

Scale of Ecosystem Units

Scale implies a certain level of perceived detail. Suppose, for example, that we carefully examine an area of intermixed grassland and pine forest. At one scale, the grassland and the stand of pine each appear spatially homogeneous and look uniform. Yet linkages of energy and material exist between these ecosystems. Having determined these linkages, we intellectually combine the locationally separate systems into a new entity of higher order and greater size. These larger systems represent patterns or associations of linked smaller ecosystems.

Several countries have proposed and implemented schemes for recognizing such scale levels (Table 2.1; see also Zonneveld 1972; Salwasser 1990; Klijn and Udo de Haes 1994; Blasi et al. 2000). In these schemes, the nomenclature and number of levels vary. One scheme, proposed by Miller (1978), recognizes linkages at three scales of perception. Rowe and Sheard (1981), although using different terminology, advanced a similar scheme (Table 2.2). A few years later (Bailey 1985, 1987, 1988a), I proposed a hierarchical ecosystem classification inspired by both of these schemes and closely following Miller's terminology. It is the framework for this book. A hierarchy of ecosystem units based on this framework is illustrated in Figure 2.1.

Site

The smallest (a few hectares), or local, ecosystems are the homogeneous *sites* commonly recognized by foresters and range scientists. We refer to these as microecosystems.

Table 2.1. Comparison of the nomenclature of some ecological classification systems of hierarchical character—comparable concepts have been placed on the same level^a

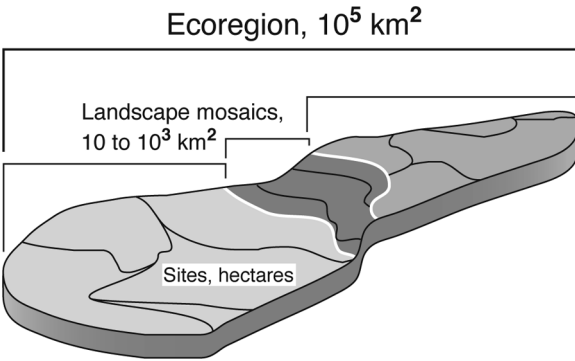
Australia	Britain	Canada	USSR	United States
			Zone	Domain
	Land zone			Division
	Land region	Ecoregion	Province	Province
	Land district	Ecodistrict		Section
			Landscape	
Land system	Land system	Ecosection		District
	Land type	Ecosite	Urochishcha	Landtype association
Land unit				
Land type	Land phase			Landtype
Site		Ecoelement		Landtype phase
			Facia	Site

^aFrom Bailey (1981).

Table 2.2. Levels of generalization in a spatial hierarchy of ecosystems

Scheme			
Miller (1978)	Rowe and Sheard (1981)	Approximate size (km ²)	Map scale for analysis
Region	Macroecosystem	10 ⁵	1:3,000,000
Landscape mosaic	Mesoecosystem	10 ³	1:250,000–1:1,000,000
Ecosystem (site)	Microecosystem	10	1:10,000–1:80,000

Figure 2.1. Hierarchy of ecosystems.



Landscape Mosaic

Linked sites create a *landscape mosaic* (mesoecosystem), or simply landscape, that seen from above looks like patchwork. A landscape mosaic is made up of spatially contiguous sites distinguished by material and energy exchange between them. They range in size from 10 km² to several thousand square kilometers.

A mountain landscape is a classic example of a landscape mosaic. A lively exchange of materials occurs among the component ecosystems of a mountain range: water and products of erosion move down the mountains; updrafts carry them upward; animals can move from one ecosystem into the next; seeds are easily scattered by the wind or distributed by birds.

Ecoregion

On broader scales, landscapes are connected to form larger units (macroecosystems). Mountains and plains illustrate this well (Fig. 2.2). For



Figure 2.2. Ecosystems can be considered at various scales. In this view of Death Valley in California, the *macroscale* is represented by the mosaic of deeply eroded ranges and smooth basin floors. The *mesoscale* is represented by the two components of the mosaic—ranges and basins. The *microscale* is represented by individual slopes within the mountain ranges. Photograph by Warren Hamilton, U.S. Geological Survey.

example, as a mosaic, the lowland plains of the western United States contrast with steep landscapes in adjacent mountain ranges. As water from the mountains flows to the valley and as the mountains affect the climate of the valley through sheltering, two large-scale linkages are evident. Such linkages create real economic and ecological units. This unit is called an *ecoregion*, or simply region. Regions occur in many scales (Bailey 1983). Like landscapes, they stand in contrast with one another, while long-distance linkages connect them. Finally, this progression reaches the scale of the planet.

National Hierarchy of Ecological Units

Recently, the U.S. Forest Service (ECOMAP 1993) more elaborately followed the ideas presented above. Instead of three levels to be distinguished, they recognized more levels but on the same principles (Fig. 2.3). In 1993, the agency adopted this hierarchy for use in ecosystem management.

I mapped ecoregions down to the province level for the United States (Bailey 1976, revised 1994), North America (Bailey and Cushwa 1981, revised 1997), and the world's continents (Bailey 1989). Bailey et al. (1994) mapped the ecoregion subregions or sections of the United States. Cleland et al. (2005) developed a map of the conterminous United States showing subsection boundaries as well as another approximation of section boundaries. This map was compiled from subsection maps of each Forest Service region (cf. Nesser et al. 1997). Many national forests in different parts of the country have produced maps of landtype associations.

USDA Forest Service		
<i>Bailey 1988a</i>	<i>Ecomap 1993</i>	
Ecoregion	Ecoregion	Domain
		Division
Landscape Mosaic	Subregion	Province
		Section
	Landscape	Subsection
Site	Land Unit	Landtype Association
		Landtype
		Landtype Phase

Figure 2.3. Comparison of hierarchies used for ecological land classification in the U.S. Forest Service.



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