769
H&/SF	.1037	.0400
H/SF	.0903	.1187
Hd/SB-SF	.0739	.1395
H&/SF-O	.0266	.0989

$r_s = +.5125$

f. Random Sample Lowlands vs. Uplands

Community Type	Lowland AC	Upland AC
S/SB-SF	.2361	.0401
H/SF	.1705	.2496
H&/SB-SF	.1684	.2241
Hd&/SB-SF	.1329	.0756
S(&)/Sh-He(&)	.1314	.0216
Hd/SB-SF	.1156	.1172
Gr,He,Sh	.0409	.0772
D/SB-SF	.0126	.2156
H/SF-O	.0065	.0041

$r_s = +.3000$

show more consistency in AC rank. By and large however consistent trends in areal correspondence are lacking.

D. Comparison of Shape and Areal Results

Thus far elongation ratios and areal relationships have been addressed separately. In each case, soil and vegetation delineations have not been noticeably associated. However, a few differences are present in specific results from the two sets of analyses. For instance, site appears to make a difference in the degree of correlation between soil and vegetation elongation ratios, yet uplands and lowlands are indistinguishable in terms of areal correspondence. Also, the 31-V-45 complexes behave more like the random sample than do the 31-U-45 complexes in the ER studies and in comparing AC ranks of specific communities, yet the reverse is true in comparing overall AC. Plausible explanations for these observations are difficult to formulate. Such observations do, however, raise the question of interdependency between elongation ratio and areal correspondence.

Chi-square tests were used to evaluate the notion of similarity in elongation ratio and areal correspondence trends. Each vegetation polygon in a complex was classified according to two criteria. First, the magnitude of the difference between its ER and that of the soil polygon ($|$veg. ER - soil ER$|$) was compared with the results for all other vegetation polygons in the complex. The difference was then classified as being in the low range (signifying a degree of elongation similar to that of the soil) or the high range for that complex. Secondly, AC values within a complex were ranked and sorted into high or low ranges. In this case, the high range implies a greater association with the underlying soil. For complexes with an odd number of vegetation polygons, the middle value was assigned to a category according to the most natural break with the flanking values. Table 12 presents an example of how the data were categorized. The category assignments for all complexes in a data set were then summarized in a 2x2 contingency table and the chi-square test statistic was computed.

The results are presented in Appendix II. The null hypothesis of independence can be rejected for both of the Hembre soils, but not for the complexes in the random sample if $\alpha = .05$. This suggests that on these Hembre mapping units, and perhaps on other soil types as well, vegetation polygons having shapes similar in terms of elongation to the underlying soil also tend to have higher intersection/union ratios. Going a step further, the implication is that long axis orientations tend to be similar. In future investigations long axis orientation should perhaps be recorded with the rest of the data, in spite of the problems noted in the preliminary study for determining this.

More striking still is the disparity in upland and lowland results. Areal correspondence and elongation ratio trends are related in the uplands but are independent in the lowlands. The explanation may relate to the average ER correlation findings. Comparisons of soil ERs to the average ER of overlapping vegetation polygons showed a more positive correlation in the uplands (although the r_s values were of marginal or no significance). The greater similarity between soil and vegetation shapes in the uplands may contribute to the association between ER comparisons and areal correspondence for such sites. In the lowlands, where ER relationships are either more haphazard or are negatively correlated, no association with

TABLE 12. Analysis of Vegetation and Soil Polygon Association. 31-U-45 Complex #4

INCREASING ASSOCIATION WITH SOIL POLYGON

Vegetation Polygon	ER	|veg ER-soil ER|[a]		Rank	Range	Vegetation Polygon	AC		Rank	Range
9HF2/SF	.5797	.0463		1	Low	7HS2/SB-SF	.2609		7	High
3HS2,1/SB-SF	.6007	.0673		2	Low	3HS2,1/SB-SF	.1709		6	High
9HS2/SF	.4534	.0800	Δ=.0111	3	Low	9HS2/SF	.1347	Δ=.0062	5	High
7HS2/SB-SF	.6245	.0911	Δ=.0241	4	LOW[b]	9H2/SF	.1285	Δ=.0008	4	LOW[c]
9H2/SF	.6486	.1152		5	High	9HF2/SF	.1277		3	Low
NS/SF-O^{CO}1	.6843	.1509		6	High	NS/SF-O^{CO}1	.0505		2	Low
9H2/SF′	.7483	.2149		7	High	9H2/SF′	.0165		1	Low

[a] Soil Elongation Ratio = .5334

[b] This assignment was made because .0911 is closer to the next lowest value (.0800) than it is to the next highest value (.1152)

[c] This assignment was made because .1285 is closer to the next lowest value (.1277) than it is to the next highest value (.1347)

2x2 CONTINGENCY TABLE FOR COMPLEX #4

	High Range AC	Low Range AC
Low Range |veg ER-soil ER|	3	1
High Range |veg ER-soil ER|	0	3

intersection/union ratios is seen. The upland-lowland dichotomy may also explain the independence of results for the random sample overall. Vegetation and soil elongation ratios were found to be negatively correlated in the lowlands; possibly this inverse relationship affects the ER-AC association to the point where the measures are judged to behave independently for the entire sample.

Whether the independence of ER and AC is related to particular mapping units within the random sample is difficult to discern. The lack of association is most apparent on Astoria soils, but many of the lowland delineations sampled are Astoria soils. Further studies would be needed to test the association of the two measures on different mapping units.

Elongation ratios and areal correspondence can also be compared on a complex-by-complex basis. Tables 13, 14, and 15 summarize the data collected for each soil-vegetation complex. The vegetation polygon with the ER most similar to the soil delineation ER is listed, as are the vegetation communities having the greatest areal correspondence and the greatest overlap area with the soil. Hemlock with subdominants and a salmonberry-sword fern understory is the prevalent community type in all three categories for both Hembre mapping units. In the random sample, communities with a similar canopy but a vine maple-sword fern understory appear in the tabulations more frequently than other community types. Usually these are associated with Astoria soils, again supporting the survey's report regarding the association between the soil and vegetation types (Meurisse and Youngberg, 1971).

Comparisons of the three vegetation categories in these tables show that in the majority of complexes, polygons having the greatest intersection/union ratios also have the greatest intersection areas. Exceptions do

TABLE 13. Summary Table: 31-U-45 Complexes

SOIL					VEGETATION COMMUNITY WITH GREATEST CORRESPONDENCE		
Complex	Upland/ Lowland	Size(ha)	Elongation Ratio	No. of Veg. Polygons	Elongation Ratio	Areal Corresp.	Areal Overlap
1	Up	15.84	.7652	4	3H1/RH-SB	3H1/RH-SB	3H1/RH-SB
2	Up	2.41	.8398	2	1H1/SB-SF^{CO}1	1H1/SB-SF^{CO}1	1H1/SB-SF^{CO}1
3	Up	9.92	.5435	5	7HdHD2,1/TB-ST	7HdHD2,1/TB-ST	7HdHD2,1/TB-ST
4	Up	21.63	.5334	7	9HF2/SF	7HS2/SB-SF	7HS2/SB-SF
5	Up	5.60	.5362	3	1HF1/RH-SB	3HF1,3/RH-SB	3HF1,3/RH-SB
6	Up	23.13	.5302	4	5HSHd2,1/SB-SF	5HSHd2,1/SB-SF	5HSHd2,1/SB-SF
7	Up	60.98	.4021	13	9H2/SF	9H2/SF	9H2/SF
8	Low	26.10	.4489	11	1S1/He,Sh,Gr^{CO}1	1S1/SF^{CO}1	1S1/SB-SF^{CO}1
9	Low	36.95	.4486	12	3HSHd2/SB-SF	9HHdS2/SB-SF	3HSHd2/SB-SF
10	Up	117.88	.3231	23	9HHd2/SF	7HSHd2/SB-SF	7HSHd2/SB-SF
11	Low	2.85	.5040	2	9HHd2/VM-SF	9Hd2/VM-SF	9Hd2/VM-SF
12	Low	24.41	.5940	4	7HdH1/VM-SF	7HdH1/VM-SF	7HdH1/VM-SF
13	Up	16.01	.4401	6	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1
14	Up	19.27	.5245	4	7HdH2/SB-SF	7HdH2/SB-SF	7HdH2/SB-SF
15	Up	80.95	.5358	31	7H2/SB-SF	7Hd2/SB-SF	7HdH2/SB-SF
16	Low	168.50	.5357	32	5HdH1/SB-SF	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1
17	Low	3.08	.3830	2	7HHd2/VM-SF	7HHd2/VM-SF	5HdH2/VM-SF
18	Up	13.39	.5245	8	7HS2/SB-SF	7HS2/SB-SF	7HS2/SB-SF

TABLE 14. Summary Table: 31-V-45 Complexes

		SOIL			VEGETATION COMMUNITY WITH GREATEST CORRESPONDENCE		
Complex	Upland/ Lowland	Size(ha)	Elongation Ratio	No. of Veg. Polygons	Elongation Ratio	Areal Corresp.	Areal Overlap
A	Up	12.88	.6516	4	5H3,2/SB-SF	3HS2,1/SB-SF	3HS2,1/SB-SF
B	Up	16.66	.5090	3	7HHd2/SB-SF	7HHd1,2/SB-SF	7HHd1,2/SB-SF
C	Up	25.18	.5920	10	9HdH2/SB-SF	7H5/SB-SF(H)	7H5/SB-SF(H)
D	Up	11.16	.6698	3	9HD4/SF	7HCD4,5/SB-SF	7HCD4,5/SB-SF
E	Up	8.98	.5602	5	5HdH2,1/TB-ST	7HHd2,1/RH-SB	7HHd2,1/RH-SB
F	Up	10.32	.6913	4	5HdH2,1/TB-ST	3HC2,5/TB-ST	3HC2,5/TB-ST
G	Up	9.55	.6544	3	9DH4/SF-O	9DH4/SF-O	9DH4/SF-O
H	Up	6.61	.6969	2	9H4/SF	9H4/SF	9H4/SF
I	Low	34.14	.5985	6	9H2/SF	3HSHd1,2/SB-SF	3HSHd1,2/SB-SF
J	Low	38.44	.4924	11	9Hd2/SB-SF	9HHd2/VM-SF	9HHd2/VM-SF
K	Low	61.08	.3379	11	7HS2,1/SB-SF	7HS4,2/SB-SF	7HS4,2/SB-SF
L	Up	240.28	.3905	31	9HHd2/SB-SF	7HS4/SB-SF	7HS4/SB-SF
M	Low	99.98	.5580	20	9HHd2/SB-SF	5HS4/SB-SF	5HS4/SB-SF
N	Low	27.55	.4742	6	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1
O	Up	129.39	.5084	25	3HHd1,2/SB-SF	7HdH2/SB-SF	7HdH2/SB-SF
P	Up	65.89	.3963	12	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1
Q	Up	4.08	.3816	3	9HHd2/SB-SF	3HS2/SB-SF	9HHd2/SB-SF
R	Low	53.37	.4455	7	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1	1S1/SB-SF^{CO}1
S	Low	267.57	.5070	29	1S1/Sh,He	7HdH1/SB-SF	7HdH1/SB-SF
T	Low	23.62	.5100	4	1DHd1/Sh-He	1DHd1/Sh-He	1DHd1/Sh-He
U	Up	14.90	.6367	4	9H1/SF	7HdH1/SB-SF	7HdH1/SB-SF

TABLE 15. Summary Table: Random Sample Complexes

				SOIL		VEGETATION COMMUNITY WITH GREATEST CORRESPONDENCE		
Complex	Mapping Unit	Upland/ Lowland	Size(ha)	Elongation Ratio	No. of Veg. Polygons	Elongation Ratio	Areal Corresp.	Areal Overlap
I	32-U-45	Low	5.14	.3768	3	1S1/He,Sh,Gr$^{C\&B}$	7HdH1,4/SB-SF	7H2/VM-SF
II	32-R-15	Low	3.66	.2545	3	1S1/He,Sh,Gr^{CO1}	1S1/He,Sh,Gr^{CO1}	1S1/He,Sh,Gr^{CO_1}
III	32-b-45	Low	.83	.4316	2	9H2/SF	9H2/SF	1S1/SB-SF^{CO1}
IV	21-U-45	Low	9.84	.5275	3	NS/VM-SF^{CO1}	1HSHd2/VM-SF	NS/VM-SF^{CO1}
V	31-V-75	Up	16.10	.6330	4	1D1/SB-SF^{CO1}	1D1/SB-SF^{CO1}	1D1/SB-SF^{CO1}
VI	32-M-75	Up	25.86	.3819	7	9HS2/SF	9H2/SF	9H2/SF
VII	31-X-15	Up	3.52	.7177	1	1S1/SB-SF^{CO_1}	1S1/SB-SF^{CO_1}	1S1/SB-SF^{CO_1}
VIII	32-R-15	Up	8.07	.4679	2	9H2/SB-SF	9H2/SB-SF	9H2/SB-SF
IX	21-U-15	Low	40.22	.5045	5	9HHd2/VM-SF	9HHd2/VM-SF	9HHd2/VM-SF
X	31-U-15	Low	69.30	.4696	10	5HSHd2/VM-SF	5HSHd2/VM-SF	5HSHd2/VM-SF
XI	31-U-15	Low	3.04	.6257	1	9HHd2/SB-SF	9HHd2/SB-SF	9HHd2/SB-SF
XII	32-R-45	Up	4.18	.2405	5	9HS2/SF	9HD2/RH-SB	9HD2/RH-SB
XIII	21-U-15	Low	39.89	.7028	7	7HHdS5/SB-SF	7HHdS2/VM-SF	7HHdS2/VM-SF
XIV	32-U-15	Up	23.77	.4977	9	7H1/SB-SF	3HS1/SB-SF	3HS1/SB-SF
XV	31-X-15	Up	5.69	.4057	2	9Hd2/SB-SF	9Hd2/SB-SF	9Hd2/SB-SF
XVI	21-V-15	Low	18.26	.4515	8	5HdHS1,2/SB-SF	7HHd2/SB-SF	7HHd2/SB-SF
XVII	21-V-45	Low	134.97	.4873	39	5HHd2/VM-SF	7Hd2/SB-SF	7Hd2/SB-SF
XVIII	21-U-15	Low	6.43	.5560	3	9DH4/SF	7H5/SB-SF	7H5/SB-SF
XIX	12-a-5	Up	20.76	.3798	5	7HdHS2,1/SB-SF	1Hd1/SB-SF^{CO1}	1Hd1/SB-SF^{CO_1}
XX	32-V-75	Up	283.38	.4175	71	7Hd2/SB-SF	9HHdS2,1/SB-SF	9HHdS2,1/SB-SF
XXI	33-V-75	Up	38.45	.6884	12	5H1/SB-SF	1H1/TB-ST	1H1/TB-ST
XXII	32-V-75	Up	38.31	.6340	8	3HdD1/BR-LO	1D1/BR-LO	1D1/BR-LO
XXIII	33-M-45	Up	12.31	.6284	7	3HF1/RH-SB	5FH2,1/RH-SB	5FH2,1/RH-SB
XXIV	33-R-15	Up	4.46	.3636	4	1HF1/RH-SB	7HF2/SB-SF	7HF2/SB-SF
XXV	32-M-45	Up	44.25	.6570	17	1HSHd1/RH-SB	1HS1,2/RH-SB	1HS1,2/RH-SB
XXVI	32-V-75	Up	27.25	.8182	4	7HHd2/SB-SF	7HHd2/SB-SF	7HHd2/SB-SF
XXVII	33-M-75	Up	11.43	.5144	5	1DH1/RH-SB	5HF4/RH-SB	5HF4/RH-SB

exist, however, again indicating that the vegetation polygon with the largest percent overlap does not necessarily exhibit the highest areal correspondence value. Still less agreement is found between the ER and AC categories. In ten of the eighteen 31-U-45 complexes, the same vegetation polygon has the ER most similar to the soil and the largest AC ratio. This is true for only one-third of the complexes in the other two soil categories.[6] Differences between uplands and lowlands are not apparent in this regard. These results are not in keeping with the chi-square tests, in which it is the dissected Hembres that show the greatest overall association between the two measures. But since only the top-most community in each category is being examined here, the results are not necessarily contradictory. Generally, a vegetation polygon which ranks first in one category is not guaranteed a top-ranking in the other.

E. Summary of Findings

Many findings have been reported in the previous four sections. Some appear to fit a pattern and have logical explanations, while others have neither of these desirable attributes. Results of the various studies conducted are summarized below. Possible explanations for the findings are given where applicable. Implications of the research as well as factors influencing its outcome are discussed in the final chapter.

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[6] It should be noted that the fewer the number of vegetation polygons in a complex, the greater the probability that a given community will rank highest in both categories.

Soil Delineation Relationships

-Size. Distributions of sizes do not differ significantly between the Hembre soils, between these soils and the random sample, or between uplands and lowlands. All are skewed toward small sizes.

-Shape (elongation). Klickitat ridge soils and Gauldy alluvial soils could be distinguished by their shape from the other soils investigated, but not from each other. No statistically significant distinctions could be made between the Hembres, or between the Hembres and the random sample. Upland and lowland soils follow similar distributions, but upland soils tend to be slightly more rounded.

Soil-Vegetation Shape Comparison

-Overall. A strong correlation is lacking between the elongation ratio of a soil polygon and the average ER of its overlapping vegetation polygons. Vegetation polygons are generally more rounded than soil polygons.

-Soil Mapping Unit. The highest positive correlation, which is only of marginal statistical significance, is found on 31-U-45 delineations.

-Site. Soil and vegetation polygon shapes tend to be more similar in the uplands than in the lowlands. Soil and vegetation boundaries may be responding to the same physiographic transitions in the uplands and thus may have more similar shapes. Greater microsite uniformity in the lowlands may allow vegetation communities to become established in reference to factors (disturbance, seed source, microclimate differences) that have not influenced the location of soil delineation boundaries.

-Vegetation Community Types. On both Hembre soils, delineations of western hemlock with subdominants and a salmonberry-sword fern understory most frequently show the smallest difference between their ER and that of the soil. In the random sample complexes, this distinction goes to communities having the same canopy and a vine maple-sword fern understory. The first community is the most extensive overall; the second shows great correspondence with Astoria soils.

Areal Relationships and Areal Correspondence

-Number of Vegetation Polygons in a Complex. This is shown to be highly correlated with soil delineation size, refuting the idea that larger bodies of soil support (areally) larger vegetation communities. Lowland complexes show a higher correlation than upland complexes. Tortuosity of the soil delineation boundary may inflate the number of vegetation polygons overlapping the soil.
-Areal Overlap. Communities with salmonberry-sword fern understories, particularly with hemlock, spruce, or alder in the canopies, are the most extensive. Many communities are found only on the randomly sampled soils; others are found on only one of the two Hembres investigated. Clear trends as to vegetation and soil mapping unit assocations are generally lacking. Differences in community distributions between uplands and lowlands are often pronounced and are probably related to effective moisture conditions.
-Areal Correspondence. Intersection/union ratio values are much below the maximum possible value. The highest values are associated with small soil delineations, indicating the need to account for soil delineation size in such computations. No differences in overall AC are found with soil mapping unit or site distinctions.

Individual community types show no definable AC trends except when 31-V-45 and the random sample are compared. Upland and lowland AC trends are most similar on 31-V-45 delineations. Possibly dissection is a more important influence on AC than physiographic position. Greater consistency in AC rank is found with the more extensive community types, yet these do not necessarily have the highest ranks.

Comparison of Shape and Areal Results

-Overall. ER similarities and areal correspondence are related on the Hembre soils but not in the random sample. The two measures are independent in the lowlands but are associated in the uplands. Differences in ER relationships between lowlands and uplands may partially explain the discrepancy.

-By Complex. The same vegetation polygon has maximum correspondence (as measured by ER and AC) with the soil in one-half of the 31-U-45 complexes and one-third of the 31-V-45 and random sample complexes.

V. INFLUENCES AND IMPLICATIONS

The research project described has demonstrated that map analysis can yield information about soil-vegetation relationships beyond what is presented in a survey description. Spatial relationships may exist of which even the mappers are not aware, especially if the focus is on specific types of delineations in an extensive study area. Furthermore, survey descriptions may not be entirely objective, due to subtle biases of the surveyors or less than thorough field notes. Quantitative delineation comparisons can thus supplement survey reports and serve as an independent check of their accuracy.

If it is accepted that such map analyses can be useful, three questions (at least) arise: Are modifications in the procedure desirable? Would similar results be expected in subsequent studies? What are the implications of the results as they stand?

Additions and improvements on the methodology are certainly advisable. Use of both air photos and maps should be preserved, but delineations made on the photos beyond the survey boundary should be transferred to the base maps using the same procedure that was employed for all photo delineations. A consistent method for determining long axis orientation is desirable, as is the use of one or more shape indices illustrative of different shape properties. For example, it has been shown that perimeter tortuosity can influence the number of vegetation polygons overlapping the soil delineation in question. Fridland (1972) indicates that the ratio of perimeter to the circumference of a circle having the same area can serve as a measure of tortuosity. The elongation ratio, while fairly descriptive of polygon shapes, does not describe all aspects of shape. For instance, the soils depicted in Figure 5a and 5b have identical elongation ratios, yet their shapes are far from identical.

Storing the data in a computer file would be another methodological improvement. Entire soil maps and vegetation maps could be digitized, thereby allowing the study of any soil-vegetation combinations of interest through the use of polygon overlay algorithms. The amount of information extractable would be limited only by user needs and funds available. Computer-assisted interpretation would also promote the feasibility of additional types of polygon comparisons. The degree to which soil and vegetation polygon boundaries coincide might be investigated, for example. Such an analysis would require consideration of degrees of contrast across boundaries, information which could be most easily extracted from a computer data file. Computers could also facilitate the examination of correspondence patterns over the entire landscape, rather than focusing on isolated delineations. Other methodological changes might be advisable depending on site characteristics and analytical resources available.

Several factors would determine whether subsequent analyses would yield results comparable to those achieved here. Foremost among these is the perception of the mapper regarding soil-vegetation relationships. The surveyors of the Munson Falls Tree Farm did not believe a great dependency existed between soil and vegetation types except in certain situations.[7] This being the case, the general lack of correspondence between vegetation and soil delineations is not surprising. However, quite different results might have been achieved if the mappers

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[7] R.T. Meurisse, personal communication, 1982.

had believed the two factors were strongly interrelated. Another consideration is the purpose for which the maps were drawn. If the maps were to be used primarily for scientific purposes, delineation boundaries might be drawn with more precision than on more utilitarian maps. Even the criteria used for defining mapping units would differ according to management objectives. The varying capabilities of surveyors to recognize the same differentiating criteria in the field (Bie and Beckett, 1971) also affects the analysis. Similar results achieved in spite of these differences would indicate the existence of consistent trends in soil-vegetation associations.

An additional factor influencing the results obtainable is the scale of mapping. At Munson Falls the level of classification was fairly detailed: the soils mapped were phases of series, and vegetation communities were differentiated according to density and age class as well as canopy and understory flora. The overall lack of correspondence at this level of detail is in accordance with the findings of Stephens (1965), who dealt with similarly detailed surveys, and those of Valentine (1981), who empahsized the differences in mapping criteria used for the two factors. The degree of coincidence between vegetation communities and soil types is a function of the criteria used to differentiate soils (Küchler, 1967). Yet definite correspondences have been noted over broader areas, from the early Russian pedological work through more recent studies (e.g. Singh, 1973). Apparently, as the level of generalization increases (with attendant changes in mapping criteria), a greater correspondence between the distribution of soil and vegetation arises. A study on the level of aggregation at which this transition takes place would be illuminating.

Conditions from site to site are of course infinitely variable, and any one or combination of these site conditions may influence the degree to which vegetation distributions are related to the soil substrate. Disturbance history and soil contrasts are two such conditions with particular relevance to the Munson Falls Tree Farm. Portions of the higher elevations were subject to the Tillamook Burn (Meurisse and Youngberg, 1971), and much of the site has been disturbed by logging operations. The existence of such disturbance tends to subdue the associations that might otherwise exist.[8] The degree to which local disturbance affected the research outcome is a potential topic for future investigation. The degree of contrast among neighboring soils would also be expected to influence soil-vegetation correspondences. A soilscape having a high degree of contrast in properties of importance to vegetation should exhibit more correspondence than a relatively homogeneous soilscape. The latter condition applies to Munson Falls; the Astoria, Hembre, Klickitat, and Kilchis soils are all mixed, mesic Haplumbrepts, with differences mainly in particle-size classes (fine to loamy-skeletal) and subgroup properties (Andic, Typic, and Lithic subgroups) (Bailey and Poulton, 1968).

Implications of the research, like the results themselves, are of varying clarity. Managers interested in applying the information obtained should at least gain the impression that soil and vegetation transitions are not tightly associated. At this level of detail, many other factors influence the distribution of vegetation communities; microclimate, moisture regime, aspect, and disturbance history often supercede the influence of soil differences. Bailey and Poulton (1968), working at a

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[8] R.T. Meurisse, personal communication, 1982.

nearby site in the Coast Range, found that the totality of environmental factors, of which soils are but one component, act together with competition to determine the mosaic of vegetation communities on the landscape.

Beyond this, managers should be aware that physiographic position and degree of dissection may affect the correspondence between bodies of soil and vegetation communities.[9] In particular, the association appears to be closer in steep upland terrain than in more uniform lowlands. Küchler (1967) reported the same site distinction in analyzing maps of the California Vegetation-Soil Survey. The upland correspondence probably reflects the response of both features to the same set of environmental factors rather than a direct association between them. Those vegetation communities found on dissected Hembre soils show more consistent areal correspondence trends than communities on the other soil types investigated. Whether this relation holds for all dissected soils remains to be determined.

The implications of the research therefore strike a middle ground. To those who assert that a high degree of correspondence exists between soil and vegetation, the results indicate: not for all sites; not for all soils; not for all environmental conditions. To those who dismiss the existence of any meaningful association between the two features, the results indicate that the degree of correspondence might vary significantly according to certain parameters. Map analysis can reveal such relationships that might not be suspected otherwise. The reasons for variations in delineation correspondence now need

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[9] Although not investigated here, it is conceivable that degrees of association would vary with geomorphic units (see for example Fisher, 1977).

examination. As T.J. Orr (1965, pp. 500-501) so aptly stated: "The soil-vegetation survey ... is a potent example of the maxim that as one broadens the area of knowledge, he lengthens the perimeter of ignorance."

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APPENDICES

APPENDIX I

TABLE A1. 31-U-45 Soil-Vegetation Complexes - Basic Cartometric Data

COM-PLEX	DELINEATION	(1) PERIMETER(km)	(2) AREA(ha)	(3) LONG AXIS(m)	(4) ELONGATION RATIO[a]	(5) $V \cap S$[b]	(6) $V \cup S$[c]	(7) $\frac{V \cap S}{V \cup S}$[d]	(8) $\frac{V \cap S}{\text{SOIL}}$[e]	(9) $\frac{V \cap S}{\text{VEG.}}$[f]	LOCATION[g]
1	31-U-45	1.723	15.84	587	.7652						E 1,182,500 N 650,000
	1D1/RH-SB	2.210	21.26	835	.6229	2.01	35.10	.0574	.1272	.0948	
	1HF1/RH-SB	2.231	12.23	811	.4865	2.00	26.02	.0769	.1263	.1635	
	3H1/RH-SB	1.625	11.11	563	.6682	10.12	17.03	.5939	.6387	.9106	
	5HF2/RH-SB	1.132	3.92	431	.5186	1.18	18.68	.0630	.0743	.3001	
2	31-U-45	.576	2.41	209	.8398						E 1,187,500 N 652,500
	1H1/SB-SF^{CO_1}	.526	1.83	186	.8215	1.41	2.79	.5066	.5868	.7727	
	3HF1,2/RH-SB	1.871	5.88	516	.5303	.92	7.33	.1249	.3798	.1560	
3	31-U-45	2.148	9.92	654	.5435						E 1,175,000 N 642,500
	9Hd1/SB-SF	1.242	3.23	581	.3493	.52	12.65	.0414	.0528	.1622	
	9HHd1,2/SB-SF	1.326	4.58	355	.6802	2.38	12.03	.1979	.2400	.5196	
	7HdHD2,1/TB-ST	1.289	8.09	494	.6492	4.33	13.63	.3177	.4365	.5354	
	9HdD2/SB-SF	.724	2.83	257	.7388	.34	12.43	.0273	.0342	.1202	
	5HdD2/TB-ST	.656	2.48	270	.6581	1.71	10.52	.1629	.1727	.6912	
4	31-U-45	2.527	21.63	984	.5334						E 1,177,500 N 650,000
	9HS2/SF	1.502	5.33	575	.4534	3.20	23.78	.1347	.1481	.6006	
	7HS2/SB-SF	1.372	7.70	502	.6245	6.06	23.22	.2609	.2801	.7863	
	3HS2,1/SB-SF	1.271	4.08	379	.6007	3.73	21.84	.1709	.1726	.9159	
	9H2/SF	.874	3.29	274	.7483	.41	24.64	.0165	.0188	.1237	
	9H2/SF	1.624	7.50	476	.6486	2.91	22.66	.1285	.1346	.3883	
	9HF2/SF	1.124	3.65	372	.5797	2.89	22.66	.1277	.1338	.7926	
	NS/SF-O^{CO_1}	1.312	5.46	385	.6843	1.30	25.78	.0505	.0602	.2386	

[a] Diameter of a circle having the same area/length of longest axis

[b] Area(ha) covered by both the vegetation and the soil

[c] Area(ha) covered by either the vegetation or the soil

[d] (7)=(5)÷(6)

[e] (8)=(5)÷entry for soil in column (2)

[f] (9)=(5)÷(2)

[g] Expressed in State Plane Coordinates to the nearest 2,500 ft.

TABLE A1 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
5	31-U-45	1.151	5.60	498	.5362						E 1,185,000 N 647,500
	1HF1/RH-SB	2.821	23.58	1024	.5353	.63	28.25	.0222	.1120	.0266	
	3HF1,3/RH-SB	.990	4.20	365	.6341	3.31	6.56	.5049	.5915	.7884	
	5FH2,1/SB-SF	.617	2.52	266	.6725	1.35	6.70	.2014	.2410	.5354	
6	31-U-45	2.552	23.13	1024	.5302						E 1,172,500 N 645,000
	1HS2,1/SB-SF	2.220	13.96	730	.5778	8.22	28.70	.2864	.3554	.5889	
	7HS2/SB-SF	3.224	15.98	1106	.4077	2.08	37.47	.0555	.0899	.1302	
	7HHd2/RH-SB	1.063	3.93	490	.4570	2.58	24.82	.1040	.1116	.6562	
	5HSHd2,1/SB-SF	1.980	10.48	733	.4981	9.36	23.92	.3912	.4046	.8934	
7	31-U-45	4.980	60.98	2191	.4021						E 1,172,500 N 650,000
	5HSHd2/RH-SB	1.594	5.11	707	.3608	3.47	62.74	.0553	.0569	.6798	
	9H2/SF	2.801	14.20	1040	.4087	11.88	63.49	.1872	.1949	.8371	
	5Hd2/SB-SF	1.115	2.78	444	.4237	1.06	62.78	.0169	.0174	.3819	
	7HdHS2/SB-SF	1.404	7.16	606	.4982	6.49	61.56	.1054	.1064	.9064	
	7Hd1/SB-SF	2.160	4.99	1039	.2425	2.58	63.69	.0405	.0423	.5168	
	9H2/SF	1.393	7.26	581	.5234	4.13	64.50	.0641	.0678	.5696	
	9Hd/SB-SF	.584	1.36	230	.5716	1.36	60.98	.0223	.0223	1.0000	
	1SH1/SB-SF	1.026	6.10	379	.7347	6.10	60.98	.1000	.1000	1.0000	
	7H2/SB-SF	2.498	9.36	964	.3584	3.32	67.55	.0492	.0545	.3549	
	3HSHd2/SB-SF	1.350	4.18	437	.5279	2.98	62.64	.0476	.0489	.7144	
	1H1/SB-SF	1.340	6.41	498	.5739	5.99	61.35	.0976	.0982	.9341	
	3SHdH1,2/SB-SF	3.394	11.15	1070	.3521	4.55	68.00	.0669	.0746	.4076	
	1SH1/RH-SB	1.168	6.87	462	.6401	4.04	63.87	.0633	.0663	.5890	
8	31-U-45*	2.797	26.10	1284	.4489						E 1,162,500 N 652,500
	9H2/SF*	.514	1.52	204	.6832	.41	27.49	.0150	.0158	.2698	
	9H1/SF	.689	2.64	240	.7646	1.11	27.93	.0399	.0427	.4212	
	9HdHS1/SB-SF*	.769	2.38	293	.5952	2.38	26.10	.0914	.0914	1.0000	
	5HS4/SB-SF*	1.007	3.74	322	.6781	3.54	26.59	.1333	.1358	.9490	
	1S1/He,Sh,Gr^{CO1}	1.646	7.89	696	.4554	3.30	30.74	.1074	.1265	.4185	
	1S1/SB-SF^{CO1}	1.628	2.31	251	.6842	2.31	26.10	.0886	.0886	1.0000	
	1S1/SF^{CO1}	1.088	4.14	445	.5158	4.14	26.10	.1587	.1587	1.0000	
	1S1/SB-SF^{CO1}	.998	5.02	367	.6889	4.23	27.12	.1561	.1622	.8422	
	9H2/SF	1.397	4.84	454	.5471	.90	30.44	.0295	.0344	.1855	
	9HHd2/SF	1.100	5.61	438	.6104	1.23	30.64	.0402	.0472	.2195	
	5HS4,3/SF-O	1.433	8.41	446	.7332	1.34	33.39	.0401	.0513	.1590	

*Boundary outside surveyed area was photo-interpreted

TABLE A1 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S/VUS	V∩S/SOIL	V∩S/VEG.	LOCATION
9	31-U-45*	5.635	36.95	1529	.4486						E 1,162,500 N 652,500
	7HDS3/SB-SF*	2.851	8.33	1188	.2741	2.62	43.37	.0604	.0709	.3143	
	9HD4/SF*	.682	2.47	278	.6373	1.27	38.99	.0326	.0344	.5145	
	5HS4,3/SF-O	1.433	8.41	446	.7332	2.50	43.67	.0572	.0676	.2967	
	CO_1/SB-SF*	1.003	2.47	455	.3092	2.18	37.59	.0581	.0591	.8828	
	5HHd2/VM-SF	.889	2.71	347	.5356	1.37	38.62	.0354	.0370	.5043	
	1HSHd2/VM-SF	2.638	8.82	958	.3500	2.74	44.09	.0621	.0741	.3102	
	9HHd2/SF	1.100	5.61	438	.6104	3.08	40.28	.0766	.0835	.3498	
	5HdH2/SB-SF	.720	2.87	268	.7149	2.48	37.97	.0652	.0670	.8612	
	9HHdS2/SB-SF	3.050	13.39	1199	.3445	6.61	44.52	.1484	.1788	.4933	
	3HSHd2/SB-SF	5.712	32.42	1496	.4293	6.86	63.74	.1077	.1858	.2118	
	9H2/SF	.587	2.20	241	.6945	.46	39.12	.0119	.0126	.2113	
	3HHdS2/VM-SF	.902	3.28	418	.4893	2.91	38.06	.0764	.0787	.8863	
10	31-U-45*	9.359	117.88	3792	.3231						E 1,167,500 N 650,000
	9Hd2/SB-SF*	6.499	31.27	2172	.2905	9.48	139.79	.0678	.0804	.3029	
	3HHdS2,1/VM-SF	1.384	5.16	662	.3870	3.64	119.82	.0304	.0309	.7048	
	3Hd2/SB-SF	1.391	2.20	576	.2903	.56	120.39	.0047	.0048	.2567	
	5HS2/VM-SF	.760	2.36	362	.4780	1.93	118.60	.0163	.0164	.8188	
	7HHd2/SB-SF	1.091	4.90	368	.6778	1.14	121.64	.0094	.0097	.2338	
	5HHd2/VM-SF	1.043	3.71	451	.4818	3.54	118.27	.0299	.0300	.9517	
	9H2/SF	1.106	5.08	438	.5804	3.80	118.99	.0319	.0322	.7483	
	9HS2/SB-SF	.576	1.89	247	.6275	1.52	118.80	.0128	.0129	.8048	
	7HSHd2/SB-SF	2.797	15.62	1098	.4061	15.62	117.88	.1325	.1325	1.0000	
	9HHd2/SF	1.765	5.20	859	.2993	1.38	122.05	.0113	.0117	.2665	
	7H4/SF-O(H)	1.870	10.48	781	.4675	9.06	119.75	.0757	.0769	.8652	
	7Hd2/SB-SF	3.121	10.08	1214	.2950	9.24	118.94	.0777	.0784	.9170	
	7H4,2/SB-SF	.492	1.24	186	.6765	.82	118.27	.0069	.0070	.6620	
	3HS5,4/SB-SF	1.760	6.32	730	.3887	6.32	117.88	.0536	.0536	1.0000	
	7HS4/SF-O(H)	1.646	8.84	592	.5672	8.25	118.56	.0696	.0700	.9325	
	7HSHd2/SB-SF	1.990	8.90	809	.4161	8.48	118.03	.0718	.0719	.9533	
	9H2/SF	1.669	7.38	702	.4368	1.11	124.50	.0089	.0094	.1495	
	9Hd2/SB-SF	1.117	2.85	438	.4346	1.16	119.10	.0097	.0098	.4059	
	9H4/SF	1.345	6.94	457	.6503	1.02	123.56	.0083	.0087	.1474	
	SHS2/SB-SF	1.415	6.66	431	.6759	6.66	117.88	.0565	.0565	1.0000	
	3HSHd2/SB-SF	1.561	5.59	557	.4792	2.53	120.69	.0210	.0215	.4531	
	3HS3,2/SB-SF	.844	2.73	383	.4868	2.45	118.21	.0207	.0208	.9012	
	1S1/SB-SF^{CO1}	2.752	26.09	1060	.5440	13.10	130.18	.1006	.1111	.5019	

*Boundary outside surveyed area was photo-interpreted

TABLE A1 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
11	31-U-45*	.908	2.85	378	.5040						E 1,162,500 N 647,500
	9Hd2/VM-SF*	2.317	6.68	1015	.2862	2.18	7.45	.2927	.7651	.3265	
	9HHd2/VM-SF*	4.908	26.86	1129	.5179	.38	29.31	.0130	.1337	.0142	
12	31-U-45*	2.224	24.41	944	.5904						E 1,157,500 N 637,500
	9Hd2/SB-SF	2.155	9.17	731	.4677	6.56	26.82	.2447	.2689	.7156	
	7HdH1/VM-SF*	1.619	8.38	575	.5682	8.32	24.77	.3358	.3407	.9927	
	7HD4/SF	1.481	6.37	398	.7149	1.49	29.66	.0502	.0610	.2336	
	9HdH2/SB-SF*	1.397	4.27	569	.4099	2.07	26.99	.0767	.0848	.4848	
13	31-U-45	2.749	16.01	1026	.4401						E 1,167,500 N 645,000
	7HS5/SB-SF	1.681	8.53	445	.7401	2.03	22.77	.0890	.1266	.2378	
	9Hd2/SB-SF	.752	1.44	232	.5841	.65	16.62	.0393	.0408	.4546	
	7H5/SB-SF	.696	2.52	259	.6908	1.60	16.98	.0945	.1002	.6373	
	1S1/SB-SF^{CO1}	2.665	17.66	1037	.4573	5.85	27.58	.2121	.3654	.3313	
	1SH1/SB-SF	1.996	11.83	796	.4879	3.64	24.56	.1482	.2273	.3076	
	1SH1/RH-SB	2.082	9.68	761	.4614	2.34	24.93	.0939	.1462	.2419	
14	31-U-45*	3.125	19.27	944	.5245						E 1,170,000 N 645,000
	9H2/SB-SF*	2.509	14.99	1045	.4179	1.80	33.14	.0543	.0934	.1202	
	7HdH2/SF-SF*†	3.980	28.02	1132	.5279	13.26	34.34	.3861	.6881	.4733	
	7H4,2/SB-SF	.656	2.88	250	.7669	2.52	19.31	.1306	.1309	.8764	
	9H2/SB-SF	1.574	7.02	529	.5648	.82	24.99	.0330	.0428	.1176	
15	31-U-45*	10.232	80.95	1895	.5358						E 1,162,500 N 635,000
	3H1/RH-SB	1.337	5.34	361	.7221	2.34	84.15	.0278	.0289	.4379	
	5HHd1/RH-SB	1.600	5.72	583	.4627	.93	86.20	.0108	.0115	.1627	
	9H2/SF	1.484	7.15	580	.5205	6.39	81.47	.0784	.0789	.8938	
	5Hd1/SB-SF	.721	2.27	277	.6138	1.95	81.29	.0240	.0241	.8575	
	7HHd2/SB-SF	.889	2.82	280	.6777	.69	83.91	.0082	.0085	.2429	
	9H2/SF	.553	1.64	198	.7296	.93	81.66	.0114	.0115	.5672	
	7HHd2,1/RH-SB	1.037	4.62	336	.7217	.72	84.76	.0085	.0089	.1562	
	5HHd1,2/SB-SF	1.376	7.34	554	.5513	5.12	83.05	.0616	.0632	.6969	
	3H1,2/RH-SB	.871	3.94	316	.7095	3.94	80.95	.0486	.0486	1.0000	
	7HdH2/SB-SF	1.919	9.40	521	.6645	7.18	82.44	.0871	.0887	.7631	
	3HHd1/SB-SF	.701	1.96	269	.5873	1.96	80.95	.0242	.0242	1.0000	
	7H2/SB-SF	2.545	9.41	648	.5342	1.70	89.00	.0191	.0210	.1804	

*Boundary outside surveyed area was photo-interpreted

†Contains an enclave of 9H2/SF

TABLE A1 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V\cap S$	$V\cup S$	$\frac{V\cap S}{V\cup S}$	$\frac{V\cap S}{SOIL}$	$\frac{V\cap S}{VEG.}$	LOCATION
15 Continued											
	5HHd1/SB-SF	2.639	10.13	665	.5402	3.58	87.27	.0410	.0442	.3530	
	7H2,1/SB-SF	1.159	4.79	376	.6574	3.29	82.37	.0400	.0407	.6888	
	9H2/SF	1.298	5.22	485	.5317	2.93	82.78	.0354	.0362	.5617	
	7HHd1,2/SB-SF	2.147	11.55	632	.6064	6.93	85.44	.0811	.0856	.5999	
	5HHd1/RH-SB	1.198	3.89	386	.5759	1.16	83.45	.0139	.0143	.2980	
	5HHd1,2/RH-SB	2.632	12.37	883	.4494	4.00	89.06	.0449	.0494	.3230	
	7HS5,4/SF	2.059	8.74	911	.3663	2.25	87.22	.0258	.0278	.2572	
	7HdH1,2/SB-SF	1.314	6.19	400	.7026	4.36	82.64	.0528	.0539	.7046	
	9H5,2/SF	.380	1.07	158	.7385	.50	82.28	.0061	.0062	.4647	
	7HHd2/SB-SF	1.807	6.15	524	.5337	3.94	83.35	.0473	.0487	.6413	
	9H2/SB-SF	.635	2.67	236	.7806	1.71	82.12	.0208	.0211	.6385	
	7H2/SB-SF	.443	1.35	164	.7970	1.21	81.05	.0149	.0150	.9035	
	5H2,5/SB-SF	.583	2.13	212	.7761	.50	82.28	.0061	.0062	.2356	
	3HdH1/TB-ST	.659	2.11	286	.5738	.48	82.34	.0058	.0059	.2265	
	5HHd1/TB-ST*	1.043	5.40	409	.6410	2.75	83.66	.0329	.0340	.5096	
	7HHd1/TB-ST*	.838	3.51	311	.6801	.58	83.26	.0070	.0072	.1658	
	7H1/SB-SF*	.354	.92	138	.7834	.83	80.99	.0102	.0102	.8990	
	5H1/TB-ST	.533	1.96	198	.7974	1.35	81.93	.0165	.0167	.6884	
	7H1/SB-SF	.676	1.38	241	.5499	.44	82.48	.0053	.0054	.3138	
16											
	31-U-45*	11.584	168.50	2725	.5375						E 1,157,500 N 632,500
	5HdH1/SB-SF*	2.308	14.11	778	.5451	5.86	176.62	.0332	.0348	.4154	
	9Hd2/SB-SF*	.845	3.65	326	.6605	2.98	169.46	.0176	.0177	.8178	
	7DHd5/SB-SF*	1.252	9.84	486	.7283	8.80	169.47	.0519	.0522	.8940	
	1H1/SB-SF	1.361	5.42	539	.4877	2.43	172.08	.0141	.0144	.4467	
	9Hd3/SB-SF*	1.193	5.30	449	.5786	4.94	169.08	.0292	.0293	.9309	
	7HdDS3/SB-SF*	.899	2.38	298	.5847	2.34	168.51	.0139	.0139	.9843	
	9HD4,5/SB-SF	1.873	6.01	593	.4668	2.39	172.14	.0139	.0142	.3985	
	7HdS3/SB-SF*	1.452	11.31	517	.7339	7.80	172.22	.0453	.0463	.6888	
	1HS3,4/SB-SF	1.123	6.70	401	.7288	2.02	172.82	.0117	.0120	.3017	
	7HDS3/SB-SF*	2.506	22.12	1028	.5161	3.72	187.13	.0199	.0221	.1687	
	7HD5/SF(H)	.658	2.75	250	.7499	1.52	169.74	.0090	.0090	.5540	
	7H5/SB-SF	.756	3.46	311	.6752	2.76	169.53	.0163	.0164	.7993	
	5H1/SB-SF	.580	1.79	238	.6362	.94	169.25	.0056	.0056	.5284	
	3DHd1/SB-SF	.647	1.69	298	.4928	1.58	168.64	.0094	.0094	.9335	
	7HC5/SB-SF*	1.745	13.49	566	.7317	2.85	179.10	.0159	.0169	.2110	
	7HD5/SF(H)	1.127	4.96	448	.5616	4.96	168.50	.0294	.0294	1.0000	
	3H1/RH-SB	2.582	9.74	763	.4615	9.60	168.80	.0569	.0570	.9849	
	5HdH1/SB-SF	1.044	3.75	422	.5171	3.47	168.68	.0206	.0206	.9250	
	SH1/SB-SF^{CO1}	.912	4.63	347	.6999	4.63	168.50	.0275	.0275	1.0000	

*Boundary outside surveyed area was photo-interpreted

TABLE A1 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
16 Continued											
	SH1/SB-SF^{CO1}	.912	4.63	347	.6999	4.63	168.50	.0275	.0275	1.0000	
	7H1/SB-SF	1.255	4.75	523	.4702	4.63	168.62	.0275	.0275	.9743	
	9Hd1/SB-SF	1.489	3.98	625	.3603	2.27	169.76	.0134	.0135	.5728	
	7HHd2,1/RH-SB	1.019	4.37	332	.7094	.66	172.22	.0038	.0039	.1519	
	5HHd1,2/RH-SB	2.618	12.53	880	.4540	4.11	176.45	.0233	.0244	.3283	
	5HHd1,2/RH-SB	.907	4.51	378	.6341	3.99	169.21	.0236	.0237	.8839	
	1S1/SB-SF^{CO1*}	1.620	11.00	540	.6931	10.36	168.77	.0614	.0615	.9416	
	5H2,1/SB-SF	.532	1.40	191	.6999	1.06	171.22	.0062	.0063	.7524	
	5H5,4/SF-O(H)	.844	2.78	301	.6250	1.21	170.87	.0071	.0072	.4343	
	3H1/SB-SF*	1.219	4.20	480	.4816	3.79	169.25	.0224	.0225	.9037	
	7H5,4/SF	.878	3.45	308	.6797	2.64	169.20	.0156	.0157	.7680	
	7H5,4/SF-0*	1.184	8.24	434	.7456	8.19	168.85	.0485	.0486	.9931	
	7HD5/SF-0*	1.114	5.44	358	.7360	5.26	168.61	.0312	.0312	.9659	
	9HD5,4/SF*	1.132	8.97	395	.8561	8.37	169.18	.0495	.0497	.9332	
17	31-U-45	1.060	3.08	517	.3830						E 1,160,000 N 647,500
	5HdH2/VM-SF*	2.503	9.03	672	.5047	1.68	10.68	.1577	.5466	.1864	
	7HHd2/VM-SF	.828	1.78	373	.4029	1.20	3.81	.3165	.3917	.6795	
18	31-U-45	2.011	13.39	787	.5245						E 1,175,000 N 645,000
	9H2/SF	1.360	4.68	424	.5766	1.16	16.81	.0693	.0870	.2485	
	7H5/SB-SF(H)	.997	4.39	338	.6988	.44	17.08	.0261	.0333	.1014	
	1D1/SB-SF^{CO1}	1.651	8.72	498	.6692	1.83	20.28	.0903	.1368	.2099	
	1H1,2/SB-SF	.624	2.05	241	.6697	2.05	13.39	.1531	.1531	1.0000	
	7H2/SB-SF	.426	1.18	152	.8047	1.18	13.39	.0882	.0882	1.0000	
	3H1/SB-SF	.712	1.92	271	.5772	1.92	13.39	.1438	.1438	1.0000	
	3FH2/SB-SF	.786	2.92	276	.6981	1.35	15.24	.0884	.1006	.4619	
	7HS2/SB-SF	1.626	8.42	596	.5492	3.12	18.64	.1671	.2327	.3698	

*Boundary outside surveyed area was photo-interpreted

TABLE A2. 31-V-45 Soil-Vegetation Complexes - Basic Cartometric Data

COM-PLEX	DELINEATION	(1) PERIMETER(km)	(2) AREA(ha)	(3) LONG AXIS(m)	(4) ELONGATION RATIO[a]	(5) $V \cap S$[b]	(6) $V \cup S$[c]	(7) $\frac{V \cap S}{V \cup S}$[d]	(8) $\frac{V \cap S}{\text{SOIL}}$[e]	(9) $\frac{V \cap S}{\text{VEG.}}$[f]	LOCATION[g]
A	31-V-45	1.667	12.88	626	.6516						E 1,175,000 N 645,000
	3SHHd1,2/RH-SB	1.252	5.70	506	.5320	.70	18.23	.0385	.0545	.1231	
	3HS2,1/SB-SF	1.696	9.68	659	.5329	6.77	15.92	.4254	.5257	.6998	
	5H3,2/SB-SF	1.786	8.30	554	.5862	3.35	18.32	.1829	.2602	.4042	
	5HdHF2,1/SB-SF	1.714	6.29	563	.5030	1.90	17.50	.1086	.1476	.3021	
B	31-V-45	2.195	16.66	905	.5090						E 1,180,000 N 655,000
	7HHd1,2/SB-SF	2.552	17.42	892	.5282	9.18	25.36	.3621	.5512	.5271	
	9H2/SF	.551	1.65	236	.6130	1.29	17.12	.0753	.0774	.7812	
	7HHd2/SB-SF	2.972	14.88	866	.5025	5.26	27.10	.1942	.3159	.3534	
C	31-V-45*	2.298	25.18	956	.5920						E 1,172,500 N 640,000
	7Hd2,1/SB-SF*	2.203	8.17	706	.4572	1.65	31.94	.0518	.0657	.2023	
	9HdH2/SB-SF	1.415	7.75	534	.5883	2.14	30.93	.0692	.0850	.2763	
	9Hd2/SB-SF	.938	3.05	379	.5201	1.82	26.85	.0677	.0722	.5951	
	7H2,5/SB-SF	1.560	5.42	655	.4010	4.00	26.74	.1497	.1590	.7381	
	7HC5/SB-SF	.731	2.44	304	.5808	2.41	25.31	.0953	.0958	.9879	
	7H2,5/SB-SF	.781	2.83	331	.5732	1.95	26.16	.0745	.0774	.6884	
	9HHd1,2/SB-SF	1.285	4.48	362	.6594	1.14	28.82	.0394	.0451	.2530	
	7H5/SB-SF(H)	1.189	5.93	475	.5783	5.78	25.76	.2242	.2294	.9736	
	9H25/SF	.652	2.00	256	.6239	1.14	26.34	.0434	.0454	.5721	
	9HHd2/SB-SF	1.889	6.06	720	.3857	2.21	29.25	.0755	.0877	.3645	
D	31-V-45*	1.352	11.16	563	.6698						E 1,177,500 N 625,000
	7HCD4,5/SB-SF*	2.251	13.27	754	.5455	7.91	16.53	.4785	.7089	.5962	
	9HD4/SF*	1.574	10.61	562	.6545	.93	20.75	.0447	.0831	.0874	
	9HD4/SF*	1.696	12.94	510	.7958	.72	23.37	.0307	.0643	.0554	

[a] Diameter of a circle having the same area/length of longest axis
[b] Area(ha) covered by both the vegetation and the soil
[c] Area(ha) covered by either the vegetation or the soil
[d] (7)=(5)÷(6)
[e] (8)=(5)÷entry for soil in column (2)
[f] (9)=(5)÷(2)
[g] Expressed in State Plane Coordinates to the nearest 2,500 ft.

*Boundary outside surveyed area was photo-interpreted

TABLE A2 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
E	31-V-45*	1.430	8.98	604	.5602						E 1,180,000 N 637,500
	5HdH2,1/TB-ST	.785	3.11	347	.5736	.84	11.48	.0729	.0932	.2692	
	unlabelled*	1.393	4.49	482	.4955	1.51	11.79	.1280	.1681	.3363	
	7HHd2,1/RH-SB*	1.132	5.32	506	.5140	3.44	10.53	.3265	.3830	.6462	
	9HF2/RH-SB*	1.124	3.62	487	.4405	1.92	10.31	.1861	.2137	.5304	
	7HFHd2,1/RH-SB*	2.060	10.46	758	.4811	.65	18.76	.0347	.0725	.0622	
F	31-V-45	1.592	10.32	524	.6913						E 1,177,500 N 637,500
	5HdH2,1/TB-ST*	1.261	6.77	497	.5910	2.46	14.33	.1719	.2387	.3638	
	3HC2,5/TB-ST*	1.384	4.34	535	.4394	3.84	10.97	.3503	.3725	.8852	
	3HdFH1/TB-ST	1.225	4.37	436	.5413	1.00	13.38	.0751	.0974	.2302	
	7HC5/SF-O*	2.453	14.55	894	.4815	2.27	22.44	.1010	.2196	.1557	
G	31-V-45*	1.315	9.55	533	.6544						E 1,182,500 N 632,500
	9DH4/SF-O*	1.530	10.92	575	.6488	4.60	15.92	.2888	.4814	.4207	
	7HCD4/SF-O*	1.684	6.50	601	.4784	2.34	13.83	.1694	.2454	.3606	
	9DH4/SF-O	.744	3.93	304	.7365	2.56	10.62	.2410	.2679	.6514	
H	31-V-45*	.985	6.61	416	.6969						E 1,182,500 N 632,500
	9H4/SF*	1.450	9.51	500	.6953	4.36	11.74	.3715	.6598	.4590	
	unlabelled	.840	2.74	324	.5767	1.82	7.75	.2343	.2746	.6623	
I	31-V-45	2.755	34.14	1102	.5985						E 1,167,500 N 652,500
	9HS2/SF	3.695	25.11	1433	.3946	5.60	54.06	.1037	.1642	.2233	
	9HHdS2/SB-SF	3.636	15.28	1219	.3618	6.72	42.15	.1594	.1968	.4397	
	3HSHd1,2/SB-SF	5.584	32.60	1489	.4327	14.66	52.49	.2793	.4294	.4497	
	1HSHd2/VM-SF	2.629	8.70	946	.3520	1.78	41.19	.0431	.0520	.2041	
	9H2/SF	.588	2.12	244	.6749	1.70	34.56	.0491	.0497	.7994	
	3H24/SB-SF	1.082	4.10	493	.4631	3.06	35.32	.0867	.0897	.7473	
J	31-V-45	6.395	38.44	1421	.4924						E 1,165,000 N 650,000
	3HSHd1,2/SB-SF	5.584	32.60	1489	.4327	4.64	66.53	.0698	.1208	.1424	
	9HHd2/VM-SF	2.276	16.05	785	.5760	8.74	46.80	.1867	.2273	.5444	
	7HHd2/SB-SF	1.087	5.01	360	.7019	.99	42.95	.0230	.0257	.1971	

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*Boundary outside surveyed area was photo-interpreted

TABLE A2 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
J Continued											
	9Hd2/SB-SF	2.041	7.18	630	.4798	5.35	40.75	.1312	.1391	.7452	
	3HS2,1/VM-SF	1.775	12.30	528	.7495	2.11	48.85	.0432	.0549	.1717	
	7HdH2/SB-SF	.637	2.25	234	.7239	1.66	39.35	.0422	.0432	.7363	
	1HS2/VM-SF	.557	1.57	226	.6272	1.36	39.33	.0347	.0355	.8673	
	7HSHd2/VM-SF	.761	2.96	283	.6852	2.73	38.71	.0705	.0710	.9235	
	5HdS2,1/VM-SF	2.900	14.41	904	.4741	6.03	47.20	.1277	.1568	.4184	
	7HHd2/VM-SF	2.072	10.44	706	.5168	2.12	43.13	.0492	.0552	.2031	
	7HdH2/VM-SF	1.838	6.58	526	.5507	2.28	47.77	.0478	.0594	.3472	
K	31-V-45	9.336	61.08	2610	.3379						E 1,167,500 N 655,000
	1S1/Br,He^{CO_1}	.685	2.61	275	.6635	.96	62.68	.0153	.0157	.3663	
	1S1/SB-SF^{CO_1}	3.070	19.81	968	.5186	10.48	70.68	.1483	.1716	.5292	
	1S1/He,Sh,Gr^{CO_1}	1.660	8.22	710	.4555	2.23	67.35	.0331	.0365	.2712	
	1S1/SB-SF†	1.715	12.34	614	.6452	4.06	69.45	.0584	.0664	.3286	
	9H2/SF	1.632	9.28	667	.5152	7.62	63.26	.1205	.1248	.8213	
	9HHd2/SB-SF	4.033	30.35	1292	.4810	10.90	80.60	.1352	.1784	.3591	
	7HS4,2/SB-SF	1.885	14.07	722	.5860	10.49	64.18	.1634	.1717	.7453	
	1D1/SB-SF^{CO_1}	1.390	8.97	533	.6344	2.37	67.52	.0351	.0388	.2641	
	7HS2,1/SB-SF	1.944	9.40	844	.4102	5.28	65.39	.0808	.0865	.5620	
	3HS2,1/SB-SF	1.093	3.57	450	.4738	2.71	61.64	.0440	.0444	.7591	
	1D1/SB-SF(O)^{CO_1}	1.420	8.77	506	.6600	1.12	68.11	.0165	.0184	.1279	
L	31-V-45*	17.826	240.28	4480	.3905						E 1,170,000→ 1,185,000
	9Hd2/SB-SF*	8.036	43.14	1988	.3727	26.91	257.52	.1045	.1120	.6237	N 657,500
	9HHd2/SB-SF*	3.030	7.64	691	.4513	4.93	246.29	.0200	.0205	.6453	
	9HdH2/SB-SF	1.325	4.56	418	.5772	2.69	242.44	.0111	.0112	.5878	
	5H4,5/SB-SF	2.513	17.11	802	.5823	3.80	254.79	.0149	.0158	.2215	
	5HdH2,1/RH-SB	1.903	10.54	778	.4712	2.23	248.29	.0090	.0093	.2119	
	9HdH2/SB-SF	.866	4.52	329	.7294	.50	244.36	.0021	.0021	.1114	
	7Hd2/SB-SF	1.188	5.36	401	.6515	.89	246.95	.0036	.0037	.1640	
	7HHd5,2/SB-SF	2.190	12.85	720	.5618	1.99	249.29	.0080	.0083	.1554	
	7HdH2/SB-SF#	2.792	9.81	733	.4820	9.23	240.37	.0384	.0384	.9418	
	7HHd5,2/SB-SF	.750	2.41	311	.5641	2.41	240.28	.0100	.0100	1.0000	
	7HdHS2,1/SB-SF	2.238	16.07	836	.5409	13.31	243.35	.0547	.0554	.8277	
	1Hd1/SB-SF^{CO_1}	.792	3.63	348	.6175	1.39	244.50	.0057	.0058	.3834	
	7HS4/SB-SF	1.045	3.59	418	.5119	.46	243.54	.0019	.0019	.1273	
	7HS4/SB-SF	.646	2.47	276	.6428	2.47	240.28	.0103	.0103	1.0000	
	9H2/SF	2.536	8.47	650	.5050	5.77	243.32	.0237	.0240	.6796	
	7Hd2/SB-SF*	.443	1.31	185	.6987	1.31	240.28	.0054	.0054	1.0000	
	9H2/SF*	.448	1.18	186	.6591	1.18	240.28	.0049	.0049	1.0000	

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*Boundary outside surveyed area was photo-interpreted

†Contains an enclave of 9H2/SF

#Contains an enclave of 7HHd5,2/SB-SF

TABLE A2 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
L Cont.	7HS4/SB-SF*	1.858	11.28	715	.5298	10.52	240.66	.0438	.0438	.9341	
	5HS4/SB-SF	2.250	11.89	804	.4839	11.89	240.28	.0495	.0495	1.0000	
	9HdH2/SB-SF*	3.556	23.23	917	.5933	15.93	247.37	.0644	.0663	.6859	
	7HHd2/SB-SF	1.115	7.61	406	.7675	7.23	240.66	.0301	.0301	.9505	
	7HdHS2/SB-SF*	1.909	7.53	616	.5030	6.39	241.19	.0265	.0266	.8494	
	7HS4/SB-SF	.341	.72	131	.7319	.72	240.28	.0030	.0030	1.0000	
	7HdHS2/SB-SF	1.403	7.42	587	.5240	6.56	241.16	.0272	.0273	.8843	
	9H2/SF	.583	2.00	245	.6526	.62	241.50	.0026	.0026	.3130	
	9H2/SF	.558	1.48	215	.6395	1.22	240.45	.0051	.0051	.8245	
	9HHd2/SB-SF	2.047	11.08	608	.6174	3.22	247.67	.0130	.0134	.2903	
	7HS4/SB-SF*	7.619	93.67	2234	.4888	59.78	276.64	.2161	.2488	.6383	
	9HS4/SF	.923	4.72	382	.6422	1.13	245.50	.0046	.0047	.2402	
	7HHdS2,1/SB-SF	1.922	20.56	666	.7682	2.81	257.92	.0109	.0117	.1365	
	9HHd2/SB-SF	2.038	5.48	670	.3943	1.34	244.65	.0055	.0056	.2448	
M	31-V-45*	10.283	99.98	2022	.5580						E 1,167,500 N 657,500
	3Hd1/SB-SF*	1.016	3.85	466	.4758	3.85	99.98	.0385	.0385	1.0000	
	9Hd2/SB-SF*	1.516	9.10	529	.6430	6.28	102.83	.0610	.0628	.6905	
	5HS4/SB-SF(H)*	1.112	6.14	428	.6528	5.55	100.70	.0551	.0555	.9041	
	7HS4/SB-SF	1.153	6.24	426	.6614	6.24	99.98	.0624	.0624	1.0000	
	5HS4/SB-SF	3.678	12.90	865	.4684	8.06	104.79	.0769	.0806	.6247	
	9HdH2/SB-SF*	2.285	10.46	796	.4586	3.50	107.01	.0327	.0350	.3347	
	7HHdS4,2/SB-SF*	1.723	9.07	631	.5383	2.75	106.16	.0259	.0275	.3036	
	5HdH1/SB-SF	3.121	15.16	1033	.4252	5.78	109.45	.0528	.0578	.3813	
	9Hd2/SB-SF	1.338	10.46	584	.6243	7.57	103.11	.0734	.0757	.7237	
	7HS2/SB-SF	1.777	9.58	451	.7739	2.07	107.23	.0193	.0207	.2162	
	3H4/SB-SF(H)	.739	3.56	304	.7015	2.87	100.68	.0285	.0287	.8058	
	9HHd2/SB-SF	1.195	4.04	410	.5525	3.53	100.55	.0351	.0353	.8746	
	7H4/SB-SF	1.691	8.76	479	.6975	5.97	102.56	.0582	.0597	.6819	
	9H2/SB-SF	.749	2.68	302	.6111	1.34	101.49	.0132	.0134	.4994	
	9H4/SB-SF	.871	4.00	362	.6230	2.75	101.46	.0271	.0275	.6856	
	7HS3/SF-O*	.510	1.40	214	.6247	1.40	99.98	.0140	.0140	1.0000	
	7HS4/SB-SF*	1.602	7.88	643	.4924	7.26	100.81	.0720	.0726	.9210	
	9H4/SF-O*	1.560	5.75	540	.5009	5.75	99.98	.0575	.0575	1.0000	
	5HHd2/SB-SF*	.853	2.03	335	.4801	1.34	100.73	.0133	.0134	.6597	
	5H4/SB-SF	1.040	2.77	461	.4079	1.65	101.21	.0163	.0165	.5955	
N	31-V-45	3.373	27.55	1249	.4742						E 1,165,000 N 655,000
	7Hd2/SB-SF*	2.144	6.23	734	.3835	1.75	32.88	.0532	.0635	.2807	
	5HHd2/VM-SF*	1.226	4.97	478	.5267	4.25	28.17	.1509	.1543	.8552	
	1S1/SB-SF^{CO1}	1.980	9.81	736	.4805	9.77	27.61	.3538	.3546	.9959	
	5HSD4/SB-SF*	1.841	9.41	686	.5043	2.29	35.26	.0650	.0832	.2435	

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*Boundary outside surveyed area was photo-interpreted

TABLE A2 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
N Continued											
	5H4/SF	1.075	6.33	434	.6536	3.21	31.71	.1013	.1166	.5075	
O	31-V-45*	13.160	129.39	2525	.5084						E 1,170,000 N 632,500
	9Hd/SB-SF*	1.752	6.78	641	.4584	5.96	130.24	.0458	.0461	.8806	
	7HdH2,1/SB-SF*	1.954	10.33	667	.5436	4.50	135.22	.0333	.0348	.4364	
	3HHd1,3/SB-SF*	.974	4.60	317	.7641	2.30	131.61	.0175	.0178	.5008	
	7HHd2,4/SB-SF	1.250	6.54	430	.6716	4.27	131.79	.0324	.0330	.6525	
	5HC5/SB-SF*	2.004	11.52	623	.6148	4.76	129.74	.0367	.0368	.4335	
	9Hd2/SB-SF*	2.252	13.23	760	.5404	9.03	133.40	.0677	.0698	.6822	
	3HHd2,1/SB-SF	.997	4.24	356	.6519	2.04	131.05	.0156	.0158	.4820	
	5HdH2/SB-SF	2.204	13.55	762	.5450	7.92	134.21	.0590	.0612	.5843	
	7HdH2/SB-SF	1.483	7.95	485	.6561	6.66	130.66	.0510	.0515	.8378	
	3HHd2,1/SB-SF	1.759	10.50	570	.6416	8.82	131.32	.0672	.0682	.8406	
	3HHd1,2/SB-SF	1.531	6.19	569	.4935	1.75	134.37	.0130	.0135	.2822	
	7HdH2/SB-SF	.950	4.72	331	.7401	1.48	131.70	.0112	.0114	.3139	
	5HdH2/SB-SF	.737	2.92	232	.8334	.43	131.76	.0033	.0033	.1478	
	3HHd2,1/SB-SF	1.330	7.70	472	.6638	.89	137.35	.0065	.0069	.1156	
	5Hd2,1/SB-SF(H)	1.774	8.79	607	.5509	5.90	132.29	.0446	.0456	.6709	
	7HdH2/SB-SF	3.571	21.01	1075	.4810	16.87	133.27	.1266	.1304	.8034	
	5Hd2/SB-SF	.812	3.20	314	.6420	3.17	129.92	.0244	.0245	.9890	
	5HS2/SB-SF	.876	3.38	330	.6287	3.04	129.94	.0234	.0235	.8988	
	5HdH2/TB-ST	.877	3.90	319	.6979	1.19	132.26	.0090	.0092	.3067	
	7HHdS2/SB-SF	.670	2.46	242	.7298	2.46	129.39	.0190	.0190	1.0000	
	7HdH2/SB-SF*	2.892	12.69	832	.4833	5.19	136.90	.0379	.0401	.4086	
	7HdHD2/SB-SF	.781	3.21	258	.7834	1.67	130.40	.0128	.0129	.5218	
	5HHd2,1/SB-SF	.971	4.59	336	.7197	1.99	131.96	.0151	.0154	.4330	
	9Hd2/SB-SF*	2.776	12.30	894	.4427	8.68	133.16	.0652	.0671	.7055	
	7CH5,4/SB-SF(H)*	4.016	23.22	1211	.4491	2.59	150.45	.0172	.0200	.1116	
P	31-V-45*	7.416	65.89	2311	.3963						E 1,167,500 N 650,000
	9Hd2/SB-SF*	6.499	31.27	2172	.2905	6.50	90.61	.0717	.0986	.2078	
	9HS4/SF-O*	.492	1.71	194	.7584	1.41	66.51	.0212	.0214	.8271	
	9H4/VM-SF*	.589	2.16	234	.7086	1.11	67.49	.0165	.0169	.5152	
	1S1/SB-SF^{CO}1	8.068	81.40	2510	.4055	27.30	121.16	.2253	.4143	.3354	
	5HdH2/VM-SF	1.099	5.63	428	.6249	1.81	69.69	.0260	.0275	.3220	
	7HdH2/SB-SF	1.273	6.45	473	.6063	2.60	69.79	.0372	.0394	.4019	
	9H2/SB-SF	.404	.71	151	.6294	.71	65.89	.0108	.0108	1.0000	
	9HdH2/SB-SF	.725	2.35	217	.7971	2.35	65.89	.0357	.0357	1.0000	
	7HHd2/SB-SF	1.450	5.21	571	.4511	5.05	66.67	.0757	.0766	.9678	
	5HdH2/SB-SF	2.299	8.49	926	.3549	8.49	65.89	.1288	.1288	1.0000	

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*Boundary outside surveyed area was photo-interpreted

TABLE A2 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
P Continued											
	9H2/SB-SF	2.094	11.85	725	.5360	3.00	76.09	.0394	.0455	.2531	
	5HdH2/SB-SF	1.699	8.36	575	.5675	4.44	70.38	.0631	.0674	.5318	
Q	31-V-45	1.394	4.08	598	.3816						E 1,167,500 N 647,500
	7HdH2/SB-SF	1.273	6.45	473	.6063	.76	9.48	.0800	.1858	.0908	
	3HS2/SB-SF	.860	3.96	358	.6283	.71	6.59	.1076	.1738	.1790	
	9HHd2/SB-SF	1.517	8.25	734	.4414	1.16	10.96	.1057	.2840	.1405	
R	31-V-45*	6.098	53.37	1850	.4455						E 1,165,000 N 645,000
	9HS4/SB-SF*	.853	4.25	306	.7606	4.07	53.58	.0759	.0762	.9559	
	9HS4/SF-O*	.708	2.78	240	.7837	.92	54.96	.0168	.0173	.3315	
	1S1/SB-SF^{CO_1}	4.529	36.96	1649	.4160	17.33	72.14	.2403	.3248	.4690	
	7HS4/SB-SF*	2.534	20.47	952	.5365	12.11	61.47	.1970	.2269	.5916	
	9HS4/SF-O*	.472	1.71	186	.7934	1.19	53.51	.0223	.0223	.6962	
	5HHd1,2/SB-SF	1.111	2.74	535	.3489	1.85	53.84	.0343	.0346	.6740	
	9Hd2,1/SB-SF	1.783	7.17	641	.4715	1.24	58.68	.0211	.0232	.1731	
S	31-V-45*	11.974	267.57	3641	.5070						E 1,152,500 N 627,500
	7HdH1/SB-SF*	1.741	14.14	553	.7671	14.14	267.57	.0529	.0529	1.0000	
	1DH1/BR-Sh	.814	2.19	318	.5246	2.19	267.57	.0082	.0082	1.0000	
	5HdH1/SB-SF	.698	2.64	289	.6339	1.66	268.52	.0062	.0062	.6324	
	7HdH1/SB-SF	1.832	10.82	612	.6064	7.62	270.42	.0282	.0285	.7042	
	9Hd1/SB-SF*	1.417	9.92	554	.6412	9.92	267.57	.0371	.0371	1.0000	
	1DH1/SB-SF^{CO_1*}	2.044	11.13	656	.5735	10.60	268.25	.0395	.0396	.9517	
	7DHd3/SB-SF*	1.268	6.42	486	.5883	2.52	270.45	.0093	.0094	.3936	
	7Hd2/SB-SF	.623	1.58	251	.5662	.62	268.43	.0023	.0023	.3885	
	3Hd1/Sh,He^{CO_1}	.662	2.44	228	.7724	.70	269.23	.0026	.0026	.2888	
	1D1/Sh-He^{CO_1}	1.654	7.89	499	.6351	7.04	268.19	.0263	.0263	.8925	
	1DH1/VM-SF	.742	3.04	283	.6942	1.55	268.88	.0058	.0058	.5110	
	7HHd1/SB-SF	.943	6.33	367	.7731	6.33	267.57	.0237	.0237	1.0000	
	7D3/SB-SF*	.418	1.33	155	.8408	1.04	267.71	.0039	.0039	.7882	
	7DHd3/SB-SF*	.956	2.59	337	.5386	2.59	267.57	.0097	.0097	1.0000	
	5HdH1/SB-SF*	2.034	10.94	671	.5565	4.95	273.48	.0181	.0185	.4517	
	1S1/Sh,He*	1.423	7.18	601	.5030	5.38	270.26	.0199	.0201	.7472	
	3HdH1/SB-SF*	.817	3.45	361	.5799	2.92	270.05	.0108	.0109	.8435	
	5HHd2/SB-SF	1.009	3.55	367	.5787	1.98	271.24	.0073	.0074	.5557	
	3HdD1/SB-SF	.776	3.11	312	.6379	1.31	269.13	.0049	.0049	.4228	
	5HD1/SB-SF	1.218	3.91	467	.4778	1.50	269.96	.0056	.0056	.3838	

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*Boundary outside surveyed area was photo-interpreted

TABLE A2 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	$\frac{V\cap S}{VUS}$	$\frac{V\cap S}{SOIL}$	$\frac{V\cap S}{VEG.}$	LOCATION
S Continued											
	7HdHD1/SB-SF	1.432	9.16	548	.6228	6.15	269.92	.0228	.0230	.6713	
	7HHd1/SB-SF	1.259	7.62	421	.7394	6.02	268.76	.0224	.0225	.7905	
	7HdH1/SB-SF*	1.526	9.26	534	.6430	1.10	274.26	.0040	.0041	.1182	
	9Hd2/SB-SF*	.826	3.64	343	.6276	.88	270.19	.0033	.0033	.2439	
	1SHd1/Sh-He*	1.505	9.90	485	.7324	9.79	267.22	.0366	.0366	.9902	
	7HdH1/SB-SF	1.007	7.09	352	.8543	7.09	267.57	.0265	.0265	1.0000	
	3HdS1/Sh,He*	1.279	8.53	500	.6586	8.53	267.57	.0319	.0319	1.0000	
	1SHd1/SB-SF*	1.424	8.44	510	.6428	8.44	267.57	.0315	.0315	1.0000	
	HdS1/SB-SF*	1.276	10.86	523	.7112	10.86	267.57	.0406	.0406	1.0000	
T	31-V-45	3.073	23.62	1075	.5100						E 1,150,000 N 622,500
	7Hd2/SB-SF*	.844	3.64	325	.6623	.42	27.12	.0155	.0178	.1151	
	1DHd1/SH-He*	1.376	6.43	595	.4809	4.84	24.67	.1963	.2050	.7526	
	7Hd2/SB-SF	.646	1.64	262	.5522	.18	25.67	.0069	.0075	.1085	
	7DHd3/SB-SF*	1.274	6.52	494	.5829	1.65	28.77	.0573	.0698	.2528	
U	31-V-45*	1.702	14.90	684	.6367						E 1,167,500 N 630,000
	NS/SB-SF^{CO_1}	1.835	7.71	823	.3807	1.02	21.92	.0467	.0687	.1326	
	9H1/SF	.802	2.55	245	.7359	1.09	16.30	.0668	.0731	.4273	
	3HHd1/SB-SF*	.846	4.01	290	.7780	.66	18.59	.0355	.0443	.1644	
	7HdH1/SB-SF*	.617	2.55	216	.8341	2.33	14.98	.1559	.1567	.9159	

*Boundary outside surveyed area was photo-interpreted

TABLE A3. Random Sample Soil-Vegetation Complexes - Basic Cartometric Data

COMPLEX	DELINEATION	(1) PERIMETER(km)	(2) AREA(ha)	(3) LONG AXIS(m)	(4) ELONGATION RATIO[a]	(5) $V \cap S$[b]	(6) $V \cup S$[c]	(7) $\frac{V \cap S}{V \cup S}$[d]	(8) $\frac{V \cap S}{SOIL}$[e]	(9) $\frac{V \cap S}{VEG.}$[f]	LOCATION[g]
I	22-U-45*	1.374	5.14	679	.3768						E 1,162,500 N 657,500
	7H2/VM-SF*	1.057	5.33	409	.6369	1,44	8.86	.1632	.2813	.2713	
	1S1/He,Gr,Sh$^{C\&B}$*	1.396	10.69	522	.4992	.26	7.35	.0351	.0502	.1005	
	7HdH1,4/SB-SF*	1.663	12.79	644	.6263	1.32	7.44	.1775	.2570	.2147	
II	32-R-15	1.772	3.66	848	.2545						E 1,165,000 N 655,000
	9H2/SF*	.510	1.44	196	.6921	.46	5.00	.0919	.1256	.3195	
	9H1/SF	.671	2.66	244	.7548	.98	5.46	.1790	.2671	.3684	
	1S1/He,Sh,Gr^{CO_1}	1.631	7.98	698	.4565	2.18	9.58	.2276	.5959	.2734	
III	32-b-45	.570	.83	238	.4316						E 1,167,500 N 655,000
	1S1/SB-SF^{CO_1}†	1.740	11.92	617	.6316	.56	11.97	.0466	.6721	.0466	
	9H2/SF	.270	.41	118	.6165	.30	.89	.3385	.3640	.7283	
IV	21-U-45	1.568	9.84	671	.5275						E 1,162,500 N 652,500
	NSCO$_1$/VM-SF*	2.689	16.54	856	.5364	4.04	22.14	.1827	.4111	.2444	
	5HHd2/VM-SF	.905	2.63	335	.5471	1.11	11.14	.1001	.1133	.4231	
	1HSHd2/VM-SF	2.720	9.15	961	.3552	3.97	14.55	.2731	.4038	.4338	
V	31-V-75	2.096	16.10	715	.6330						E 1,167,500 N 652,500
	7HS4,2/SB-SF	1.966	14.07	742	.5707	1.94	28.46	.0681	.1204	.1377	
	1D1/SB-SF^{CO_1}	1.414	9.07	536	.6335	6.36	18.89	.3365	.3949	.7008	
	9H2/SF	3.539	14.61	982	.4393	3.38	27.42	.1234	.2102	.2316	
	1D1/SB-SF^{CO1}	1.092	5.26	440	.5873	3.19	18.02	.1769	.1980	.6065	

[a] Diameter of a circle having the same area/length of longest axis

[b] Area(ha) covered by both the vegetation and the soil

[c] Area(ha) covered by either the vegetation or the soil

[d] (7)=(5)÷(6)

[e] (8)=(5)÷entry for soil in column (2)

[f] (9)=(5)÷(2)

[g] Expressed in State Plane Coordinates to the nearest 2,500 ft.

* Boundary outside surveyed area was photo-interpreted

† Contains an enclave of 9H2/SF

TABLE A3 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
VI	32-M-75	3.566	25.86	1502	.3819						E 1,172,500 N 652,500
	9HHd2/SF	1.817	5.39	852	.3074	2.04	29.18	.0700	.0792	.3803	
	9HS2/SF	1.753	6.94	682	.4361	3.20	29.57	.1081	.1236	.4606	
	9H4,2/SF	.964	5.94	332	.8273	1.66	30.14	.0550	.0641	.2792	
	9H2/SF	2.600	12.18	692	.5688	8.25	29.60	.2788	.3191	.6775	
	9H3/SF	.578	2.08	215	.7583	1.90	26.04	.0729	.0734	.9114	
	3HS2/SB-SF	.426	1.15	161	.7521	.71	26.24	.0271	.0275	.6195	
	9H4/SF	1.298	6.76	457	.6415	5.86	27.09	.2165	.2268	.8683	
VII	31-X-15	.719	3.52	295	.7177						E 1,167,500 N 645,000
	1S1/SB-SF^{CO_1}	8.306	82.13	2531	.4041	3.31	82.49	.0401	.9397	.0403	
VIII	32-R-15	1.748	8.07	685	.4679						E 1,170,000 N 645,000
	9H2/SB-SF	1.561	7.12	582	.5175	4.02	10.92	.3683	.4985	.5648	
	7HdH2/SB-SF*[†]	4.069	29.87	1138	.5421	2.87	34.73	.0827	.3559	.0962	
IX	21-U-15*	4.295	40.22	1418	.5045						E 1,162,500 N 650,000
	7HHd2/VM-SF	2.009	10.53	715	.5120	3.36	47.57	.0706	.0835	.3189	
	9HHd2/VM-SF*	4.909	26.69	1144	.5097	24.42	42.66	.5725	.6073	.9153	
	7HdH2/VM-SF	1.812	6.89	518	.5714	4.47	42.76	.1045	.1111	.6483	
	3HSHd2/SB-SF	.917	4.64	335	.7260	3.39	41.55	.0815	.0842	.7301	
	9Hd2/VM-SF*	2.219	6.68	1015	.2862	1.57	45.19	.0348	.0391	.2355	
X	31-U-15*	6.283	69.30	2000	.4696						E 1,162,500 N 647,500
	5HSHd2/VM-SF*	1.650	10.10	748	.4798	9.86	69.64	.1416	.1423	.9761	
	9HS4/SF-O*	.709	2.76	239	.7853	1.94	70.05	.0277	.0280	.7036	
	9HS4/SF-O*	.488	1.58	180	.7870	.76	69.94	.0108	.0109	.4811	
	7HS4/SB-SF*	2.525	20.52	941	.5433	9.18	81.04	.1133	.1325	.4474	
	7Hd2/SB-SF*	1.607	3.39	773	.2690	3.19	69.45	.0459	.0460	.9400	
	7HS4/SF-O	.757	2.92	356	.5406	2.92	69.30	.0421	.0421	1.0000	
	1S1/SB-SF^{CO_1}	.949	4.26	385	.6046	4.26	69.30	.0615	.0615	1.0000	
	5HdH2/SB-SF*	1.967	7.63	691	.4510	6.96	70.71	.0985	.1005	.9124	
	3HS2/SB-SF	.868	4.01	343	.6588	.61	72.60	.0084	.0088	.1519	
	9Hd2,1/SB-SF	1.825	6.89	647	.4580	2.22	74.17	.0299	.0320	.3220	
XI	31-U-15*	.712	3.04	314	.6257						E 1,167,500 N 645,000

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*Boundary outside surveyed area was photo-interpreted

[†] Contains an enclave of 7H4,2/SB-SF

TABLE A3 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	$V \cup S$	$\frac{V \cap S}{V \cup S}$	$\frac{V \cap S}{\text{SOIL}}$	$\frac{V \cap S}{\text{VEG.}}$	LOCATION
XI Continued											
	9HHd2/SB-SF*	1.974	9.83	764	.4629	2.65	10.48	.2536	.8740	.2702	
XII	32-R-45	2.090	4.18	960	.2405						E 1,172,500 N 655,000
	9HHd2/SB-SF	.598	1.92	234	.6678	.20	5.96	.0341	.0486	.1060	
	5HHd4/SB-SF	.515	1.76	205	.7292	.25	5.80	.0437	.0606	.1443	
	9HD2/RH-SB	1.081	3.87	499	.4448	1.67	6.32	.2649	.4006	.4331	
	9HS2/SF*	1.721	7.64	722	.4317	1.19	10.60	.1124	.2849	.1561	
	1D1/SB-SF(O)^{CO_1}	1.403	8.68	511	.6505	.72	12.21	.0590	.1723	.0830	
XIII	21-U-15*	3.172	39.89	1014	.7028						E 1,152,500 N 637,500
	7HHdS2/VM-SF*	1.842	11.17	688	.5485	11.17	39.89	.2800	.2800	1.0000	
	7HHd2,4/VM-SF*	2.726	18.33	1087	.4443	6.49	51.55	.1259	.1627	.3542	
	9H3/SF	1.091	3.95	467	.4806	1.21	42.26	.0286	.0303	.3062	
	7HHdS5/SB-SF	.644	2.16	244	.6808	2.09	39.97	.0523	.0524	.9675	
	9H2/SF	.745	2.54	347	.5182	.57	41.62	.0138	.0144	.2270	
	9HdHS3,2/SB-SF*	1.697	9.66	685	.5119	6.73	43.11	.1561	.1687	.6965	
	Gr,He,Sh*	.680	3.05	245	.8048	3.05	39.89	.0764	.0764	1.0000	
XIV	32-U-15*	3.256	23.77	1105	.4977						E 1,165,000 N 635,000
	3HS1/SB-SF*	2.202	6.44	853	.3356	4.78	25.85	.1847	.2009	.7417	
	5H2,1/SB-SF*	.679	2.96	287	.6765	2.96	23.77	.1244	.1244	1.0000	
	7HHd2/SB-SF(H)(G)	.902	3.01	275	.7122	.61	26.10	.0235	.0258	.2041	
	7H2/SB-SF	2.591	9.90	678	.5235	3.70	29.85	.1240	.1557	.3739	
	7HdH1/SB-SF*	1.376	9.40	473	.7316	2.16	30.89	.0701	.0911	.2305	
	5HdH1/SB-SF	.907	3.03	368	.5331	.38	26.21	.0146	.0161	.1260	
	9H1/SF*	1.781	6.13	599	.4667	1.19	28.57	.0416	.0500	.1938	
	7H1/SB-SF	1.032	2.60	362	.5025	2.36	23.96	.0984	.0992	.9054	
	9H2/SF	.558	1.82	193	.7887	.74	25.14	.0294	.0311	.4056	
XV	31-X-15*	1.500	5.69	664	.4057						E 1,167,500 N 635,000
	9Hd2/SB-SF*	2.202	11.56	761	.5043	3.41	13.60	.2504	.5987	.2947	
	5HdH2/SB-SF	2.278	13.44	769	.5378	.96	18.60	.0518	.1693	.0717	
XVI	21-V-15*	3.186	18.26	1068	.4515						E 1,152,500 N 632,500
	9HS3/VM-SF*	1.514	10.04	498	.7180	1.30	27.41	.0475	.0713	.1297	
	5HdHS1,2/SB-SF†	3.608	10.32	808	.4488	2.41	26.53	.0907	.1318	.2334	

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*Boundary outside surveyed area was photo-interpreted

†Contains an enclave of 5CSH2,3/SB-SF

TABLE A3 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
XVI Continued											
	7HHd2/SB-SF	2.017	10.22	610	.5918	5.00	23.64	.2116	.2739	.4894	
	5CSH2,3/SB-SF	.480	1.35	190	.6920	.36	19.55	.0184	.0197	.2659	
	5HHd2/SB-SF	.721	2.76	262	.7165	.40	20.64	.0192	.0217	.1436	
	7HHd2,1/SB-SF*	2.033	10.79	638	.5807	4.64	24.90	.1863	.2541	.4299	
	7HdH1/SB-SF*	1.519	8.74	516	.6465	1.72	25.87	.0667	.0945	.1975	
	5HdD1/Sh,He,Gr	.709	2.45	265	.6659	2.28	18.57	.1225	.1246	.9287	
XVII	21-V-45*	14.431	134.97	2690	.4873						E 1,150,000 N 627,500
	7HHd2/VM-SF*	.758	2.18	349	.4769	1.46	136.23	.0107	.0108	.6687	
	9Hd2/SB-SF*	1.706	6.64	547	.5314	4.54	137.42	.0330	.0336	.6828	
	7HHd2/VM-SF	1.313	7.69	481	.6503	5.70	136.92	.0416	.0422	.7407	
	9H3/VM-SF	.646	1.84	283	.5409	1.84	134.97	.0137	.0137	1.0000	
	7H2,5/VM-SF	.965	4.66	379	.6422	.66	140.71	.0047	.0049	.1406	
	7H2/VM-SF	1.349	5.42	396	.6633	3.52	136.54	.0258	.0261	.6493	
	9H2/VM-SF*	1.541	7.82	451	.6993	7.57	135.21	.0560	.0561	.9690	
	1HD1/VM-SF	1.205	5.44	407	.6472	2.93	137.50	.0213	.0217	.5389	
	9Hd2/SB-SF	1.350	3.23	444	.4566	.43	139.22	.0031	.0032	.1341	
	7HHd2/VM-SF	1.951	12.66	612	.6561	8.81	138.36	.0637	.0653	.6964	
	5Hd1/SB-SF	.557	1.96	220	.7194	1.59	136.12	.0117	.0118	.8097	
	Sh,He,Gr	1.248	3.42	383	.5453	.74	137.47	.0054	.0055	.2157	
	9HD2/VM-SF	.476	1.58	197	.7202	.89	137.05	.0065	.0066	.5608	
	7HHd2/VM-SF	1.014	3.65	415	.5190	1.81	137.02	.0132	.0134	.4954	
	3DH1/BR-Sh	.926	2.46	239	.7419	2.23	135.10	.0165	.0165	.9056	
	9HD2/VM-SF	.241	.51	102	.7901	.32	135.18	.0024	.0024	.6296	
	9Hd2/SB-SF	1.420	5.21	922	.2794	2.85	136.92	.0208	.0211	.5474	
	5HHd2/VM-SF	1.154	3.57	442	.4829	2.05	135.86	.0151	.0152	.5756	
	3HS1/SB-SF	.719	2.64	269	.6825	1.92	135.93	.0141	.0142	.7270	
	3HdD1/Sh-He	.600	2.00	212	.7523	2.00	134.97	.0149	.0149	1.0000	
	1D1/BR-Sh	.630	1.33	278	.4675	1.19	136.52	.0087	.0088	.8899	
	7D3/SB-SF	1.394	4.67	485	.5028	1.73	137.11	.0126	.0128	.3710	
	5HHd1,2/VM-SF	1.536	9.43	496	.6993	7.91	136.13	.0581	.0586	.8390	
	7H3/SF-O*	.880	3.19	356	.5650	.90	139.12	.0065	.0067	.2827	
	5HHd2,1/SB-SF	1.090	6.17	394	.7123	4.64	136.56	.0340	.0344	.7526	
	7HHd2,5/SB-SF	.703	2.62	233	.7854	2.02	135.88	.0149	.0150	.7715	
	7H3/SF	.977	4.20	372	.6215	4.05	135.16	.0300	.0300	.9646	
	7HD3/VM-SF*	.565	1.82	208	.7343	1.82	134.97	.0135	.0135	1.0000	
	7DH4/SF-O*	1.768	11.27	560	.6759	10.00	136.07	.0735	.0741	.8875	
	1Hd1/SB-SF	.662	2.14	263	.6287	1.78	136.00	.0131	.0132	.8289	
	5HdH1/SB-SF*	2.033	11.36	677	.5620	2.08	144.34	.0144	.0154	.1827	
	7Hd2/SB-SF	2.480	16.34	661	.6899	10.38	141.02	.0736	.0769	.6348	

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*Boundary outside surveyed area was photo-interpreted

TABLE A3 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
XVII Continued											
	3HdD1/SB-SF	.810	3.13	318	.6281	1.69	137.16	.0123	.0125	.5368	
	1HdD1/SB-SF	.919	3.21	329	.6150	2.47	135.71	.0182	.0183	.7674	
	5HD1/SB-SF	1.234	4.14	488	.4704	1.54	137.38	.0112	.0114	.3697	
	7HdHD1/SB-SF	1.439	8.84	559	.5998	1.02	142.47	.0072	.0076	.1158	
	7HHd1/SB-SF*	1.229	7.34	391	.7816	1.43	140.26	.0102	.0106	.1955	
	7HdH1/SB-SF*	1.534	9.01	503	.6735	3.21	140.27	.0229	.0238	.3571	
	1DS1/Sh,He*	1.044	6.65	419	.6947	1.17	141.47	.0083	.0087	.1760	
XVIII	21-U-15*	1.253	6.43	515	.5560						E 1,145,000 N 625,000
	9DH4/SF	1.230	7.13	445	.6769	1.03	12.53	.0820	.1598	.1441	
	7H5/SF*	1.816	5.60	630	.4238	2.99	9.16	.3261	.4644	.5336	
	7H2/VM-SF*	.668	3.21	258	.7837	1.83	7.49	.2445	.2849	.5709	
XIX	12-a-5*	3.941	20.76	1354	.3798						E 1,175,000 N 657,500
	9Hd1/SB-SF*	.352	.82	148	.6927	.82	20.76	.0396	.0396	1.0000	
	Gr,He	.545	1.66	214	.6799	1.62	20.79	.0777	.0778	.9756	
	1HHd1/SB-SF	.590	1.74	262	.5694	1.74	20.76	.0839	.0839	1.0000	
	7HdHS2,1/SB-SF*	2.299	16.15	847	.5352	2.32	34.31	.0677	.1119	.1438	
	1Hd1/SB-SF CO1*	.881	5.02	374	.6753	3.00	22.39	.1339	.1444	.5971	
XX	32-V-75*	24.421	283.38	4549	.4175						E 1,170,000→ 1,182,500 N 655,000
	9Hd2/SB-SF*	8.018	43.66	1996	.3736	8.30	319.35	.0260	.0293	.1900	
	9HHd2/SB-SF*	2.749	13.77	894	.4684	6.32	291.22	.0217	.0223	.4584	
	9HdH2/SB-SF	1.610	3.36	492	.4204	1.67	285.16	.0059	.0059	.4998	
	9HdH2/SB-SF	1.318	4.46	420	.5672	1.56	286.17	.0055	.0055	.3503	
	7HdH2,1/SB-SF	1.046	4.39	449	.5267	4.39	283.38	.0155	.0155	1.0000	
	9HHdS2,1/SB-SF	2.437	14.17	727	.5841	13.72	283.97	.0483	.0484	.9678	
	5H4,5/SB-SF	2.586	17.41	812	.5796	11.84	288.91	.0410	.0418	.6797	
	7HHd2,1/SB-SF	1.043	5.34	408	.6389	5.34	283.38	.0188	.0188	1.0000	
	5HdH2,1/RH-SB	1.895	10.68	786	.4691	7.11	286.81	.0248	.0251	.6667	
	7HS2/SB-SF	2.108	8.88	652	.5160	3.71	290.02	.0128	.0131	.4167	
	7H4/SF	.822	2.45	299	.5915	.79	284.90	.0028	.0028	.3210	
	9HdH2/SB-SF	.821	4.42	319	.7937	3.17	284.50	.0112	.0112	.7210	
	5HSHd2,1/SB-SF	2.321	8.69	786	.4232	5.75	286.20	.0201	.0203	.6620	
	7HS2/SB-SF	.866	3.97	348	.6464	3.71	283.60	.0131	.0131	.9339	
	7HS2,5/SB-SF	.992	4.37	406	.5813	3.43	284.24	.0121	.0121	.7867	

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*Boundary outside surveyed area was photo-interpreted

TABLE A3 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
XX Continued											
	7Hd2/SB-SF	.660	2.93	262	.7377	2.72	283.56	.0096	.0096	.9290	
	5H4,2/SB-SF	1.589	5.99	656	.4209	4.73	285.09	.0166	.0167	.7885	
	7HHd5,2/SB-SF	2.248	12.62	718	.5585	1.30	296.26	.0044	.0046	.1027	
	7HS2/SB-SF	1.651	10.08	612	.5853	10.08	283.38	.0356	.0356	1.0000	
	9H2/SF	.760	1.90	257	.6056	.82	284.34	.0029	.0029	.4370	
	5H4/SB-SF	1.075	5.87	401	.6821	3.94	285.43	.0138	.0139	.6691	
	5HHdS5,2/SB-SF	1.278	9.58	523	.6674	8.87	284.01	.0313	.0313	.9274	
	9HdH2/SB-SF	.720	2.32	323	.5329	1.62	284.08	.0057	.0057	.6970	
	9H2/SF	1.130	4.13	479	.4790	2.86	286.21	.0100	.0101	.6897	
	5HS2/SB-SF	1.025	3.74	428	.5092	3.48	283.43	.0123	.0123	.9312	
	7HS2/SB-SF	1.075	3.32	398	.5158	3.32	283.38	.0117	.0117	1.0000	
	9HS2/SF	.563	1.72	258	.5729	1.72	283.38	.0061	.0061	1.0000	
	9HS2/SB-SF	1.086	5.28	430	.6038	2.52	286.09	.0089	.0089	.4797	
	7SH2/SB-SF	1.229	5.92	409	.6712	5.89	283.40	.0208	.0208	.9966	
	3HdH1/TB-ST	1.020	4.44	388	.6138	4.44	283.38	.0157	.0157	1.0000	
	7HCS2,5/SB-SF	1.792	11.57	649	.5912	11.11	283.51	.0392	.0392	.9607	
	7HS2/SB-SF	1.273	6.47	418	.6876	5.33	284.23	.0188	.0188	.8241	
	9HS2/SF	1.456	5.37	576	.4539	1.76	286.55	.0062	.0062	.3285	
	7HS2/SB-SF	1.327	7.84	499	.6329	1.36	289.41	.0047	.0048	.1725	
	5HS2,1/SB-SF	1.595	7.06	574	.5227	6.80	283.69	.0240	.0240	.9636	
	7HdHS2/SB-SF	1.932	11.00	593	.6313	2.49	293.38	.0085	.0088	.2266	
	9HHd2/SF	.943	3.61	402	.5333	2.98	283.96	.0105	.0105	.8253	
	9H2/SF	1.603	11.13	539	.6988	1.47	294.72	.0050	.0052	.1323	
	7HSHd2/SB-SF	1.129	4.26	451	.5161	4.02	283.69	.0142	.0142	.9473	
	5HSHd2/SB-SF	1.560	5.93	613	.4482	4.36	285.23	.0153	.0154	.7376	
	7HdHS1,2/SB-SF	2.214	5.68	788	.3412	3.85	285.48	.0135	.0136	.6765	
	7HS2/SB-SF	1.451	5.24	607	.4254	4.50	285.17	.0158	.0159	.8581	
	7Hd2/SB-SF	1.130	3.48	504	.4177	3.29	283.55	.0116	.0116	.9434	
	5HSHd2,1/SB-SF	1.903	12.12	554	.7085	2.89	291.97	.0099	.0102	.2395	
	7HS2,1/SB-SF	2.280	9.61	620	.5640	3.71	290.02	.0128	.0131	.3848	
	7Hd2/SB-SF	.469	1.56	196	.7215	1.56	283.38	.0055	.0055	1.0000	
	1HHd1/RH-SB	.689	2.08	284	.5715	2.08	283.38	.0073	.0073	1.0000	
	5H2,1/SB-SF$_{CO_1}$	1.066	3.23	356	.5687	1.33	285.48	.0047	.0047	.4126	
	NS/SB-SF^{CO_1}	2.482	12.10	845	.4646	9.66	285.05	.0339	.0341	.7994	
	NS/SF-O^{CO_1}	1.369	5.20	391	.6575	3.48	285.02	.0123	.0123	.6730	
	/SB-SF^{CO1}	.826	1.97	334	.4753	1.02	284.06	.0036	.0036	.5178	
	7H5/SF-O	.445	1.15	162	.7468	1.15	283.38	.0041	.0041	1.0000	
	7HF5/SB-SF	.469	1.16	187	.6479	1.08	283.48	.0038	.0038	.9242	
	3H1/SB-SF	1.093	2.89	408	.4700	.40	285.62	.0014	.0014	.1421	
	5HF5/SB-SF	.871	3.38	275	.7549	2.46	284.34	.0087	.0087	.7304	
	1HF1/SB-SF	1.699	5.57	641	.4157	.99	291.71	.0034	.0035	.1757	
	7HF2/SF	1.117	2.86	464	.4109	.94	292.24	.0032	.0033	.3229	
	3FHdH1/RH-SB	.925	5.09	404	.6294	1.93	287.61	.0067	.0068	.3780	

TABLE A3 CONTINUED

COM-PLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	$V \cap S$	VUS	$\frac{V \cap S}{VUS}$	$\frac{V \cap S}{SOIL}$	$\frac{V \cap S}{VEG.}$	LOCATION
XX Continued											
	5H5/SB-SF	.830	2.82	276	.6867	2.46	283.76	.0087	.0087	.8752	
	9HF2/SF	1.033	2.71	480	.3872	1.76	284.10	.0062	.0062	.6457	
	1HF1/RH-SB	2.282	12.12	814	.4828	6.46	288.44	.0224	.0228	.5341	
	5HS2,1/SB-SF	1.265	7.17	445	.6786	2.01	291.59	.0069	.0071	.2787	
	7HHd2,4/SB-SF	2.293	17.99	865	.5532	1.90	301.37	.0063	.0067	.1052	
	9H2/SF	1.252	4.40	454	.5221	3.80	283.93	.0134	.0134	.8626	
	7HSHd2/SB-SF	1.036	4.34	354	.6637	3.17	284.35	.0112	.0112	.7350	
	7HHd2/SB-SF	.839	2.01	299	.5353	1.13	284.30	.0040	.0040	.5598	
	9Hd2/SB-SF	.409	.90	166	.6477	.90	283.38	.0032	.0032	1.0000	
	9H2/SF	.793	1.94	354	.4442	.57	284.92	.0020	.0020	.2877	
	7HCS5/SB-SF	2.978	17.18	972	.4811	12.67	287.89	.0440	.0447	.7375	
	1D1/TB-ST	1.332	10.07	509	.7037	6.20	287.32	.0216	.0219	.6173	
XXI	33-V-75	3.050	38.45	1016	.6884						E 1,187,500 N 655,000
	1H1/TB-ST	2.028	6.46	696	.4122	6.46	38.45	.1682	.1682	1.0000	
	5HDHd1/RH-SB	1.196	5.97	382	.7224	3.94	40.46	.0974	.1025	.6607	
	7H1/RH-SB	2.659	9.37	762	.4534	1.86	46.18	.0403	.0484	.1987	
	3HD1/RH-SB	.676	2.27	277	.6134	.84	39.91	.0211	.0219	.3717	
	9H2/SF	.986	4.03	391	.5789	1.78	40.83	.0436	.0463	.4424	
	1H1/SB-SF^{CO_1}	.888	4.70	320	.7637	4.70	38.45	.1223	.1223	1.0000	
	5H1/SB-SF	.905	3.22	300	.6752	3.22	38.45	.0838	.0838	1.0000	
	3H1/RH-SB	.958	3.37	320	.6461	3.37	38.45	.0875	.0875	1.0000	
	1H1/SB-SF^{CO_1}	.688	2.88	259	.7387	2.68	38.78	.0692	.0698	.9319	
	1H1/RH-SB^{CO_1}	1.451	6.42	461	.6207	5.11	39.92	.1280	.1329	.7953	
	5DH2/SB-SF	.577	1.56	215	.6558	1.56	38.45	.0405	.0405	1.0000	
	1H1/SB-SF^{CO_1}	.529	1.88	187	.8255	.41	39.96	.0102	.0106	.2166	
XXII	32-V-75*	3.968	38.31	1102	.6340						E 1,187,500 N 650,000
	1D1/BR-LO*†	4.910	59.28	1304	.6660	11.29	86.91	.1299	.2947	.1904	
	3D1/BR-LO	.924	3.00	302	.6460	1.41	39.93	.0354	.0369	.4717	
	3DHd1/BR-LO	1.600	7.19	527	.5743	4.44	40.88	.1087	.1160	.6184	
	1D1/TB-ST	.628	1.79	260	.5794	1.62	38.40	.0421	.0422	.9046	
	5HdD1/BR-LO	.814	4.01	358	.6322	2.56	39.19	.0653	.0688	.6377	
	3HdD1/BR-LO	1.061	5.17	404	.6347	3.10	40.78	.0759	.0808	.5980	
	1D1/BR-LO	1.218	5.68	505	.5321	3.06	41.37	.0739	.0798	.5385	
	7Hd1/SB-SF*	1.118	5.06	451	.5628	4.03	39.74	.1015	.1053	.7970	

* Boundary outside surveyed area was photo-interpreted

† Contains an enclave of 1F1/TB-ST

TABLE A3 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S / VUS	V∩S / SOIL	V∩S / VEG.	LOCATION
XXIII	33-M-45	2.240	12.31	630	.6284						E 1,180,000 N 647,500
	5FH2,1/RH-SB	1.252	3.92	484	.4622	.54	15.08	.0360	.0441	.1383	
	3FH1/RH-SB	.498	.87	174	.6060	.47	12.64	.0375	.0385	.5434	
	9H1,2/RH-SB	.434	1.18	148	.8310	.46	13.00	.0355	.0375	.3911	
	1FH1/RH-SB	1.028	6.66	367	.7933	3.81	15.19	.2509	.3097	.5719	
	3HF1/RH-SB	.696	2.22	276	.6088	.96	13.47	.0713	.0780	.4328	
	5FH2,1/RH-SB	1.003	4.88	384	.6489	4.11	12.87	.3192	.3338	.8427	
	3F1/RH-SB	.724	2.56	272	.6621	1.18	13.39	.0878	.0955	.4602	
XXIV	33-R-15	1.418	4.46	655	.3636						E 1,180,000 N 647,500
	1HF1/RH-SB	1.078	3.78	478	.4595	1.42	6.68	.2132	.3195	.3766	
	7HF2/SB-SF	.832	2.54	374	.4808	1.72	5.59	.3072	.3849	.6742	
	7H5/RH-SB	.372	.95	140	.7829	.53	5.00	.1054	.1182	.5552	
	9H2/RH-SB	.658	2.54	278	.6465	.66	6.23	.1068	.1491	.2613	
XXV	32-M-45	3.259	44.25	1142	.6570						E 1,177,500 N 647,500
	9HF2/SB-SF	.913	2.94	371	.5222	.89	46.08	.0193	.0201	.3026	
	1HF1/RH-SB	1.078	3.78	478	.4595	1.94	46.47	.0418	.0439	.5140	
	5HF2/RH-SB	1.268	4.06	526	.4326	3.40	45.13	.0754	.0769	.8374	
	1HS1,2/RH-SB	.968	5.09	406	.6277	5.09	44.25	.1151	.1151	1.0000	
	3SH1,2/RH-SB	1.690	5.81	550	.4948	3.34	46.79	.0714	.0755	.5753	
	3SHdH1/SB-SF	1.314	4.90	565	.4420	4.90	44.25	.1108	.1108	1.0000	
	5HS1/SB-SF	.737	3.40	301	.6907	2.96	44.65	.0663	.0669	.8702	
	5HF4,2/SB-SF	.991	3.17	342	.5875	1.57	46.34	.0339	.0355	.4947	
	9HF2/SB-SF	1.600	5.82	559	.4870	.93	49.40	.0189	.0211	.1600	
	1SF1/Gr,He,Sh CO1	1.116	4.94	408	.6148	1.04	48.35	.0216	.0236	.2113	
	1D1/SB-SF	.899	3.30	343	.5971	3.30	44.25	.0745	.0745	1.0000	
	1SH1/SB-SF	.744	3.45	281	.7466	3.29	44.31	.0743	.0744	.9536	
	1HSHd1/RH-SB	1.726	9.86	538	.6590	1.07	54.08	.0198	.0242	.1087	
	7HdS1/SB-SF	2.311	9.74	656	.5364	4.76	50.06	.0952	.1077	.4894	
	1SH1/SB-SF	1.037	3.27	373	.5465	3.23	54.38	.0594	.0730	.9885	
	9H2/RH-SB	.658	2.54	278	.6465	1.72	45.54	.0378	.0389	.6759	
	7H5/RH-SB	.372	.95	140	.7829	.23	45.12	.0051	.0052	.2434	
XXVI	32-V-75*	2.100	27.25	720	.8182						E 1,172,500 N 642,500
	7HHd2/SB-SF*	3.182	30.26	853	.7275	15.03	42.81	.3512	.5517	.4969	
	7H5,2/SB-SF	1.372	5.58	493	.5405	4.58	28.68	.1596	.1680	.8203	
	7HHd2/SB-SF	1.079	4.41	448	.5294	.91	31.17	.0292	.0334	.2065	

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* Boundary outside surveyed area was photo-interpreted

TABLE A3 CONTINUED

COMPLEX	DELINEATION	PERIMETER(km)	AREA(ha)	LONG AXIS(m)	ELONGATION RATIO	V∩S	VUS	V∩S/VUS	V∩S/SOIL	V∩S/VEG.	LOCATION
XXVI Continued											
	7Hd2,1/SB-SF*	2.196	7.77	694	.4535	3.43	32.03	.1071	.1259	.4416	
XXVII	33-M-75*	1.834	11.43	742	.5144						E 1,182,500 N 640,000
	5HdH1/RH-SB*	1.351	5.50	444	.5960	1.42	15.56	.0910	.1239	.2576	
	1DH1/RH-SB	1.234	4.37	487	.4843	1.44	14.57	.0990	.1262	.3300	
	1D1/BR-LO	1.078	4.40	430	.5508	.45	15.33	.0293	.0393	.1022	
	5HF4/RH-SB*	.530	2.14	208	.7951	1.95	11.52	.1696	.1709	.9131	
	9Hd1/SB-SF*	.994	3.45	342	.6131	.40	14.51	.0278	.0353	.1167	

*Boundary outside surveyed area was photo-interpreted

Appendix II

Statistical Tests

Kolmogorov-Smirnov Analysis of Differences in Soil Polygon Size Distributions[a]

H_o: The distribution functions of soil polygon size are identical

H_a: The distribution functions of soil polygon size differ

Comparison	Test Statistic	Probability of observing a test statistic $\geq$ the calculated statistic if H_o is true
31-U-45/31-V-45	$.59^b$	.8772
31-U-45/Random Sample	$.67^b$	.7604
31-V-45/Random Sample	1.20^b	.1123
31-U-45 lowland/ upland	7.00^c	.1146
31-V-45 lowland/ upland	71.80^c	.0087
Random sample lowland/upland	42.00^c	>.1004

[a] The two-sample Kolmogorov-Smirnov test (two-sided) is described in Hollander and Wolfe (1973)

[b] The large-sample approximation of the test statistic was employed:

$$J_3' = \left(\frac{m+n}{mn}\right)^{\frac{1}{2}} \max\left\{|s_1|, \ldots |s_n|\right\}$$

[c] The standard test statistic was employed:

$$J_3 = \left(\frac{N}{d}\right) \max\left\{|s_1|, \ldots |s_n|\right\}$$

Appendix II - continued

Kolmogorov-Smirnov Analysis of Differences in Soil Polygon Elongation Ratio Distributions

H_o: The distribution functions of soil polygon elongation ratios are identical

H_a: 13-a-5 or 32-R-45 polygons are more elongate than polygons of the other soil type

Comparison	Test Statistic	Probability of observing a test statistic $\geq$ the calculated statistic if H_o is true
13-a-5/31-U-45	16.00[a]	<.0000
13-a-5/31-V-45	36.00[a]	<.0000
13-a-5/Random sample	42.00[a]	<.0000
32-R-45/31-U-45	81.00[a]	<.0000
32-R-45/31-V-45	189.00[a]	<.0000
32-R-45/Random sample	199.00[a]	<.0000

H_o: The distribution functions of soil polygon elongation ratios are identical

H_a: The distribution functions of soil polygon elongation ratios differ

Comparison	Test Statistic	Probability of observing a test statistic $\geq$ the calculated statistic if H_o is true
13-a-5/32-R-45	10.00[b]	>.1251
31-U-45/31-V-45	.96[c]	.3154
31-U-45/Random sample	.73[c]	.6609
31-V-45/Random sample	.76[c]	.6104
31-U-45 lowland/upland	5.00[b]	>.1146
31-V-45 lowland/upland	51.00[b]	>.1097
Random sample lowland/upland	61.00[b]	>.1004

[a] The one-sided test statistic ($J_2 = \frac{N}{d} \max\{-s_1, \ldots -s_n\}$) was employed

[b] The standard two-sided test statistic was employed

[c] The large-sample approximation of the two-sided test statistic was employed

Appendix II - continued

Analysis of Association Between Soil Polygon Elongation Ratio and the Average Elongation Ratio of Overlapping Vegetation Polygons, Using Spearman's Rank Correlation Coefficient[a]

H_o: Soil elongation ratios and average elongation ratios of overlapping vegetation polygons are independent

H_a: The elongation ratios are related

Comparison	r_s	Probability of observing an r_s value $\geq$ the the calculated r_s if H_o is true
All 31-U-45 complexes	+.5577	$.005 < p < .010$
Lowland 31-U-45 complexes	+.3143	$> .100$
Upland 31-U-45 complexes	+.6783	$.005 < p < .010$
All 31-V-45 complexes	+.0864	$> .100$
Lowland 31-V-45 complexes	-.1429	$> .100$
Upland 31-V-45 complexes	+.1813	$> .100$
All random sample complexes	-.2208	$> .100$
Lowland random sample complexes	-.6773	$.010 < p < .025$
Upland random sample complexes	-.1324	$> .100$

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[a] The use of Spearman's rank correlation coefficient ($r_s = 1 - \frac{6 \Sigma d^2}{n(n^2-1)}$) as a test statistic is described in Daniel (1978)

Appendix II - continued

Analysis of Association Between Soil Polygon Size and Number of Overlapping Vegetation Polygons, Using Spearman's Rank Correlation Coefficient

H_o: There is no association between soil polygon size and the number of overlapping vegetation

H_a: There is a direct relationship between soil polygon size and the number of overlapping vegetation polygons

Comparison	r_s	Probability of observing an r_s value $\geq$ the calculated r_s if H_o is true
All 31-U-45 complexes	+.8658	$<.001$
Lowland 31-U-45 complexes	+.9857	$<.001$
Upland 31-U-45 complexes	+.7483	$.001 < p < .005$
All 31-V-45 complexes	+.9182	$<.001$
Lowland 31-V-45 complexes	+.9524	$<.001$
Upland 31-V-45 complexes	+.8407	$<.001$
All random sample complexes	+.8565	$<.001$
Lowland random sample complexes	+.9318	$<.001$
Upland random sample complexes	+.8169	$<.001$

Appendix II - continued

Analysis of Association Between Areal Overlap and Areal Correspondence, Using Spearman's Rank Correlation Coefficient

H_o: There is no association between the total amount of overlap vegetation communities have with particular soil types and the index of areal correspondence for the same soil-vegetation combination

H_a: There is a relationship between areal overlap and areal correspondence

Comparison	r_s	Probability of observing an r_s value $\geq$ the calculated r_s if H_o is true
All 31-U-45 complexes	+.4013	$.010 < p < .025$
Lowland 31-U-45 complexes	+.1352	$> .100$
Upland 31-U-45 complexes	+.5766	$.001 < p < .005$
All 31-V-45 complexes	+.5433	$.001 < p < .005$
Lowland 31-V-45 complexes	+.7178	$< .001$
Upland 31-V-45 complexes	+.7074	$< .001$
All random sample complexes	+.6338	$< .001$
Lowland random sample complexes	+.5722	$.001 < p < .005$
Upland random sample complexes	+.6605	$< .001$

Appendix II - continued

Kolmogorov-Smirnov Analysis of Differences in Areal Correspondence Distributions

H_o: The distribution functions of areal correspondence are identical

H_a: The distribution functions of areal correspondence differ

Comparison	Test Statistic	Probability of observing a test statistic $\geq$ the calculated statistic if H_o is true
31-U-45/31-V-45	1.09[a]	.1857
31-U-45/Random sample	.67[a]	.7604
31-V-45/Random sample	.99[a]	.2809
31-U-45 lowland/upland	.47[a]	.9800
31-V-45 lowland/upland	5.00[b]	>.1324
Random sample lowland/ upland	.39[a]	.9981

[a] The large-sample approximation of the two-sided test statistic was employed

[b] The standard two-sided test statistic was employed

Appendix II - continued

Analysis of Association Between the Areal Correspondence of Vegetation Communities on Delineations of Different Soil Mapping Units, Using Spearman's Rank Correlation Coefficient

H_o: There is no association between the areal correspondence of vegetation communities on delineations of one soil type and the areal correspondence with delineations of the other soil type.

H_a: There is a relationship between the areal correspondence value on the different types of soil.

Comparison	r_s	Probability of observing an r_s value $\geq$ the calculated r_s if H_o is true
31-U-45/31-V-45	+.2902	>.100
31-U-45/Random sample	+.2559	>.100
31-V-45/Random sample	+.4044	$.010 < p < .025$
31-U-45 lowland/upland	+.1329	>.100
31-V-45 lowland/upland	+.5125	$.050 < p < .100$
Random sample lowland/upland	+.3000	>.100

Appendix II - continued

Chi-square Analysis of Association between Elongation Ratio and Areal Correspondence Trends[a]

H_o: Trends within complexes in elongation ratio and areal correspondence are independent

H_a: Trends within complexes in elongation ratio and areal correspondence are related

	High Range AC	Low Range AC
Low Range |veg. ER - soil ER|	(1)	(2)
High Range |veg. ER - soil ER|	(3)	(4)

Data Set	Expected/Observed	Values for contingency table element				X^2 statistic[b]	Probability of observing X^2 value $\geq$ the X^2 statistic if H_0 is true
		(1)	(2)	(3)	(4)		
All 31-U-45 complexes	Expected	45	44	43	41		
	Observed	54	35	34	50	7.054	$.005 < p < .01$
Lowland 31-U-45 complexes	Expected	16	15	16	16		
	Observed	19	12	13	19	2.690	$> .10$
Upland 31-U-45 complexes	Expected	30	29	26	25		
	Observed	35	23	21	31	4.371	$.025 < p < .05$
All 31-V-45 complexes	Expected	50	51	50	51		
	Observed	62	39	38	63	11.638	$< .005$
Lowland 31-V-45 complexes	Expected	24	24	22	22		
	Observed	24	25	23	22	.043	$> .10$
Upland 31-V-45 complexes	Expected	26	26	27	28		
	Observed	38	14	15	41	23.119	$< .005$
All random sample complexes	Expected	60	62	60	63		
	Observed	67	55	53	70	3.429	$.05 < p < .10$
Lowland 31-V-45 complexes	Expected	22	21	21	19		
	Observed	20	23	23	17	1.002	$> .10$
Upland 31-V-45 complexes	Expected	38	41	39	44		
	Observed	47	32	30	53	8.848	$< .005$

[a] The chi-square test for 2 x 2 contingency tables is described in Daniel (1978).

[b] Degrees of freedom = 1