

---

United States  
Department of  
Agriculture

Natural  
Resources  
Conservation  
Service

---

# National Range and Pasture Handbook

Ch. 3 Section I

---

## Chapter 3

---

# Ecological Sites and Forage Suitability Groups

### Section 1

## Ecological Sites for Rangeland and Forest Land

---

**600.0300 Rangeland ecological sites****(a) Definition**

Rangeland landscapes are divided into ecological sites for the purposes of inventory, evaluation, and management. An ecological site, as defined for rangeland, is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation.

An ecological site is the product of all the environmental factors responsible for its development, and it has a set of key characteristics that are included in the ecological site description. Ecological sites have characteristic soils that have developed over time throughout the soil development process. The factors of soil development are parent material, climate, living organisms, topography or landscape position, and time. These factors lead to soil development or degradation through the processes of loss, addition, translocation, and transformation.

An ecological site has a characteristic hydrology, particularly infiltration and runoff, that has developed over time. The development of the hydrology is influenced by development of the soil and plant community.

An ecological site has evolved a characteristic plant community (kind [cool season, warm season, grassland, shrub-grass, sedge meadow] and amount of vegetation). The development of the vegetation, the soil, and the hydrology are all interrelated. Each is influenced by the others and influences the development of the others. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species, or in total production.

Most ecological sites evolved with a characteristic kind of herbivory (kinds and numbers of herbivores, seasons of use, intensity of use). Herbivory directly influences the vegetation and soil, both of which influence the hydrology.

An ecological site evolved with a characteristic fire regime. Fire frequency and intensity contributed to the characteristic plant community of the site.

Soils with like properties that produce and support a characteristic native plant community are grouped into the same ecological site.

An ecological site is recognized and described on the basis of the characteristics that differentiate it from other sites in its ability to produce and support a characteristic plant community.

## 600.0301 Plant community development and dynamics

### (a) Succession and retrogression

Succession is the process of soil and plant community development on an ecological site. Retrogression is the change in species composition away from the historic climax plant community because of management or severe natural climatic events.

Succession occurs over time and is a result of interactions of climate, soil development, plant growth, and natural disturbances. Plant succession is defined as the progressive replacement of plant communities on an ecological site that leads to development of the historic climax plant community.

Primary succession is the formation process that begins on substrates having never previously supported any vegetation (lava flows, volcanic ash deposits, etc.). Secondary succession occurs on previously formed soil from which the vegetation has been partially or completely removed.

In some locations, primary succession was never completed before the site was disturbed by human intervention. An example is the historic lakebed of Lake Bonneville in the Great Basin area of Utah, Nevada, and Idaho.

Ecological site development, along with associated climatic conditions and normal disturbances (occurrence of fire, grazing, flooding) remaining within normal ranges, produces a plant community in dynamic equilibrium with these conditions. This plant community is referred to as the historic climax plant community. Vegetation dynamics on an ecological site includes succession and retrogression. The pathway of secondary succession is often not simply a reversal of disturbances responsible for retrogression and may not follow the same pathway as primary succession.

### (b) Historic climax plant communities

The historic climax plant community for a site in North America is the plant community that existed at the time of European immigration and settlement. It is the plant community that was best adapted to the unique combination of environmental factors associated with the site. The historic climax plant community was in dynamic equilibrium with its environment. It is the plant community that was able to avoid displacement by the suite of disturbances and disturbance patterns (magnitude and frequency) that naturally occurred within the area occupied by the site. Natural disturbances, such as drought, fire, grazing of native fauna, and insects, were inherent in the development and maintenance of these plant communities. The effects of these disturbances are part of the range of characteristics of the site that contribute to that dynamic equilibrium. Fluctuations in plant community structure and function caused by the effects of these natural disturbances establish the boundaries of dynamic equilibrium. They are accounted for as part of the range of characteristics for an ecological site. Some sites may have a small range of variation, while others have a large range. Plant communities that are subjected to abnormal disturbances and physical site deterioration or that are protected from natural influences, such as fire and grazing, for long periods seldom typify the historic climax plant community.

The historic climax plant community of an ecological site is not a precise assemblage of species for which the proportions are the same from place to place or from year to year. In all plant communities, variability is apparent in productivity and occurrence of individual species. Spatial boundaries of the communities; however, can be recognized by characteristic patterns of species composition, association, and community structure.

### (c) State and transition models

A state and transition model will be used to describe vegetation dynamics and management interactions associated with each ecological site. The model provides a method to organize and communicate complex information about vegetation response to disturbances (fire, lack of fire, drought, insects, disease, etc.) and management.

A state is a recognizable, relatively resistant and resilient complex with attributes that include a characteristic climate, the soil resource including soil biota, and the associated aboveground plant communities. The soil and vegetative components are inseparably connected through ecological processes that interact to produce a sustained equilibrium that is expressed by a specific suite of plant communities. The primary ecological processes are water cycle, nutrient cycle, and the process of energy capture. Each state has distinctive characteristics, benefits, and values depending upon the intended use, products, and environmental effects desired from the site.

Two important attributes of a state are resistance and resilience. Resistance refers to the capability of the state to absorb disturbance and stresses and retain its ecological structure. Resilience refers to the amount of disturbance or stress a state can endure and still regain its original function after the disturbances and stresses are removed.

States are relatively stable and resistant to change caused by disturbances up to a threshold point. A threshold is the boundary between two states such that one or more of the ecological processes has been irreversibly changed. Irreversible implies that restoration cannot be accomplished through natural events or a simple change in management. Active restoration (brush management, range planting, prescribed burning, etc.) must be accomplished before a return to a previous state is possible. Additional thresholds may occur along the irreversible portion of a transition causing a change in the trajectory toward another state as illustrated in figure 3-1. Once a threshold is crossed, a disequilibrium among one or more of the primary ecological processes exists and will be expressed through changes in the vegetative community and eventually the soil resource. A new stable state is formed when the system reestablishes equilibrium among its primary ecological processes.

Transition is the trajectory of system change between states that will not cease before the establishment of a new state. A transition can be triggered by natural events, management actions, or both. Some transitions may occur very quickly and others over a long period. Two phases of a transition are recognized: reversible and irreversible. Prior to crossing a threshold, a transition is reversible and represents an opportunity to reverse or arrest the change. Vegetation management

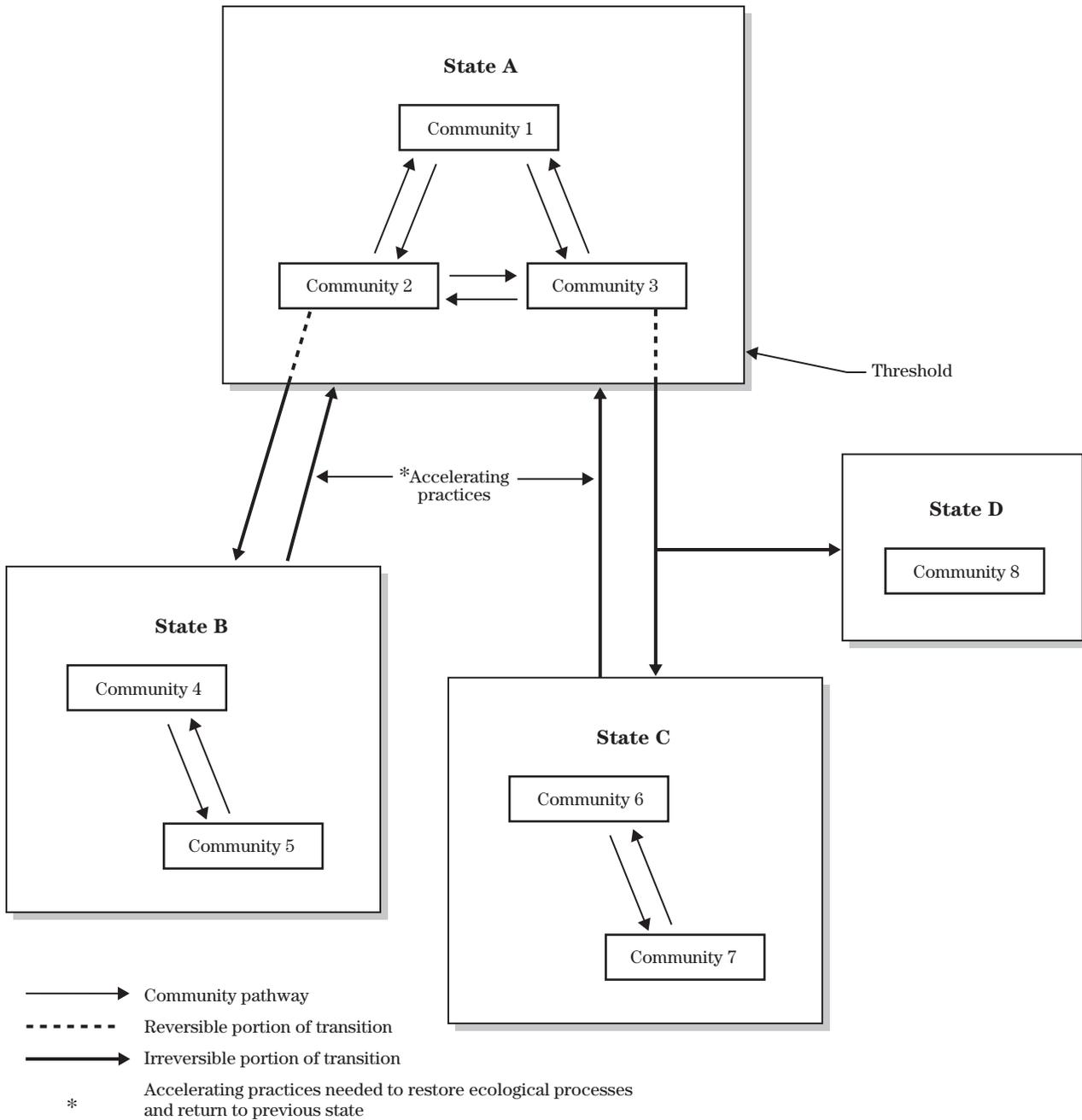
practices and, if needed, facilitating practices are used to reverse the transition. Once a threshold is crossed, the transition is irreversible without significant inputs of management resources and energy. Significant inputs are associated with accelerating practices, such as brush management and range planting.

States are not static, as they encompass a certain amount of variation because of climatic events, management actions, or both. Dynamics within a state do not represent a state change since a threshold is not crossed. To organize information for management decisionmaking purposes, these different expressions of dynamics within the states may need to be described. These different vegetative assemblages within states will be referred to as plant communities and the change between these communities as community pathways.

Figure 3-1 illustrates the different components of a state and transition model diagram for an ecological site. States are represented by the large boxes and are bordered by thresholds. The small boxes represent plant communities with community pathways representing the cause of change between communities. The entire trajectory from one state to another state is considered a transition (i.e., from State A to State B). The portion of the transition contained within the boundary of a state is considered reversible with a minimum of input from management. Once the transition has crossed the threshold, it is not reversible without substantial input (accelerating practices). The arrow returning to a previous state (State B to State A) is used to designate types of accelerating practices needed. Additional thresholds occurring along a transition may change the trajectory of a transition (from State C to State D).

The first state described in an ecological site description is the historic climax plant community or naturalized plant community. From this state, a "road map" to other states can be developed. Each transition is to be identified separately and described, incorporating as much information as is known concerning the causes of change, changes in ecological processes, and any known probabilities associated with the transitions. Plant communities and community pathways within states may be described as needed.

**Figure 3-1** Example of state and transition model diagram for an ecological site



**(d) Naturalized plant communities**

Ecological site descriptions are to be developed for all identified ecological sites. In some parts of the country, however, the historic climax plant community has been destroyed, and it is impossible to reconstruct that plant community with any degree of reliability. In these regions, site descriptions will be developed using the naturalized plant communities for the site. The use of this option for ecological site descriptions is limited to those sites where the historic climax plant community has been destroyed and cannot be reconstructed with any degree of reliability. Examples of the areas in the United States where this may be used are the State of Hawaii, the Caribbean Area, and the annual grasslands of California. Approval to describe additional rangeland ecological regions in this way must be obtained from the national program leader for range and pasture.

**(e) Permanence and change of ecological site potential on rangeland**

Retrogression can occur on a given ecological site resulting in a number of different states depending on the type of disturbance(s), the sequence of disturbances, climatic variations, and other variables. Many states that are considered vegetative expressions of degraded historic climax plant communities are stable and can persist for many years without evidence of secondary succession. This persistence certainly extends beyond practical timeframes for use and management planning. As long as the physical environment supporting these states remains similar to that unique mix of conditions required by the historic climax plant community, change to another ecological site is not recognized. The ecological potential for the site is not considered to have been altered merely because the present state is stable and can persist for many years.

Severe physical deterioration can permanently alter the potential of an ecological site to support the original plant community. Examples include permanently lowering the water table, severe surface drainage caused by gullying, and severe soil erosion by water or wind. When the ecological site's potential has significantly changed, it is no longer considered the same

site. A change to another ecological site is then recognized, and a new site description may need to be developed based on its altered potential.

Some ecological sites have been invaded by or planted to introduced species. The introduced species may become well established or naturalized to the site. They may dominate the site, or they may continue to occupy part of the site even when secondary succession has restored the plant community to near historic climax conditions. In these cases of invasion or introduction of introduced species, a change in ecological site is not recognized because the edaphic and climatic potential for the site has not been altered.

## 600.0302 Determining the characteristic vegetation states of an ecological site

Where possible, the historic climax plant community for each ecological site is to be determined. Where it is not possible to determine the historic climax plant community, the naturalized plant community will be described. In addition to the historic climax plant community or naturalized plant community, other known states occurring on the site are to be included in the ecological site description.

The description of each state should be considered as an approximation and subject to modification as additional knowledge is gained. Every effort should be made to examine plant communities within the ecological site's area of occurrence during different seasons and in different years. This is necessary to adequately describe the vegetation dynamics within a site.

Characteristics of a state obtained from a single source or site are not conclusive for describing the state. In evaluating plant information, consideration must be given to many factors including:

- Effects of fire or lack of fire
- Impacts of grazing or lack of grazing
- Impacts of rodent concentrations
- Impacts of insects
- Soil erosion or deposition by wind and/or water
- Drought or unusually wet years
- Variations in hydrology and storm events
- Plant disease
- Introduced plant species

The following methods are used in determining the characteristic states of an ecological site:

- Identification and evaluation of reference sites with similar plant communities and associated soils. When describing the historic climax plant community, the reference sites should not have been subjected to abnormal disturbances (or the lack of normal disturbance). The productivity and the species composition of the plant community should be evaluated.

- Interpolation and extrapolation of plant, soil, and climatic data from existing historic reference areas along a continuum to other points on that continuum for which no suitable reference community is available.
- Evaluation and comparison of the same ecological sites occurring in different areas, but that have experienced different levels of disturbance and management. Further comparison should be made with areas that are not disturbed. Projecting the response of plant species to given disturbances and relating the present day occurrence of species on a site to past disturbances (type and extent of disturbance, frequency, and magnitude) provides a basis for approximating certain vegetative characteristics of the plant community.
- Evaluation and interpretation of research data dealing with the ecology, management, and soils of plant communities.
- Review of historical accounts, survey and military records, and botanical literature of the area.

The NRCS Ecological Site Inventory Information System (ESIS)-Ecological Site Inventory (ESI) database can provide useful data in identifying plant communities. This database can be accessed on the Internet at

<http://plants.usda.gov/esis>

### (a) Differentiation between ecological sites

When writing an ecological site description, the following criteria are used to differentiate one ecological site from another:

- Significant differences in the species or species groups that are in the historic climax plant community.
- Significant differences in the relative proportion of species or species groups in the historic climax plant community.
- Significant differences in the total annual production of the historic climax plant community.
- Soil factor differences that determine plant production and composition, the hydrology of the site, and the functioning of the ecological processes of the water cycle, nutrient cycles, and energy flow.

Initial guidelines for determining significant differences follow:

- Presence (or absence) of one or more species that make up 10 percent or more of the historic climax plant community by air-dry weight.
- A 20 percent (absolute) change in composition, by air-dry weight, between any two species in the historic climax plant community.
- A difference in average annual herbaceous production of
  - 50% @ 200–500 lb/ac
  - 30% @ 500–1,000 lb/ac
  - 20% @ 1,000 lb/ac or greater
- Any differences in guidelines above, either singly or in combination, great enough to indicate a different use potential or to require different management are basis for establishing or differentiating a site.

The above guidelines for initial comparisons are not definitive for site differentiation or combination. The differences between sites may be finer or broader than these guidelines. Rationale and the site features listed in the respective ecological site descriptions should readily and consistently distinguish the differences.

Differences in kind, proportion, and/or production of species are the result of differences in soil, topography, climate, and other environmental factors. Slight variations in these factors are not criteria for site differentiation; however, individual environmental factors are frequently associated with significant differences in historic climax plant communities. The presence or absence of a water table within the root zone of highly saline soil in contrast to a nonsaline soil is dramatically reflected in plant communities that such soils support. Marked changes in soil texture, depth, and topographic position usually result in pronounced differences in plant communities, total production, or both. Therefore, such contrasting conditions in the soil characteristics, climate, topography, and other environmental factors known to be associated with a specific ecological site can be used as a means of identifying the site when the historic climax plant community is absent.

Generally, one species or a group of species dominates a site. Dominant status does not vary from place to place or from year to year. Because of their stability in the historic climax plant community, dominant species can often be used to distinguish sites and to differenti-

ate one site from another. When dominant species are in equal proportion, species in minor proportions can be used to distinguish sites.

In evaluating the significance of kinds, proportion, and production of species or species groups that are dominant in a historic climax plant community, and given different soil characteristics, the relative proportion of species may indicate whether one or more ecological sites are involved. For example, in one area the historic climax plant community may consist of 60 percent big bluestem and 10 percent little bluestem, and in another area it may consist of 60 percent little bluestem and 10 percent big bluestem. Thus, two ecological sites are recognized. Although the production and species are similar, the proportion's difference distinguishes them as separate sites.

The effect of any single environmental factor can vary, depending on the influence of other factors. For example, soil depth is more significant on a site that receives extra water from runoff or in a high precipitation zone, than on an upland site in a low precipitation area. An additional 2 inches of annual rainfall may be highly important in a section of the country that has an arid climate, but of minor significance in a humid climate. A difference in average annual production of 100 pounds per acre, dry weight, is of minor importance on ecological sites capable of producing 2,000 pounds per acre. This difference, however, is highly significant on sites capable of producing only 200 to 300 pounds per acre. Similar variations in degree of significance apply to most factors of the environment. Consequently, in identifying an ecological site, consideration must be given to its environment as a whole as well as to the individual components.

Where changes in soils, aspect, topography, or moisture conditions are abrupt, ecological site boundaries are distinct. Boundaries are broader and less distinct where plant communities change gradually along broad environmental gradients of relatively uniform soils and topography. Making distinctions between ecological sites along a continuum is difficult. Thus, the need for site differentiation may not be readily apparent until the cumulative impact of soil and climatic differences on vegetation is examined over a broad area. Although some plant communities may appear to be along a continuum, distinctive plant communities can be identified and described.

At times, normally less frequently occurring plants may increase on a site, or the site may be invaded by plants not formerly found in the historic climax plant community. The presence or absence of these plants may fluctuate greatly because of differences in microenvironment, weather conditions, or human actions. Consequently, using them for site identification can be misleading, so they should not be used to differentiate sites. Site differentiation, characterization, and determination are based on the plant community that develops along with the soils. A study of several locations over several years is needed to differentiate and characterize a site.

Availability and accessibility to domestic livestock grazing are not factors in ecological site determination and differentiation. Site differentiation is based on those soil characteristics, response to disturbance, and environmental factors that directly affect the nature of the historic climax plant community composition and production.

### **(b) Assembly of ecological site data**

To evaluate plant communities and to make meaningful distinctions between ecological sites, the data collected at each location must be recorded in an orderly manner. Complete data on species, composition, production, soils, topography, climate, and other pertinent factors should be recorded carefully. Using plant association tables to assemble data makes it possible to readily identify the important similarities and differences. Exhibit 3.1-1 is a recording of production and composition data from sample locations that includes four identified soils on which the plant community was assumed to be climax. Exhibit 3.1-2 illustrates the means by which these data are used to group similar plant communities into ecological sites. It also illustrates that composition and production of the historic climax plant community on one soil is consistently comparable and that different soils can be grouped into a single ecological site. The occurrence in three plant communities of Idaho fescue, a significant difference in forb and shrub components, and a significant difference in production indicate two different sites.

The Ecological Site Inventory database contains information about species composition and production that has been collected on specific ecological sites. The Ecological Site Inventory database should be used in conjunction with other supporting data for the documentation, modification, and creation of ecological site descriptions.

A documentation file containing all supportive information used for the development and modification of ecological site descriptions will be established and maintained in the state office.