11 Continental Patterns and Boundaries

11.1 Pattern Within Zones

The zones give only a broad-brush picture. Variations within a zone break up and differentiate the major, subcontinental zones. For example, the vegetation of the savanna is highly differentiated related to variation in length of the dry season (Fig. 11.1). The geographic patterns of ecosystems within zones caused by these variations are reviewed here; see the author's *Ecosystem Geography* (Bailey 1996 et seq.) for details.

Within the same macroclimate, broad-scale landforms (geology and topography) breaks up the zonal pattern and provide a basis for further delineation of mesoscale ecosystems, known **as landscape mosaics**. The same geologic structure in different climates results in different landscapes. For example, limestone in a subarctic climate occurs in depressions and shows intense karstification, while in hot and arid climates it occurs in marked relief with a few cave tunnels and canyons inherited from colder Pleistocene time (Fig. 11.2).

A landscape mosaic may be further subdivided into microscale ecosystems called **sites**. Within a landscape, the sites are arranged in a specific pattern. For example, the Idaho Mountains, a temperate-steppe regime highland in the western United States, are made of a complex mosaic of riparian, forest, and grassland sites (Fig. 11.3).

Even in areas of uniform macroclimate, topography leads to differences in local climates and soil conditions. Topography causes variations in the amount of solar radiation received, creating **topoclimates** (Thornthwaite 1954), and affects the soil moisture (Fig. 11.4).

Variations in drainage, and in steepness of slopes, further affect the soil moisture and biota, in turn creating ecosystem sites. A sequence of moisture regimes, ranging from drier to wetter from the top to the bottom of a slope (Fig. 11.5), may be referred to as a soil catena, or a **toposequence** (Major 1951).

Figure 11.6, in a simplified way, illustrates how topography, even in areas of uniform macroclimate, leads to differences in local climates and soil conditions. The climatic climax theoretically would occur over the entire region but for topography leading to different local climates.

Other topographic, hydrologic, geologic and/or geochemical deviations may also occur. We can place ecosystem sites into three basic categories: (1) **zonal**, which are typical for the climatic conditions, such as on well-drained sagebrush terraces in a semiarid climate (Fig. 11.7); (2) **azonal** such as riparian forests and (3) **intrazonal**, which may occur on extreme types of soil that override the climatic effect, such as very dry sand dunes or black soil over certain limestone (Fig. 11.8).

In summary, the pattern of ecosystems in a region is the product of all these factors, some climatic (resulting from the average state of the atmosphere), and some **edaphic** (resulting from the character of the soil and surface). In general,

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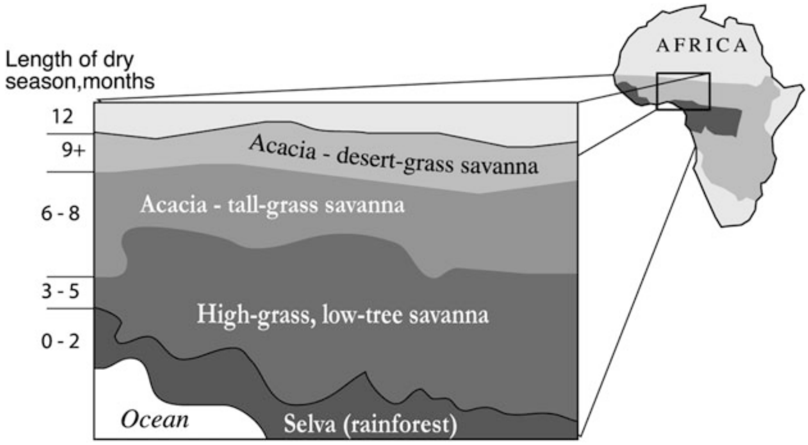

Fig. 11.1 Subdivision of the savannas of central Niger. From Shantz and Marbut; from *A Geography of Man*, 2nd ed., by Preston E. James, p. 304. Copyright © 1959 Ginn and Company; reprinted by permission of John Wiley & Sons, Inc.

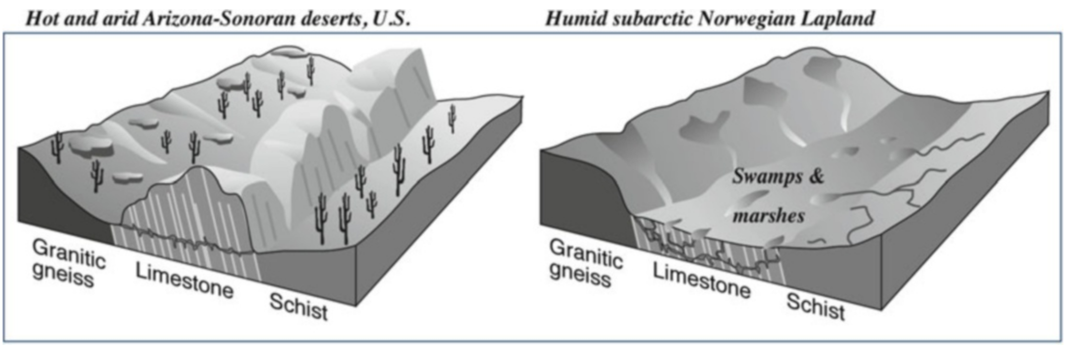

Fig. 11.2 Landscape types resulting from similar geology in two different climatic regions. From Corbel (1964)

Fig. 11.3 A mosaic site in the Idaho Mountains. Sketch by Nancy Maysmith, from photographs by John S. Shelton

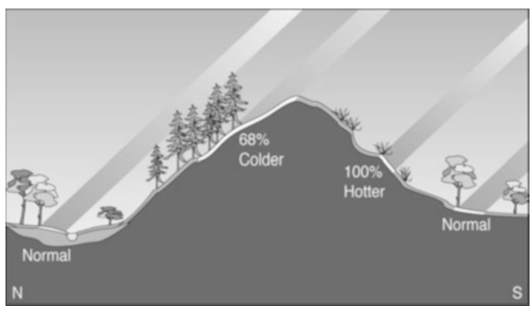

Fig. 11.4 Slope and aspect affect temperature, creating topoclimates

the broad outline of the region is the result of climatic conditions, whereas the details observed in a particular place are the result of edaphic conditions.

Many smaller, natural, and man-made ecosystems are incorporated in the larger systems. These systems appear to have their own dynamics, but nevertheless are bound into the surrounding larger systems in many different ways. Three examples scattered through the land ecoregions are rivers, lakes, and towns (Fig. 11.9).

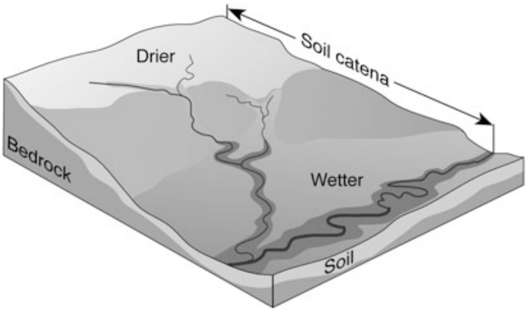

Fig. 11.5 Variation in moisture creates a toposequence or catena of soil moisture regimes

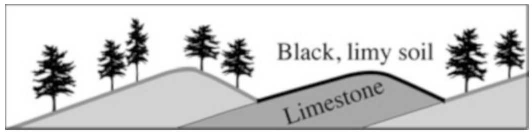

Fig. 11.8 An example of intrazonal site type where a limestone outcrop creates black, limey soil that supports grasses in the midst of a pine forest, Alabama. From Hunt (1974), p. 170

Fig. 11.6 Forest climaxes relate to topography in the temperate continental zone of southern Ontario. (Diagram is truncated, showing only three of nine possible climaxes.) Simplified from Hills (1952)

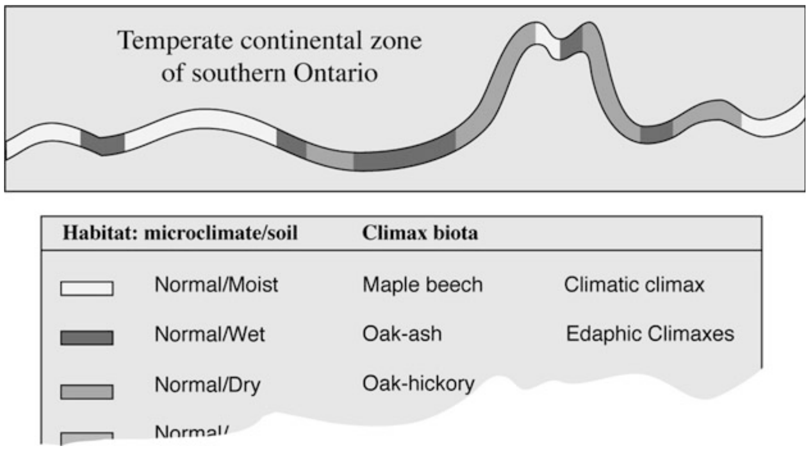

Fig. 11.7 Zonal sites on sagebrush terraces and azonal riparian forests in Jackson Hole, Wyoming. Photograph by National Park Service

The foregoing analysis shows how a hierarchy of spatially nested ecosystem units can be constructed by successively subdividing large ecosystems based on controlling or causal factors operating at different scales. It is about patterns created by changes in the environmental controls rather than by disturbance.

11.2 Disturbance and Succession

Disturbance and subsequent vegetation development contribute significantly to a landscape pattern at various spatial and temporal scales. An ecosystem's vegetation changes with time, and that compositional change occurs in a sequence from pioneer vegetation through successive intermediate steps to a relatively stable state called "late successional vegetation." The late successional types are used to characterize ecosystems because they tend to be far more site-specific than pioneer types, which might occur over a wider range of conditions. Furthermore,

Fig. 11.9 Man-made ecosystem; houses sprout from brown soil in the semiarid steppe near Fort Collins, Colorado. Photograph by Robert G. Bailey

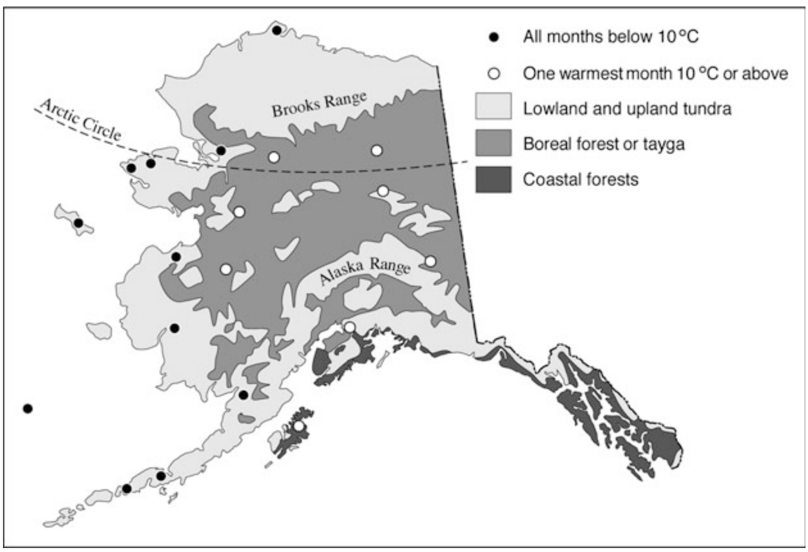

Fig. 11.10 The northern and western edges of the boreal forest (tayga) in Alaska correspond closely to a line beyond which all months are below 10 °C. Climate data from Walter and Lieth (1960–1967) and Walter et al. (1975); vegetation from Viereck et al. (1992)

they are used as baselines for contending with the temporal variability associated with disturbance regimes and attending successional states of vegetation.

11.3 Boundaries Between Zones

This scheme of defining ecosystems gives a general picture: however, the boundaries may be imprecise. For example, the 10 °C isotherm coincides with the northernmost limits of tree growth; hence it separates boreal forest from treeless tundra (Fig. 11.10).

The observer, of course, would not see an abrupt line but a transition zone—trees on favorable sites, muskeg and bog on wetter sites, with tundra on exposed ridges (Fig. 11.11).

For more information about ecoregion boundaries, including 20 principles to be observed in their delineation, see my chapter on the subject (Bailey 2004).

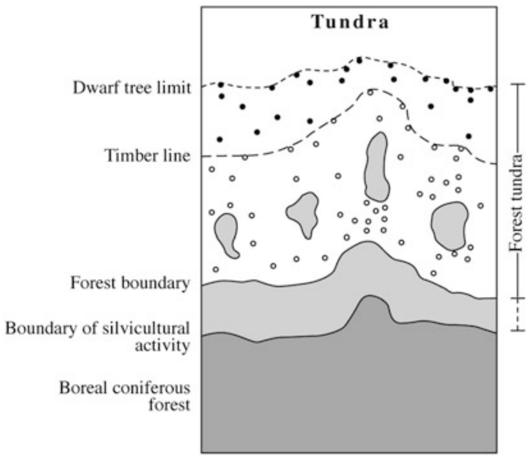

Fig. 11.11 The boundary between boreal coniferous forest and tundra is usually a transition zone rather than a sharp line. From Hustich (1953); reproduced with permission

As discussed in Chap. 10, climate exerts a very strong effect on ecoregion patterns, and climate change may cause shifts in those patterns. As the climate changes so will changes in the distribution of ecoregions as well as the boundaries between ecoregions.

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