The Role of Disturbance in Ecosystem Management

Forests are dynamic ecosystems and are almost always in some stage of transformation after one or more disturbances. In Alaska, geological processes, climatic forces, insects, plant diseases, and the activities of animals and humans have shaped the existing forests. How these cycles of disturbances have shaped and continue to influence the forest's structure and ecological functions.

Disturbances result in changes to ecosystem structure and function. In forests, this often involves death or removal of trees. Disturbances caused by physical forces such as volcanoes, earthquakes, storms, droughts, and fire can affect the entire plant community, although some species may withstand damage better than others. Insects, plant diseases, animal and human activities are usually more selective, directly affecting one or several species.

Figure 1. *2005 marked a second consecutive record fire year in interior Alaska.*

Cycles of disturbance and recovery repeat over time and across landscapes. From evidence of past disturbances on a landscape, we can predict what type of disturbance is likely to occur in the future. Landscapes supporting large areas of single-age stands indicate less frequent, but intense large-scale disturbances. Landscapes with a variety of age classes and species suggest more frequent, smaller scale events. Usually, several types of disturbances at various scales of space, time and intensity have influenced forest structure and composition on a given site. The role of disturbance in ecological processes is well illustrated in Alaska's two distinct forest ecosystem types and transition zones (Map 3).

The temperate rain forests of southeast Alaska are dominated by western hemlock with components of Sitka spruce, Alaskan yellow-cedar, western redcedar, shore pine and mountain hemlock. Along the mainland in southeast Alaska, black cottonwood, paper birch and several conifers appear in small amounts. Trees are long-lived, but become heavily infected with heart-rot fungi, hemlock dwarf mistletoe, and root rot fungi as they age. Weakened trees commonly break under the stress of gravity and snow loading. Canopy gaps generated this way do not often result in exposed mineral soil. Trees on productive sites can attain great size due to abundant rainfall, moderate temperatures, and infrequent disturbance.

Wind is the major large-scale disturbance agent in southeast Alaska. Degree of impact and scale depends on stand composition, structure, age and vigor and as well as wind speed, direction, duration and topographic effects on wind flow. The forest type most susceptible to wind throw is mature spruce or hemlock on productive, wind-exposed sites. The large, top-heavy canopies act as sails and uprooting is common, resulting in soil churning, which expedites nutrient cycling and increases soil permeability. Even-aged forests develop following large-scale catastrophic wind events. Old-growth forest structure develops in landscapes protected from prevailing winds. In these areas, small gap-forming events dominate.

The boreal forests of interior Alaska are comprised of white spruce, black spruce, paper birch, quaking aspen, balsam poplar and tamarack. The climate is characterized by long, cold winters, short, hot summers, and low precipitation. Cold soils and permafrost limit nutrient cycling and root growth. Topographic features strongly influence microsite conditions; north-facing slopes have wet, cold soils, whereas south-facing slopes are warm and well drained during the growing season. Soils are usually free from permafrost along river drainages, where flooding is common. Areas more distant from rivers are usually underlain by permafrost and are poorly drained. Fire is the major large-scale disturbance agent; lightening strikes are commonly the source of ignition. All tree species are susceptible to damage by fire, and all are adapted, in varying degrees, to regeneration following fire. Fire impacts go beyond removal of vegetation. Depending on the intensity and duration of a fire, soil may be warmed, upper layers of permafrost may thaw, and nutrient cycling may accelerate. Patterns of forest type development across the landscape are defined by the basic silvics of the species involved. Hardwoods are seral pioneers, resprouting from roots or stumps. White spruce stands are usually found on better-drained soils, along flood plains, river terraces, and on slopes with southern exposure. Black spruce and tamarack occur in areas of poor drainage, on north-facing slopes, or on upland slopes more distant from rivers where permafrost is common.

South-central Alaska is a transition zone between the coastal marine climate of the southeast and the continental climate of the interior. These forest communities are more similar to those in the interior, except where Sitka spruce and white spruce ranges overlap and the Lutz spruce hybrid is common. Fire has been a factor in the forest landscape patterns we see today. These fires, however, were mostly the result of human activity since lightning strikes are uncommon in the Cook Inlet area. Major disturbances affecting these forests in the past century have been human activity and spruce beetle caused mortality. Earthquakes, volcanic eruptions, and flooding following storm events have also left significant signatures on the landscape.

Disturbances play an important role in shaping forest composition, structure, and development. With knowledge of disturbance regimes, managers can understand key processes driving forest dynamics and gain insight into the resiliency (the ability to recover) and resistance (the ability to withstand change) of forests to future disturbance. As we improve our understanding of the complexities of these relationships, we are better able to anticipate and respond to natural disturbances and mimic the desirable effects with management activities. Ecological classification is one tool available to help us understand disturbance patterns.

Several useful systems of classification have been developed for Alaska's ecosystems and vegetation. Field and resource specialists representing a variety of organizations, including representatives from Canada, delineated ecoregions based on climate, physiography, vegetation, and glaciation. In Alaska, three distinct climatic-vegetation regimes exist: polar, boreal, and maritime. These regimes cover broad areas and grade from one to another across the state (see Map 3). To accommodate this spatial arrangement, ecoregion groups were arranged in a triarchy, reflecting the major regimes and gradations between them (see Figure 2). Through this triarchy, the natural associations among ecoregion groups are displayed as they occur on the land without loss of information (i.e., retains the spatial interrelations of the groups). An ecoregion map and further ecoregion descriptions can be found at: **http://agdc.usgs.gov/data/projects/fhm/.**

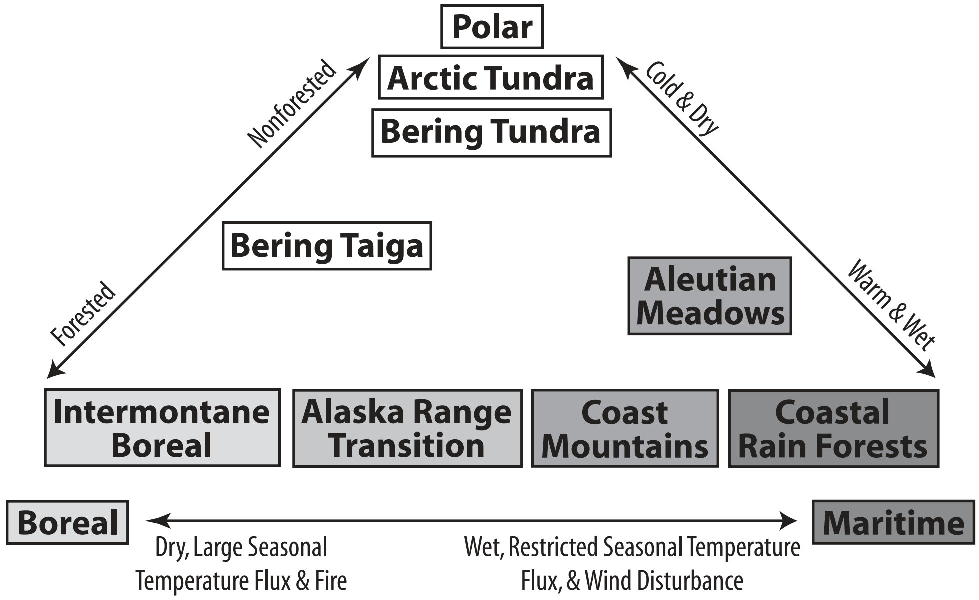

Figure 2. *This triarchy illustrates the major regimes and gradations between the Alaska ecoregions.*

Map 3. Alaska ecoregion map.