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**Grazing
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National Range and Pasture Handbook

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Foreword

The National Range and Pasture Handbook (NRPH) constitutes Natural Resources Conservation Service (NRCS) basic policy and procedures for assisting farmers, ranchers, groups, organizations, units of government, and others working through conservation districts in planning and applying resource conservation on non-Federal grazing lands throughout the United States. This handbook may also serve as a general reference for grazing lands resource information. It was prepared primarily for NRCS use, but others who are interested in grazing lands conservation may find it useful.

The NRPH was developed by NRCS grazing lands specialists using their experience and many textbooks, scientific publications, manuals, and other references. The authors of the National Range and Pasture Handbook thank the many authors of these references for their work and contribution. The NRPH does not use scientific reference notations or citations in the text unless a direct quote is used. It does list references in a reference section. This format was chosen to make the NRPH a resource manager, field-user friendly, easy-to-read handbook and reference.

There are 634 million acres of non-Federal (privately owned, state and local publicly owned, and tribally owned) grazing lands in the United States. Non-Federal grazing lands are in every state. These rangelands, pasturelands, haylands, grazed forest lands, grazed croplands, and naturalized pastures constitute about half of the total lands on which the NRCS provides technical assistance, through conservation districts, at the request of the cooperator (the owners or managers of these lands). This technical assistance provides a source of expertise to guide cooperators in solving resource problems and in sustaining or improving their grazing lands resources and operations. Guidance for developing conservation plans with cooperators on grazing lands is based on current NRCS policy relative to consideration of all soil, water, air, plant, and animal resources, as well as, the cooperator's objectives.

This handbook replaces the National Range Handbook (1976), which was only applicable to rangelands and other native grazing lands. In addition to providing guidance for rangelands, the NRPH includes information and guidance for pasturelands, haylands, grazed forests, grazed croplands, and naturalized pastures. The ecological principles used in the former handbook are updated, and new ecological principles have been added. New technology is included for enterprise diversification and grazing lands hydrology. Technical guidance for livestock husbandry, nutrition, and behavior science, as well as wildlife habitat management has been expanded. Economic analysis tools and their interpretations are explained.

This handbook, along with other appropriate NRCS technical and policy guidance manuals and handbooks, contains information to assist the NRCS conservationist in providing technical assistance to cooperators in all phases of the planning and application process. The NRPH deals with the policy and procedures for the study, inventory, analysis, treatment, and management of the grazing lands resources.

The appendixes in this handbook are to be considered an official part of the handbook. As time passes and the need arises, more appendixes will be added.

This handbook is included in the references section (Section I) of the Field Office Technical Guide in all NRCS field office locations with grazing lands.

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National Range and Pasture Handbook

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Section 1 Ecological Sites for Rangeland and Forest Land

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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.

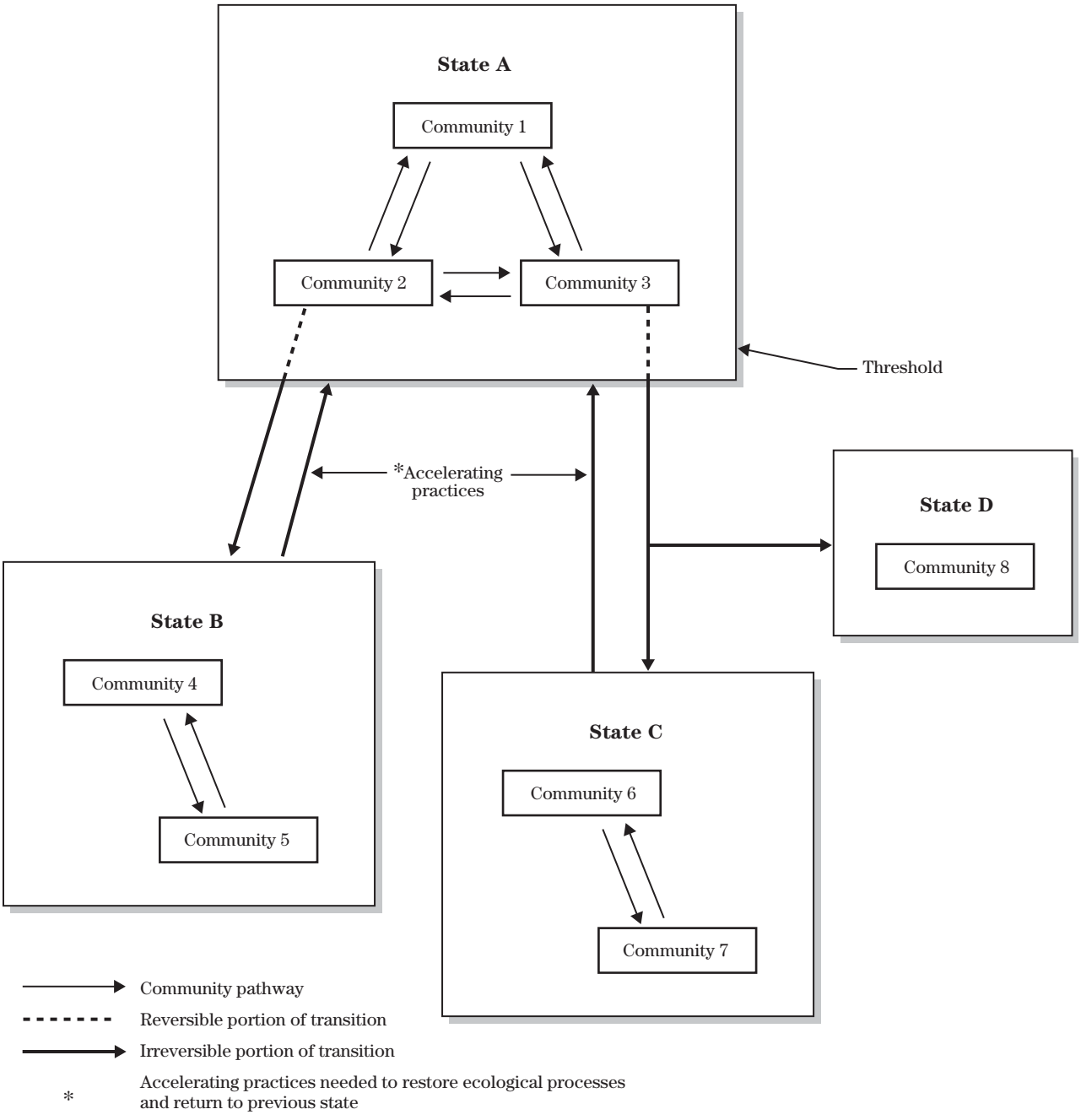
Transition is the trajectory of system change between states that will not cease before the establishment of a new state. A transition can be triggered by natural events, management actions, or both. Some transitions may occur very quickly and others over a long period. Two phases of a transition are 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 differentiate 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.

600.0303 Name, number, and correlation of ecological sites

The demand for broader interpretation of rangeland resources, the increasing uses to which ecological site information is being applied, the Ecological Site Information System, and computerized programs for soil classification have created a need for a standardized system of naming or numbering ecological sites.

(a) Naming ecological sites on rangeland

Ecological sites are named to help users recognize the different sites in their locality. Names of ecological sites should be brief and should be based on such readily recognized permanent physical features as the kinds of soil, climate, topography, or a combination of these features. Some examples of ecological site names based on these criteria are Deep Sand, Sandy, Sandy Plains, Limestone Hills, Clay Upland, Saline Lowland, Gravelly Outwash, Level Winding Riparian, Pumice Hills, Sub-irrigated, Wet Meadows, Fresh Marsh, and Sandy Savanna.

Names depicting landforms and using physiographic features that are complexes of ecological sites generally should not be used. Because of vegetation changes or absence in some places, plant names alone are unsuitable ecological site names.

Ecological sites having similar soils and topography may exhibit significant differences in their historic climax plant communities because of climatic differences. For example, the average annual precipitation of the sandy plains of the Oklahoma Panhandle ranges from 16 to 23 inches. Quantitative evaluation indicates that the amount of vegetation produced in areas where precipitation is 16 to 19 inches is significantly less than that produced in areas where precipitation is 20 to 23 inches. Thus two ecological sites are recognized and can be distinguished by the inclusion of the precipitation zone (PZ) in the name of the sites; e.g., Sandy Plains Ecological Site 16-19 PZ and Sandy Plains Ecological Site 20-23 PZ.

The limited number of permanent physiographic features or other features that can be used in naming ecological sites makes repeated use of these terms inevitable. Deep sands, for example, occur in areas of widely divergent climate and support different historic climax plant communities. The name Deep Sand is appropriate for each of these areas, but obviously, it is used throughout the country to designate several ecological sites. Where this occurs within a major land resource area, the applicable precipitation zone or other differentiating factors are to be included as part of the name. Sites that have the same name, but are in different major land resource areas are different sites.

(b) Numbering ecological sites

Ecological sites are numbered for use in the Ecological Site Information System. The ecological site number for rangelands consists of five parts:

1. The letter **R** identifies the type of ecological site as rangeland. This designation precedes the 10-character site number, but is not actually a part of the number.
2. A three-digit number and a one-digit letter Major Land Resource Area (MLRA).
3. A single letter Land Resource Unit (LRU), where applicable.
4. A three-digit site number, assigned by the state.
5. A two-digit letter state postal code.

If the MLRA is only two numbers and no letters, insert a zero in the first space followed by the two numbers. The letters A, B, C, etc., following the MLRA, represent the MLRA subdivisions. Where no MLRA subdivision exists, put an **X** in the fourth space to denote that there is no MLRA subdivision. For states using LRU's, enter appropriate letter in the space provided. Insert a **Y** when LRU's are not used. The next three digits represent the individual ecological site number and are assigned by the state. The first and second digits should be filled with 0's rather than left blank. The final two letters are the state's two-letter postal code. An example ecological site number for rangeland is:

R070CY123NM

(c) Correlating ecological sites

Soil-ecological site correlation establishes the relationship between soil components and ecological sites. Ecological sites are correlated on the basis of soils and the resulting differences in species composition, proportion of species, and total production of the historic climax plant community. Sometimes it is necessary to extrapolate data on the composition and production of a plant community on one soil to describe the plant community on a similar soil for which no data are available. The separation of two distinct soil taxonomic units does not necessarily delineate two ecological sites. Likewise, some soil taxonomic units occur over broad environmental gradients and may support more than one distinctive historic climax plant community. Changes may be brought about by other influences, such as an increase or decrease in average annual precipitation.

Ecological sites are to be correlated between states. Only one name should be given to a single site that occurs in adjacent states within the same MLRA.

The following procedures for soil-ecological site correlation are compatible with procedures in National Soil Survey Handbook, Part 627.

(1) Responsibilities of state conservationists

- Maintain all ecological site descriptions within their state.
- Propose and develop new sites.
- Consult with administrators of cooperating agencies for correlating all sites within their states.
- Designate which state is responsible for maintaining and updating ecological site descriptions when a site occurs in more than one state.

(2) Responsibilities of field personnel

- Collect the necessary documentation for each site.
- Propose draft descriptions for consideration and approval by the appropriate state technical specialist.

(3) Guidelines for internal consistency of soil-ecological site correlation

These guidelines ensure that site characteristics are compatible within each feature and between individual features.

- Portray each individual feature with the narrowest feasible range of characteristics that accurately describes the site.
- Check that all combinations of features are compatible with the range of characteristics that are described for each individual feature. Coordinate the soil moisture and temperature with the climatic features described. Review the compatibility of listed plant species and the soil properties listed under soil features. Check for other apparent inconsistencies.

(4) Guidelines for correlation between ecological sites

- Make comparisons with existing site descriptions when proposing new sites, reviewing existing sites, or correlating between soil survey areas, major land resource areas, or states.
- Compare all sites that have two or more major species in common and all sites that have the same soil family, groups of similar families, or other taxa.

Soil-ecological site correlation normally takes place in conjunction with progressive soil surveys. However, ecological site correlation may also be necessary because of updates or revisions of ecological site descriptions.

600.0304 Ecological site descriptions on rangeland

An ecological site description is prepared for each ecological site that is identified (exhibit 3.1–3). Descriptions should clearly present the features that characterize the site. They are to address all the resources of the site that are important for identifying, evaluating, planning, developing, managing, and monitoring rangeland resources. Descriptions are developed as part of Ecological Site Information System (ESIS) using the ecological site description format for rangelands. ESIS – Ecological Site Description database is the official repository for all data associated with rangeland ecological site descriptions. The state office is responsible for entry and maintenance of site descriptions in this database. A Technical Support Reference (appendix B) and User's Guide (appendix C) for the Ecological Site Description database are in the appendix of this handbook. This database can be accessed at the following Internet site:

http://plants.usda.gov/esis

The description includes the information that follows, as appropriate, along with other pertinent information:

(a) Heading

All ecological site descriptions will identify USDA and Natural Resources Conservation Service.

(b) Ecological site type

All ecological site descriptions will identify whether it is rangeland or forest land.

(c) Ecological site name

The full name of the site should be placed on each page of the description. Refer to section 600.0303(a) for guidance on naming ecological sites on rangeland.

(d) Ecological site ID

The site number begins with an R followed by the site 10-digit number. This number is placed on each page of the description. Refer to section 600.0303(b) for guidance on numbering ecological sites.

(e) Major land resource area

List the major land resource area code and common name.

(f) Physiographic features

Describe the position of the site on the landscape. In reference to the historic climax plant community, does the site typically generate runoff, receive runoff from other sites, or receive and generate runoff. Most of the information for this section can be obtained from the National Soils Information System (NASIS). Physiographic features include:

- Landform (refer to NASIS for list of possible landform types)
- Aspect
- Site elevation
- Slope
- Water table
- Flooding
- Ponding
- Runoff class

(g) Climatic features

Climatic information will be developed and included in the description of the site. Climatic features that typify the site, relate to its potential, and characterize the dynamics of the site, such as storm intensity, frequency of catastrophic storm events, drought cycles, should be included. Climatic features include:

- Frost-free period
- Freeze-free period
- Mean annual precipitation
- Monthly moisture and temperature distribution
- Location of climate stations

(h) Influencing water features

Include information regarding water features where the plant community is influenced by water or water table from a wetland or stream associated with the site. Water features include the Cowardin wetland classification system and Rosgen stream classification system. Enter the system(s), associated subsystem(s), and class(es). If a riverine system is influencing the site, then enter the Rosgen stream code. More than one stream type may be associated with the site.

(i) Representative soil features

Briefly describe the main properties of the soils associated with the site. Give special attention to properties that significantly affect plant, soil, and water relationships and the site hydrology. Describe the extent of rills and gullies found in historic climax plant community. Rills and gullies are inherent to some geologic formations. Describe extent of waterflow patterns across the soil surface during overland flow. Soils with inherently high erodibility and low vegetation cover may have a large number of natural flow patterns. Describe amount and patterns of pedestalling and terracettes caused by wind or water inherent to the historic climax plant community. Describe size and frequency of wind scoured areas. Describe how susceptible the site is to compaction. Describe expected nature of surface organic layer of historic climax plant community. Describe the expected physical and chemical crusts that might be present. Most of the information for this section can be obtained from the National Soils Information System (NASIS). Representative soil features include:

- Parent materials
- Surface texture
- Subsurface Texture
- Surface fragments
- Subsurface fragments
- Drainage class
- Permeability Class
- Depth
- Electrical conductivity
- Sodium adsorption ratio
- Calcium Carbonate Equivalent
- Soil reaction (pH)
- Available waterholding capacity

(j) Plant communities

Include in this section:

- Description of the vegetation dynamics of the site
- State and Transition Model diagram
- Description of the common states that occur on the site and the transitions between the states. If needed, describe the plant communities and community pathways within the state.
- Plant community composition
- Ground cover and structure
- Annual production
- Growth curves
- Photos of each state or community

(1) Ecological dynamics of the site

Describe the general ecological dynamics of the site. States could be described at the level of growth form, lifeform, or functional group. Describe the changes that are expected to occur because of variation in the weather, and what effects this might have on the dynamics of the site. Include the assumptions made of how the site developed (fire frequency, native herbivory). Other information regarding the dynamics of the site in general should be included.

(2) Plant communities

The first plant community entered into site description should be the interpretative community. This plant community will be either the historic climax plant community or, where applicable, the naturalized plant community for the site. **The first sentence in this section will clearly state whether the interpretative plant community is the historic climax or naturalized plant community.**

Describe other states and plant communities that may exist on the site. One or more plant communities for each state can be described. If only one plant community is described for a state, the community narrative can be used to describe the dynamics of that state. If more than one plant community is described for each state, the amount of detail entered into site description is determined by site description authors. As a minimum, information should be entered into the community narrative describing dynamics of the plant community and causes of community pathway changes. Identify and describe the thresholds between states. Provide information that will aid in the identification and evaluation of how the ecological processes of the

site are functioning. These processes include the water cycle, nutrient cycle, and energy flow. Explain what causes shifts or changes, and what effect these changes will have on these ecological functions. Describe changes in hydrologic and erosion characteristics of the site resulting from changes in states. Describe amount and distribution of litter expected. Describe the patterns of plant mortality. Some plants have been found to be cyclic, going through cycles of large-scale mortality followed by recruitment.

Information in regards to transitions between states should be described in the plant community narrative. Incorporate as much information as is known concerning the causes of change and any know probabilities associated with the transitions.

(i) Plant community composition—A detailed species composition list will be entered for the historic climax plant community or naturalized plant community. A detailed species composition list needs to be developed for any other states or plant communities that are considered desired plant communities, and a similarity index calculation is made. List the major plant species and their normal relative production, expressed in pounds air-dry weight (pounds per acre per year), in the total plant community. Species should be listed by group, common name, scientific name, pounds per acre allowable for group, and pounds per acre by species.

If plant groups are used, plant groupings must identify whether individual species within the group will have a production limitation or whether a single species can account for the entire group allowable. Numerous items must be considered when placing plant species into groups for the purpose of ecological site description development. Some of these items are kind of plant, structure, size, rooting structure, life cycle, production, niche occupied, and photosynthetic pathways. Plant groups include cool-season tall grasses, cool-season midgrasses, warm-season tall grasses, warm-season midgrasses, warm-season short grasses, annual grasses, perennial forbs, biennial forbs, annual forbs, shrubs, half-shrubs, deciduous trees, evergreen trees, cacti, yucca and yucca-like plants, succulent forbs, and leafy forbs. This list is not exhaustive, and the professionals describing the site may identify other items or situations and, therefore, identify other groups.

Professional judgment must be used when grouping plants in ecological site descriptions. Group plants in the manner that best describes the site. For instance, two or three groups of warm-season midgrasses may be described because of different niches occupied and differences in production, structure, elevation, and climatic adaptations in the area of the site.

(ii) Ground cover and structure—Soil surface cover is the percentage of the soil surface actually occupied by vegetative basal cover, biological crusts, litter, surface fragments, water, and bare ground.

Ground cover (vertical view) is the percentage of material, other than bare ground, that protects the soil surface from being hit directly by a raindrop. This would include first contact with plant canopy cover, biological crust, litter, surface fragments, bedrock, and water.

Structure of canopy cover – Canopy cover is the percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. List the average height and canopy cover for each level of vegetative stratification.

Refer to figure 3–2 for information needed in ground cover and structure section of the site description.

Figure 3–2 Ground cover and structure

Soil Surface Cover

Basal cover				Non-vascular plants	Biological crust	Litter	Surface fragments >1/4 & 3"	Surface fragments >3"	Bedrock	Water	Bare ground
Grass/ grasslike	Forb	Shrub/ vine	Tree								
___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___

Ground Cover

Vegetative cover						Non-Vegetative cover					
Grass/ grasslike	Forb	Shrub/ vine	Tree	Non-vascular plants	Biological crust	Litter	Surface fragments >1/4 & 3"	Surface fragments >3"	Bedrock	Water	Bare ground
___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___	___ to ___

Structure of Canopy Cover

	Grasses/Grasslike	Forbs	Shrubs/Vines/Liana	Trees
0.5 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>0.5 – 1 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>1 – 2 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>2 – 4.5 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>4.5 – 13 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>13 – 40 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>40 – 80 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>80 – 120 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____
>120 feet	_____ to _____	_____ to _____	_____ to _____	_____ to _____

***(iii) Total annual production*—**Show total annual production as median air-dry production and the fluctuations to be expected during favorable, normal, and unfavorable years. In areas where examples of the historic climax plant community are not available, cite the highest production in plant communities for which examples are available.

***(iv) Plant community growth curves*—**Describe a growth curve for the state or plant community that you are describing, in percent growth by month (fig. 3–3). This includes the curve name and number.

Name—Enter a brief descriptive name for each curve.

Number—The number is to be used only one time in each state. The first two digits are for the state postal code, and the last four digits enter numbers from 0001 to 9999.

(k) Site interpretations

This section includes the site interpretations for the use and management of the site. The information includes animal community, hydrologic functions, recreational uses, wood products, other products, and other information.

Animal community—Includes information regarding wildlife and livestock interpretations.

(1) Wildlife interpretations

An introductory paragraph will be developed that provides general information about the ecological site. The information should relate to the entire site. Information in this paragraph is not specific to any particular plant community. The following information will be described:

- Landscape descriptions
- Area sensitive species
- Transitory/migratory animals
- Invasive species (plants and animals)
- Thresholds by animal species
- Species guilds, keystone species
- Aquatic elements/inclusions; e.g., mineral springs/seeps, riparian areas
- Essential habitat elements across plant communities/sites
- Potential species, e.g., extirpated, historical, incidental

The following information will be shown in the order listing lowest trophic level to highest trophic level. Specific species related to the plant community should be described along with any known interactions.

- Invertebrates (includes edaphic if known)
- Fish
- Reptiles/amphibians—according to scale
- Birds—migrant and resident, also guilds
- Mammals—nongame/game, species of interest
- Essential habitat elements; e.g., lek sites
- Variations impacting wildlife

(2) Livestock Interpretations

General descriptions for use of this site by livestock, domesticated wildlife, wild horses, and burros should be included. Suitability of this site for grazing by kind and class of livestock and potential management problems that exist (poisonous plants, topography, and physical barriers) should be described. Describe wildlife-livestock interactions and competition. Include forage preferences for livestock and wildlife by plant species and/or various parts of a plant species for each month of the year.

Figure 3–3 Plant community growth curves

Name:
Number:
Description:

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.

Hydrologic functions—Indicate changes in hydrology functions that may occur with the shift to different plant communities that can occur on the site. For each plant community, describe the changes in infiltration and runoff characteristics expected because of changes in plant species composition and soil surface characteristics. For example, with plant community composition shifts from blue grama to buffalograss, runoff is typically accelerated because of a shift in plant growth form and root morphology characteristics. Information about water budgets for each plant community can be included.

Recreational uses—Indicate the potential uses that the site can support or that may influence the management of the site. List special concerns that will maintain the recreational potentials or site conditions that may limit its potential. Also list plant species that have special aesthetic values, uses, and landscape value.

Wood products—Indicate use or potential uses of significant species that may influence the management of the site.

Other products—Indicate the use or potential uses of other products produced on the site. These may include such things as landscape plants, nuts and berries, mushrooms, and biomass for energy potentials.

Other information—Other pertinent, interpretive, and descriptive information may be included.

(l) Supporting information

Record information about the relationship of this site to other ecological sites and the documentation and references used to develop the ecological site description.

Associated sites—Identify and describe the sites that are commonly located in conjunction with the site.

Similar sites—Identify and describe sites that resemble or can be confused with this site.

Inventory data references—Enter a listing of inventory plots supporting the site description. Record the data source and sample identification of each inventory plot used in the development of the site description.

State correlation—Enter the states with which this site has been correlated.

Type locality—Enter location of a typical example of the site. Indicate township, range, section, or longitude, latitude, and specific location.

Relationship to other established classification systems—Enter a description of how this ecological site description may relate to other established classification systems.

Other references—Record other reference information used in site development or in understanding ecological dynamics of the site.

(m) Site description approval

Authorship—Original authors' names and date. Revision authors' names and revision date.

Site approval—Indicate site approval by the state technical specialist. The state specialist responsible for Field Office Technical Guide rangeland information must review and approve all site descriptions before they are distributed.

(n) Revising ecological site descriptions

Analysis and interpretation of new information about the soil, vegetation, and other onsite environmental factors may reveal a need to revise or update ecological site descriptions. Because the collection of such information through resource inventories and monitoring is a continuous process, site descriptions should be periodically reviewed for needed revision. It is especially important that site descriptions be reviewed when new data on composition, production, or response to disturbance become available. Documented production and composition data, along with related soil, climate, and physiographic data, will be the basis of the site description revisions or new site descriptions.

(o) Developing new site descriptions

A new site description should be prepared when data analysis or new information reveals that a different or new ecological site exists. Generally, enough land area must be identified to be of importance in the management or study of the site before a new site will be developed and described. A new ecological site may be differentiated from an existing site when sufficient erosion or other action has occurred to significantly alter the site's potential.

600.0305 Rangeland ecological sites and soil surveys

NRCS policy dictates mapping of soils and the publication of soil surveys that contain essential information for use in conservation and resource planning activities. These surveys must meet the requirements of the National Cooperative Soil Survey program (see National Soil Survey Handbook, part 606).

The National Soil Survey Handbook, parts 622 and 627, establishes responsibility for planning soil surveys on rangeland. Soil scientists and rangeland management specialists work together to map soils and ecological sites in rangeland areas. Essential activities include development of soil survey work plans, determination of composition of soil mapping units, preparation of map legends, determination of mapping intensity, and necessary field reviews.

(a) Using soil surveys to identify ecological sites

Where Order II soil surveys are completed and ecological site interpretations have been made, boundaries of ecological sites can generally be determined directly from the soil map.

Order III mapping describes individual soil and plant components at association or complex levels. This requires that mapping unit descriptions be developed that describe each association component and assign locations and percentages to each. Individual ecological sites must be described at a level equivalent to the individual components of the Order III soils map.

(b) Soil interpretations for rangeland use in published soil surveys

The National Soil Survey Handbook establishes NRCS policy and procedures for preparing soil interpretations for rangeland. The criteria for developing interpretations are the responsibility of grazing lands discipline leaders. Part 644 outlines policy and procedure for publishing soil surveys, and part 651 outlines policy for preparing advanced soil reports.

Each ecological site will be assigned a unique number that distinguishes it from all other ecological sites. Refer to section 600.0303(b) of this chapter for guidance. This 10-character number will be correlated to each soil series or taxonomic unit that occurs within the ecological site. This number and site name will be input into NASIS or other applicable soils database.

600.0306 Forest land ecological sites

(a) General

The guidance for preparing forest land ecological site descriptions is in the National Forestry Manual, part 537.3. The NRCS state grazing lands specialist will work with the state forester to develop understory plant community descriptions, forage preference ratings, and other appropriate information for each forest site that is suited to grazing. This information will be included in the Field Office Technical Guide.

Forest land ecological site descriptions normally characterize the mature forest plant community that historically occupied the site as well as the other states that commonly occupy the site. An example forest land ecological site description is in the National Forestry Manual, part 537.4, exhibit 537-14.

(b) Separating forest lands from rangelands in areas where they interface

Guides will be developed, as necessary, to separate rangelands from forest lands in areas where they interface. In North America, they are separated based on the historic kind of vegetation that occupied the site. Forest land ecological sites are assigned and described where the historic vegetation was dominated by trees. Rangeland ecological sites are assigned where overstory tree production was not dominant in the climax vegetation.

An example of this type guide is Inventorying, Classifying, and Correlating Juniper and Pinyon Plant Communities to Soils in Western United States (GLTI 1997).

600.0307 Native and naturalized pasture

The historic climax plant community for land managed as native and naturalized pasture was forest land or naturally open land other than rangeland. Many native and naturalized pasture plant communities closely resemble the understory of grazed forest land that has an open or sparse canopy occurring on similar soils. Therefore, ecological site descriptions for forest land will be used as interpretive units for native and naturalized pasture occurring on forest soils.

If forest land ecological site descriptions have not been developed, or if they do not adequately serve the purpose, forage suitability groups will be developed as the basic interpretive or suitability grouping for native and naturalized pasture. Forage suitability groups consist of one or more soils capable of producing similar kinds and amounts of herbaceous vegetation. These soils are also capable of producing similar kinds and amounts of overstory trees.

If forest land ecological site descriptions are to be used for native and naturalized pastures, they must have details about the herbaceous native and naturalized plant community, its production potential, and other pertinent features. Development of forest land ecological sites will follow guidance in the National Forestry Manual. The natural tree overstory part of the description will be omitted only if not known. The state forester and state grazing lands specialist, working as a team, have the responsibility of identifying and describing forest land ecological sites with native and naturalized pasture. Assistance from soil scientists and biologists will be requested as needed.

A forest land ecological site description will be prepared for each native and naturalized pasture site that is identified and named. Descriptions should clearly describe the important features of the site. All significant resources of the site will be described and characterized in sufficient detail to provide guidance for expert planning, managing, and monitoring of the native and naturalized pasture communities.

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

National Range and Pasture Handbook

Chapter 3 Ecological Sites and Forage Suitability Groups

Section 1 Ecological Sites for Rangeland and Forest Land

Exhibits

Plant Association Table (First Assemblage)

(T means trace; dashes mean did not occur)

Species	Production at location number						
	1	2	3	4	5	6	7
	Pounds per acre (air-dry)						
bluebunch wheatgrass	910	1,190	1,690	960	1,380	1,260	1,620
Sandberg bluegrass	110	120	260	95	185	70	375
Thurber needlegrass	15	T	—	15	—	10	—
needleandthread	10	—	—	10	—	T	—
cheatgrass	10	—	T	—	—	T	T
Pacific fescue	—	15	T	—	T	—	T
squireltail	—	—	T	—	—	T	—
Idaho fescue	—	—	400	—	460	—	250
lineleaf fleabane	15	15	—	20	—	15	25
snow eriogonum	15	15	50	15	50	T	25
cluster phlox	15	25	—	30	—	15	—
longleaf phlox	10	—	50	25	50	T	25
yarrow	20	15	50	20	50	15	30
pussytoes	T	15	—	—	—	T	—
arrowleaf balsamroot	—	—	50	—	25	—	50
hangingpod milkvetch	—	—	25	—	25	—	25
silky lupine	—	—	25	—	25	—	25
specklepod loco	—	—	T	—	25	—	25
indianwheat	—	10	—	—	—	—	—
tarweed	—	—	—	T	—	T	—
tapertip hawksbeard	—	—	50	—	50	—	25
filaree	—	—	—	—	—	T	—
gray rabbitbrush	10	T	T	5	T	15	T
gray horsebrush	—	—	T	—	T	—	T
Total	**1,140**	**1,420**	**2,650**	**1,195**	**2,325**	**1,400**	**2,500**
Soil Taxonomic Unit No.	1	2	3	1	4	1	3

Plant Association Table (Final Assemblage)

(T means trace; dashes mean did not occur)

Species	Production at location number						
	1	2	3	4	5	6	7
	Pounds per acre (air-dry)						
bluebunch wheatgrass	910	1,190	960	1,260	1,690	1,380	1,620
Sandberg bluegrass	110	120	95	70	260	185	375
Thurber needlegrass	15	T	15	10	—	—	—
needleandthread	10	—	10	T	—	—	—
cheatgrass	10	—	—	T	T	—	T
Pacific fescue	—	15	—	—	T	T	T
squireltail	—	—	—	T	T	—	—
Idaho fescue	—	—	—	—	400	460	250
lineleaf fleabane	15	15	20	15	—	—	25
snow eriogonum	15	15	15	T	50	50	25
cluster phlox	15	25	30	15	—	—	—
longleaf phlox	10	—	25	T	50	50	25
yarrow	20	15	20	15	50	50	30
pussytoes	T	15	—	T	—	—	—
arrowleaf balsamroot	—	10	—	—	—	—	—
hangingpod milkvetch	—	—	T	T	—	—	—
silky lupine	—	—	—	T	—	—	—
specklepod loco	—	—	—	—	50	25	50
indianwheat	—	—	—	—	25	25	25
tarweed	—	—	—	—	25	25	25
tapertip hawksbeard	—	—	—	—	50	50	25
filaree	—	—	—	—	50	50	25
gray rabbitbrush	10	T	5	15	T	T	T
gray horsebrush	—	—	—	—	T	T	T
Total	**1,140**	**1,420**	**1,195**	**1,400**	**2,650**	**2,325**	**2,500**
	Site No. 1				Site No. 2		
Soil Taxonomic Unit No.	1	2	1	1	3	4	3