

❖ Standard 7: Select terrestrial, freshwater and marine conservation targets/biodiversity elements across multiple biological and spatial scales.

---

## Case Study: **Ecological Land Units in the Central Appalachians Ecoregion (CAP)**

by Mark Anderson, The Nature Conservancy

The development and use of abiotic units is based on the widely recognized premise that the natural distribution of species and communities is driven by environmental gradients (e.g., nutrient availability, moisture, and temperature). These gradients are determined by underlying abiotic features operating at multiple scales (e.g., local, landscape, and regional). For a particular area, the distribution and composition of the key abiotic features should act as appropriate approximations for the distribution and location of many species and communities.

The CAP team used widely available data to develop discrete, mappable topographic units with a particular geologic and elevation setting as predictors of species and communities. Most ecoregions have limited or spatially biased information on species or communities, and therefore will depend heavily on the use of many data layers for a comprehensive portfolio design. Even in ecoregions such as CAP with relatively extensive element occurrence (EO) data (> 3,000 EOs), locational information on common communities is generally lacking and planning teams are using multi-scale data to help identify sites that capture all features. The primary methods used in this study were developed for a planning project in the Connecticut River watershed.

*Ecological Land Units:* Ecological land units were developed by classifying and categorizing three abiotic data layers: elevation, bedrock geology, and topographic features. These elements were combined using a GIS into unique combinations (Figure 1).

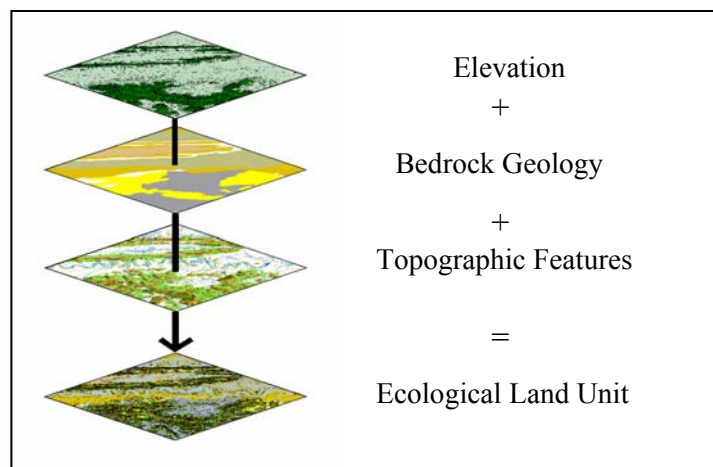


Figure 1. Ecological Land Unit components

**Elevation:** Elevation has important ecological implications. We determined three relevant elevation zones based on literature review, element occurrence analysis, and ecology planning team expertise. The zones included a high elevation zone above 3,500 feet. This boundary demarks the lower limit of red spruce. The mid elevation zone was from 3,500 feet to 1,500 feet. The lower limit of this zone generally corresponds with the upper limit for many low-elevation communities, such as floodplain forests. The low elevation zone included areas under 1,500 feet. Many common communities occur at both low and mid elevations. The area and percent for each elevation zone is shown in Table I-2. We used the USGS 1:250,000 scale digital elevation model (DEM) to generate this data layer.

Elevation Zone	Area (ha)	% of CAP
Low (< 1500 ft.)	6,508,035	51.3
Mid (1500 - 3500 ft.)	5,901,739	46.5
High (> 3500)	271,949	2.2

Table I-2. Elevation zones in CAP.

**Bedrock Geology:** The Central Appalachians have a rich and complex geologic history comprised of over 350 mapped bedrock formations. We grouped the geologic formations into 6 classes based on their litho-geochemical properties. Soil chemistry was highly correlated with the dominant chemical properties of the parent bedrock. Weathering and erosion rates also corresponded with bedrock texture. We grouped bedrock geology types into six categories (see below). These groups were highly correlated with soil chemistry and structure, which in turn should be correlated with natural community distribution. The area and percent for each geologic class in the ecoregion are shown below (Table I-3).

Geologic Class	Area (ha)	% of CAP
Acidic Sedimentary	4,577,243	36.2
Acidic Shale	3,565,948	28.2
Acidic Granitic	866,305	6.9
Calcareous Sedimentary	2,084,357	16.5
Calcareous Shale	1,239,688	9.8
Mafic	272,465	2.2

Table I-3. Geologic classes in CAP\*.

\* Note: 0.2 % was unclassified as of 5/99

**Topographic Features:** At a finer scale, the distribution of species and communities tend to follow the distribution of topographic features in the landscape. The set of topographic features we defined reflected a combination of slope, relative land position, moisture, aspect, and the presence of water features. We derived 15 discrete topographic features (Figure 2) from the USGS 1:250,000 scale DEM and the USGS 1:100,000 scale hydrography data. The topographic features in this study varied in size on the landscape. For example, cliffs and steep slopes occurred as small patches in the landscape whereas; dry flats tended to occur over vast areas (Table I-4).

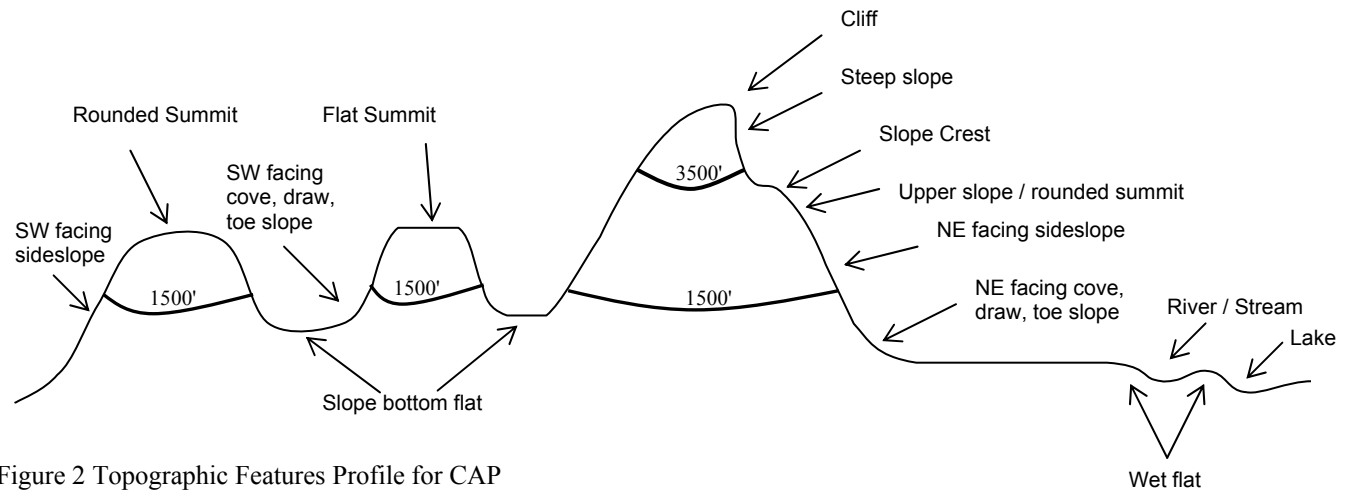


Figure 2 Topographic Features Profile for CAP

Topographic Features	Area (ha)	% of CAP
Cliff	6,078	0.1
Steep slope	115,034	0.9
Slope crest	102,488	0.8

Upper slope	470,047	3.7
Flat summit	430,911	3.4
NE facing sideslope	1,639,163	12.9
NE facing cove	713,747	5.6
SW facing sideslope	1,085,755	8.6
SW facing cove	477,635	3.8
Dry flat	5,691,926	44.9
Wet flat	807,305	6.4
Slope bottom flat	142,003	1.1
Stream	917,718	7.2
River	44,923	0.4
Lake/Pond	36,990	0.3

Table I-4. Topographic Features in CAP

**Combining Elevation, Geology, Topographic Features:** Combining the three abiotic data layers into a comprehensive set of ELUs produced 270 potential unique combinations (3 elevation zones X 6 geologic classes X 15 topographic features = 270 ELUs). Only 252 ELUs actually occurred. Of the 18 ELUs which do not occur in CAP, 17 are high elevation features with erosion prone bedrock such as calcareous and mafic cliffs. Examples of ELUs that occur are low-elevation acidic sedimentary flat summits, low-elevation mafic NE facing sideslopes, mid-elevation, calcareous shale slope bottom flats, and high elevation granitic steep slopes.

**Selecting Matrix Community Targets:** The resulting ELU's were used to sort out a whole set of intact landscapes or road bounded blocks containing matrix forming communities through 5 steps:

- 1) Develop the set of all potential matrix sites based on a GIS analysis of road-bounded areas greater than 15,000 acres.
- 2) Determine which blocks qualify for inclusion by assessing the boundaries and condition of each potential blocks and removing those blocks which are apparently non-viable or otherwise unsuitable (e.g. have been repeatedly logged and sprayed, have dead aquatic features due to acid drainage, have killer threats or are otherwise in poor condition.)
- 3) Assess the remaining blocks for ELU composition and aggregate the blocks into block-groups based on similarities in their ELU composition.
- 4) Prioritize and rank the blocks within each block-group based on their EO diversity, ELU diversity, condition, and proximity to other features, feasibility of protection work and threat.
- 5) Determine the minimum set of blocks needed to fully represent each matrix block group and select the highest priority blocks for inclusion in the first iteration matrix community sites.

1) Matrix Blocks: road bounded blocks greater than 15,000 acres

We used road-bounded "blocks" as the "site selection " unit for both the actual portfolio and the automated selection analysis. Blocks are defined as areas or polygons that are bounded by roads (ranging from major highways to local roads), utility lines, railroads,

and major water bodies. The advantage of using road-bounded blocks is that they are easily created through a process which is efficient, straightforward, uniformly applied across the entire ecoregion, and reproducible. Furthermore, the blocks represent preliminary "sites" because their boundaries are recognizable (roads, etc) and often reflect ownership patterns (parks, preserves, private lands, etc). The block coverage was created in GIS for CAP ecoregional planning purposes using techniques developed during the Northern Appalachian ecoregion planning process.

Initially, we selected a block for analysis if it was greater than 15,000 acres or if it was one of the largest 10 blocks in a subsection. Out of the initial 159,676 blocks possible in the Central Appalachians (even city "blocks" are analyzed as blocks), 213 met the criteria for consideration. We presented these 213 blocks as a starting point in matrix site selection.

### 2) Analysis of Block Condition:

The initial 213 blocks were assessed both quantitatively and qualitatively as to their current condition. First the attributes of total area, total core area, number and miles of dangling roads, percent developed land, percent agriculture, percent natural cover, etc. were summarized in a report for each block. Next, we evaluated each block for logging/spraying/management history, other anthropogenic impacts, disturbance history, notable diversity and other features in a series of state by state expert interview sessions consisting of TNC state field office staff, state natural heritage ecologists, and various state and federal land managers. At each state meeting the boundaries of the blocks were also adjusted to reflect better information provided by the experts on the type and use of local roads. Every potential block was discussed and ranked on a 5 part scale, which ranged from #1 "yes the block qualifies" to #5 "no, the block does not qualify". Based on these meetings, the original 213 sites were reduced to 57 qualifying potential matrix blocks (e.g. blocks ranked #1 or #2)

### 3) Aggregating the Blocks into Block-Groups

For each of the 57 qualifying block we tabulated the extent and type of all ELUs within the block boundaries. We used standard quantitative ordination, classification, and cluster analysis programs (DECORANA, TWINSPAN and CLUSTAN programs available in the PC-ORD for windows) to aggregate the blocks into groups within which the blocks were relatively interchangeable as to their ELU features. From this analysis we distinguished 10 groups of 2 – 7 blocks each. We also identified 3 outlier blocks which were not readily interchangeable with any of the other potential matrix sites with respect to their ELU composition. The block groups often corresponded with the subsection boundaries. This was expected as the subsection boundaries were created based on areas with similar abiotic features. However, certain subsections lumped together (i.e. Northern and Southern High Allegheny Mts.) while several of the larger ones were split into finer groups (i.e. Appalachian Ridges). This analysis suggested that a minimum of 1 site from each of the groups would be necessary to fully represent the diversity of matrix forest sites across all bedrock, topography and elevation gradients within the ecoregion.

#### 4,5) Prioritizing and selecting the final matrix blocks within each block group

Within each block group the individual blocks were assessed and compared as to their relative condition, EO representation and diversity, ELU representation and diversity, complementarity, feasibility for protection, threat and proximity to other features. This was done in small working groups at an extended core team meeting (details in CAP plan). Unavoidably, variation within the block-groups was not always identical, some groups being remarkably homogeneous and others having a fair amount of heterogeneity with respect to ELU composition. To account for differences in the internal variation, some block-groups required several blocks to fully represent their features while others needed only a single block. Only one block was actually eliminated from the set, all other blocks were assigned a Tier 1 or Tier 2 status. Tier 1 blocks formed the first iteration matrix community sites and were assumed to represent a minimum solution which maximized occurrence viability and representation of all major gradients and sources of variation. Tier 2 blocks were prioritized as reasonable alternatives to the Tier 1 sites should protection of the latter prove unfeasible or require supplementation by more sites from within the block group. The final set of Tier 1 sites consisted of 26 matrix blocks distributed across the ecoregion.

---