Using BIOS Data for Ecological Sites, STMs, & Rangeland Health Data Development

10/02/2020 | Kendra Moseley, Regional Ecologist, SPSD, NRCS
Ecological Site – 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 and in its ability to respond similarly to management actions and natural disturbances.

• In other words, a kind of land with similar potential and response to management.

ESD – Is the report that characterizes and documents the ecological site concepts synthesizing the existing knowledge, research and associated data of an ecological site (including its climate, soils, hydrology and state-and-transition model) and the interpretation of its characteristics in relation to land use planning and decision-making.
1. Stratify the landscape according to varying ecological potential in order to identify management and restoration targets

2. Assess the risk of persistent degradation and take proactive measures to avoid it

3. Specify constraints to, and opportunities for, desired ecosystem change based on a knowledge of ecological processes

4. Identify specific intervention strategies that can promote desired conditions

5. Design and interpret monitoring based on interventions and expected responses.
Figure 10.—Idealized illustration of the general relationships among marine terrace soils. This simplified cross-section is typical of the marine terraces near the town of Caspar. The width of the terrace system, from the ocean on the west to the mountainous uplands on the east, is approximately 4 miles at this location. Other cross-sections of the terrace system would reveal different combinations of soils. The upper terrace in this diagram represents perhaps three or more terrace levels. The

Sandy soil (relict basin floor)
Erodible surface soils once grasses removed: vulnerable/hard to restore

Gravelly soil (shallow, relict piedmont)
Surface soil water limited, high risk for grass loss and erosion: vulnerable/restorable

Limestone
Grass protected by rocks, higher rainfall, good water capture: low risk

Clayey soil (basin floor)
Receives water and sediment: low risk

Loamy soil (active piedmont)
Susceptible to water erosion and grass loss: vulnerable/restorable

Source: B. Bestelmeyer, Jornada ARS
Ecological sites concepts developed based on relationship of soil profiles to soil processes and vegetation pattern.
Ecological Sites are Correlated to Soil Components

Ecological sites classify soil map unit components (soil series phases) of the US National Cooperative Soil Survey.

Map unit/components = Ecological site

**ST: Stellar association**
- 40% Stellar clay loam, 0-3% slopes = Clayey
- 40% Stellar clay loam, 0-3% slopes, flooded = Bottomland
- 20% other inclusions

**BK: Berino-Dona Ana association**
- 50% Berino fine sandy loam, 1-5% slopes = Sandy
- 30% Dona Ana fine sandy loam, 1-5% slopes = Sandy
- 20% other inclusions

**OP: Onite-Pajarito association**
- 40% Onite loamy sand, 1-4% slopes = Sandy
- 30% Pajarito fine sandy loam, 0-5% slopes = Sandy
- 15% Pintura fine sand, 0-5% slopes = Deep sandy
- 15% other inclusions

A soil map unit can contain more than one ecological site

An ecological site groups several similar soil map unit components

Source: B. Bestelmeyer, Jornada ARS

[nrcs.usda.gov/](http://nrcs.usda.gov/)
Nesting Ecological Sites into Landscape Framework

Geographic areas of related ecological sites

Groups of ecological sites with common climate

Ecological sites that share landscapes

Intermingled ecological sites or single site

One ecological site or one representation of the site

An observation of plant-soil relationships
How Ecological Sites are Differentiated

• Significant differences in the species that are in the characteristic community phase

• Significant differences in the relative proportion of species in the characteristic community phase

• Significant differences in the total annual production of the characteristic community phase
State-and-Transition Models (STMs)

A diagram and description of the ecological site community dynamics

✓ Discrete community states and phases
✓ Transitions indicating change from one community phase or state to another community phase or state
✓ Thresholds which indicate the difference between states
Reference state

Illustrates management and restoration potentials

Reference State

Community Phase 1.1

Time without fire

Community Phase 1.2

Time without fire

Community Phase 1.3

Juniper control

State 2

Community Phase 2.1

No fire

State 3

Community Phase 3.1

Transitions

Cheatgrass Invasion
Ecological Site Descriptions help describe the changes from the reference state to alternative states, based on biotic and abiotic structure and function changes.
State-and-Transition Models (STMs)

Ecological sites and their STMs describe the soils properties typical of the reference communities, as well as the soil changes possible due to disturbance/management.

- Decreased surface soil stability
- Increased soil erosion potential
- Loss of Organic Matter
- Decreased infiltration
- Increased bulk density
- Decreased porosity

Reference State Soil

State 2 Soil
Ecological sites and their STMs describe the vegetation structure & cover typical of the reference communities. As well as changes possible due to disturbance/management in the alternative states.

Perennial grass dominant
Deep, fiberous roots
No bareground
1500 lbs/acre

Reference State Soil

Transition

Annual grass dominant
Shallow, fiberous roots
1.5 ft bareground patches
500 lbs/acre

State 2 Soil

nrcre.gov
Ecological Site Data Collection Strategy

Focused data collection at reference site concept locations (ideally gathered in the reference community phase)

High intensity characterization
- Line-point intercept, production
- Dynamic soil properties/indicators
- Monitoring of selected attributes
- Soil pit
  (1 day and possibly revisits)

Fine-tuned data collection narrowed down to the primary site concept locations

Medium intensity inventory (transecting or stratified)
- Ocular estimates or step/line-point intercept
- Soil function indicators
- Soil profile properties/mini-pit
  (1-2 hours)

Numerous data points to capture full range of site variation

Low intensity inventory (traverse)
- Rapid plant community characterization
- Soil surface function indicators
- General soil types/soil taxa/ecological sites
  (15-30 minutes)

-VegCAMP Relevé Plots (just need a soil confirmation)

-VegCAMP Rapid Assessments

Moseley et al., 2010
### Table 2. Representative physiographic features

<table>
<thead>
<tr>
<th>Landforms</th>
<th>(1) Mountain slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>5,300–6,200 ft</td>
</tr>
<tr>
<td>Slope</td>
<td>5–30%</td>
</tr>
<tr>
<td>Aspect</td>
<td>Aspect is not a significant factor</td>
</tr>
</tbody>
</table>

### Table 6. Ground cover

<table>
<thead>
<tr>
<th>Tree foliar cover</th>
<th>0-75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrub/vine/liana foliar cover</td>
<td>0-20%</td>
</tr>
<tr>
<td>Grass/grasslike foliar cover</td>
<td>0-40%</td>
</tr>
<tr>
<td>Forb foliar cover</td>
<td>0-20%</td>
</tr>
<tr>
<td>Non-vascular plants</td>
<td>0%</td>
</tr>
<tr>
<td>Biological crusts</td>
<td>0%</td>
</tr>
<tr>
<td>Litter</td>
<td>0-20%</td>
</tr>
<tr>
<td>Surface fragments &gt;0.25&quot; and &lt;=3&quot;</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Table 7. Canopy structure (% cover)

<table>
<thead>
<tr>
<th>Height Above Ground (Ft)</th>
<th>Tree</th>
<th>Shrub/Vine</th>
<th>Grass/Grasslike</th>
<th>Forb</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>&gt;0.5 &lt;= 1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10-40% 0-20%</td>
</tr>
<tr>
<td>&gt;1 &lt;= 2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>&gt;2 &lt;= 4.5</td>
<td>–</td>
<td>0-20%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>&gt;4.5 &lt;= 13</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>&gt;13 &lt;= 40</td>
<td>–</td>
<td>–</td>
<td>0.75%</td>
<td>–</td>
</tr>
</tbody>
</table>

### Table 9. Community 1.1 plant community composition

<table>
<thead>
<tr>
<th>Group</th>
<th>Common Name</th>
<th>Symbol</th>
<th>Scientific Name</th>
<th>Annual Production (Lb/Acre)</th>
<th>Foliage Cover (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sandberg bluegrass</td>
<td>POSE</td>
<td>Poa secunda</td>
<td>1949–2508</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>169–308</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>pullup muhly</td>
<td>MUF12</td>
<td>Muhlenbergia filiformis</td>
<td>409–748</td>
<td></td>
</tr>
<tr>
<td></td>
<td>meadow barley</td>
<td>HOB2</td>
<td>Hordeum brachyepernum</td>
<td>220–440</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>Nebraska sedge</td>
<td>CANE2</td>
<td>Carex nebrascensis</td>
<td>816–1496</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>220–440</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>220–440</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>189–308</td>
<td>–</td>
</tr>
</tbody>
</table>
### Site Characteristics
- Stand structure and age classes
- Cover % and species lists

<table>
<thead>
<tr>
<th>Database #</th>
<th>Final database #</th>
<th>Final vegetation type</th>
<th>Alliance</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**For Office Use**
- Site Characteristics
- Stand structure and age classes
- Cover % and species lists

**UTME**
- For Relevé only: Bearing*, left axis at ID point of Long / Short side

**GPS name**
- If No, cite from GPS to stand: distance (m) bearing° inclination°

**Combined Vegetation Rapid Assessment and Relevé Field Form**

- **Database #**: 1
- **UTM**:
  - **Zone**: 10
  - **NAD83**: GPS error: ft. mx. PDOP
- **UTME**:
- **UTMN**:

**Exposure, Actual °**: NE NW SE SW Flat Variable |

**Topography, Macro**: top upper mid lower bottom |

**Geology code**: Soil Texture code: |

**Restoration code**: 1-burn obvious 2-burner removal 3-Grass/forbs seeding |

**% Surface cover**:
- (Excl. exotics) (>40% EXC) (<25% EXC) |

**% C** |

**Fire**: |

**Combined V**

**Disturbance code / Intensity (L,M,H):** |

**II. HABITAT DESCRIPTION**

- **Tree DBH**: T1 (<1" dbh), T2 (1-4" dbh), T3 (4-8" dbh), T4 (8-12" dbh), T5 (12-24" dbh), T6 (>24" dbh), T7 mixed-layered (T1 or T2 layered or T5 >50% cover) |
- **Shrub**: S1 seedling (<5 yr old), S2 young (<10 yr old), S3 mature (25-75% dead), S4 decadent (>25% dead) |
- **Herbaceous**: H1 (<12" plant ht.), H2 (>12" ht.) |

**III. INTERPRETATION OF STAND**

- **Field-assessed vegetation Alliance name**: |
- **Field-assessed Association name (optional)**: |
- **Adjacent Alliances/direction**: |
- **Confidence in Alliance identification**: L M H Explain: |
- **Phenology (E,P,L)**: Herb Shrub Tree Other identification or mapping information: |

**IV. VEGETATION DESCRIPTION**

- **% Cover** - Conifer tree / Hardwood tree |
- **Height Class** - Conifer tree / Hardwood tree:
  - 1: <1/2 m, 2: 1-1/2 m, 3: 1-2 m, 4: 2-3 m, 5: 3-4 m, 6: 4-5 m, 7: 5-6 m, 8: 6-7 m, 9: 7-8 m, 10: >8 m |
- **Regenerating Tree**:
- **Shrub** |
- **Herbaceous**: |

**Stratum**
- **Species**
- **% cover**
- **C**
- **Final species determination**
- Loafercreek-Gopheridge complex, 15 to 30 percent slopes
NASIS (National Soils Information System) – NRCS ES Database

All individual plot data should be entered into a database that can be queried.

VegCAMP Access Database

<table>
<thead>
<tr>
<th>Component Ecological Site</th>
<th>Component</th>
<th>Local Database</th>
<th>T Data Mapunit</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMU Description</td>
<td>DMU Rec ID</td>
<td>Seq</td>
<td>Low</td>
</tr>
<tr>
<td>ARINE</td>
<td>789113</td>
<td>525636</td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seq</th>
<th>Plant Symbol</th>
<th>Scientific Name</th>
<th>National Vernacular Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ARINE</td>
<td>Arctostaphylos nevadensis</td>
<td>pinnatifid manzanita</td>
<td>bush manzanita</td>
</tr>
<tr>
<td>2</td>
<td>CHSE11</td>
<td>Chrysolepis sempervirens</td>
<td>bush chiquapin</td>
<td>bush chiquapin</td>
</tr>
<tr>
<td>3</td>
<td>AEMA</td>
<td>Abies magnifica</td>
<td>California red fir</td>
<td>California red fir</td>
</tr>
<tr>
<td>4</td>
<td>PECOM</td>
<td>Pinus contorta var. murrayana</td>
<td>Murray lodgepole pine</td>
<td>Sierra lodgepole pine</td>
</tr>
<tr>
<td>5</td>
<td>CAREX</td>
<td>Carex</td>
<td>sedge</td>
<td>sedge</td>
</tr>
<tr>
<td>6</td>
<td>ERMA4</td>
<td>Eriogonum marifolium</td>
<td>marumleaf budweat</td>
<td>marumleaf budweat</td>
</tr>
<tr>
<td>6</td>
<td>ERMA3</td>
<td>Eriogonum nudum</td>
<td>naked budweat</td>
<td>naked budweat</td>
</tr>
<tr>
<td>5</td>
<td>PEN3</td>
<td>Penstemon nevadensis</td>
<td>mountain pride</td>
<td>mountain pride</td>
</tr>
</tbody>
</table>
Information in ESD

Ecological dynamics

The historic natural plant community is dominated by mountain big sagebrush (Artemisia tridentata ssp. vasey) and perennial grasses. The vegetation states for ecological site range from open grassland to sagebrush steppe with a few, scattered western junipers (Juniperus occidentalis ssp. occidentalis). The distribution of vegetation states is influenced by soils, topography, and fire history. Grassland and sagebrush steppe patches occur together as a mosaic. The reference state for this ecological site is similar to its pre-European state; however, expansion of western juniper and invasion of exotic annual grasses and forbs since the late 1800s has resulted in transitions to other states.

The shrub layer of this ecological site is typically dominated by mountain big sagebrush intermixed with perennial bunchgrasses, and often contains a rich variety of forbs such as Antelope bitterbrush (Purshia tridentata) and occasional other shrubs such as a variety of ceanothus (Ceanothus spp.) and rabbitbrush (Chrysothamnus spp.) may be present. Historically herbaceous vegetation and grassland patches were dominated by Idaho fescue (Festuca idahoensis) needlegrass (Achnatherum spp.), but grazing and other disturbances have reduced diversity. Invasive species such as cheatgrass (Bromus tectorum) or medusahead (Taeniatherum caput-medusae) have invaded these ecotones. Western Juniper is the dominant species, and invasion by exotic grasses has altered the ecosystem.

Invasion by Exotic Grasses

An estimated 3 million acres in the Western United States have become dominated by invasive grasses. These grasses play a limited role in the plant community. Productivity of understory is limited by juniper dominance, shrubs may be completely absent, and bare ground is common in the interstices. Western Juniper dominance impacts ecological processes and fire regimes.

Prior to European settlement, western juniper was found primarily in places where fire was restricted - on rock outcrops, rocky ridges, and shallow, rocky or heavy clay soils with very low productivity. As a result of fire suppression and early grazing practices that began in the late 1800s, western juniper has been increasing in density and expanding its range into adjacent sagebrush steppe.

Conversion to western juniper woodland threatens to degrade sagebrush steppe ecosystems because it can reduce the quantity and quality of forage, accelerate soil erosion, and alter ecosystem dynamics.
Artemisia tridentata ssp. vaseyana / Festuca idahoensis Association

Common Name: Mountain Sagebrush / Blue Fescue

NVC Association Code: CEGL001533, Artemisia tridentata ssp. vaseyana / Festuca idahoensis Shrub Grassland

Alliance: Artemisia tridentata ssp. vaseyana Alliance

Association Concept:
The Artemisia tridentata ssp. vaseyana / Festuca idahoensis Association forms open to intermixed trees and herbaceous layers. The emergent tree layer is typically sparse to open. The association primarily from mid-hills to ridge summits at all aspects. Soils are derived from a variety of primarily general volcanic extrusives, andesite, or igneous, and textures are widely variable range from approximately 1292 to 2384 meters. Artemisia tridentata ssp. vaseyana is the dominant shrub. Characteristic herbs include Festuca idahoensis and Poa secunda, and those often Bromus tectorum and Elymus elymoides.

Diagnostic Criteria: This association is characterized by an open to intermittent shrub layer of Artemisia tridentata ssp. vaseyana with an open to intermittent herbaceous layer of Festuca idahoensis shrub cover ranges from 8 to 49 percent.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent shrub layer, and the overall shrub cover ranges from 2 to 60 percent. The tree layer is typically sparse, and the herbaceous layer is sparse to intermittent.

Vegetation Floristics: Artemisia tridentata is the dominant and characteristic shrub. Stands sometimes have sparse, emergent Juniperus occidentalis in the tree layer, Bromus tectorum and Elymus elymoides, and often include Atriplex ssp.

Dynamics: Artemisia tridentata

Species of Interest: Astragalus agrestis, Balsamorhiza elegans, Lupinus nevadensis, and Polygala subspira

Local Alliance Distribution

Modoc Plateau: Adin Mountains and Valleys (M261G), Beld Mountain - Dixie Valley (M261G), Crowder Flat (M261Gc), Devil's Garden (M261Gb), Eagle Lake - Observation Peak (M261Gm), Horsehead Mountain (M261Gk), Likely Mountain (M261Gk), Likely Tableland (M261Gh), Lower Klamath - Tule Lake Basins (M261Ga), Pile River Valley (M261Gg)

Northwestern Basin and Range: Medicine Lake Lava Flows (M261Dh)

Southern Cascades: Medicine Lake Lava Flows (M261Dh)

Associations

Artemisia tridentata Association

Artemisia tridentata – (Ericameria nauseosa) / Bromus tectorum Association

Artemisia tridentata – Ephedra viridis / Pseudoregneria spicata Provisional Association

Artemisia tridentata / Distichlis spicata Provisional Association
Reference State

**Community Phase 1.1**
Mountain sagebrush/Idaho fescue-Bluebunch wheatgrass

- Artemisia tridentata ssp. vaseyana / Festuca idahoensis Association

**Community Phase 1.2**
Mountain sagebrush/Idaho fescue-Bluebunch wheatgrass/western juniper

- Artemisia tridentata ssp. vaseyana / Festuca idahoensis Association

**Community Phase 1.3**
Idaho fescue-Bluebunch Wheatgrass

- Festuca idahoensis-Pseudoroegneria spicata Association

**State 2**
Community Phase 2.1

- Juniperus occidentalis /Poа secunda – Festuca idahoensis – Pseudoroegneria spicata

**State 3**
Community Phase 3.1

- Juniperus occidentalis /Poа secunda-Festuca idahoensis-Pseudoroegneria spicata
Reference State – Community Phase 1.1 and 1.2

(1) *Artemisia tridentata* ssp. *vaseyana* is strongly dominant to co-dominant in the shrub layer with *Purshia tridentata*, *Tetradymia canescens*, and/or *Chrysothamnus viscidiflorus*. Emergent *Pinus jeffreyi* and *Juniperus occidentalis* are often present although at low cover. *Festuca idahoensis* is dominant to co-dominant in the herb layer with *Poa secunda*, *Achnatherum thurberianum*, *Pseudoroegneria spicata* and/or *Achillea millefolium*.

*Artemisia tridentata* ssp. *vaseyana* / *Festuca idahoensis* Association (n=33)

Alternative States – Community Phase 2.1

iv) *Juniperus occidentalis* stands with minimal shrub component (typically <4% absolute cover). Juniper cover is usually greater than 10% and trees are of mixed age classes. Herb layer is sparse to moderate, sometimes with significant cover of non-native grasses such as *Bromus tectorum*. However, native grasses including *Poa secunda*, *Pseudoroegneria spicata*, *Festuca idahoensis*, and/or *Achnatherum thurberianum* are characteristic in the herb layer. If shrubs are present, they are patchy and insignificant.

*Juniperus occidentalis* / (*Poa secunda* – *Festuca idahoensis* – *Pseudoroegneria spicata*) Association (n=30)

VegCAMP plot data informing association
**INTERPRETING INDICATORS OF RANGELAND HEALTH, Version 5, REFERENCE SHEET**

- **Ecological site name:**
- **Ecological site code:**
- **Author(s)/participant(s):**
- **Contact for lead author:**
- **Date:**
- **MLRA:**
- **LRU:**
- **Composition based on (check one):** □ Cover □ Annual Production
- **Metadata storage location:**

**Indicators.** For each indicator, describe the potential for the site using the reference sheet checklist. Where possible, (1) use quantitative measurements; (2) include expected range of values for above- and below-average years and natural disturbance regimes for each community phase within the reference state; and (3) cite data sources used. Continue descriptions on separate sheet.

1. **Rills:**

2. **Water flow patterns:**

3. **Pedestals and/or terraces:**

4. **Bare ground:**

5. **Gullies:**

6. **Wind-scoured and/or depositional areas:**

7. **Litter movement:**

8. **Soil surface resistance to erosion:**

9. **Soil surface loss and degradation:**

10. **Effects of plant community composition and distribution on infiltration:**

11. **Compaction layer:**

12. **Functional/structural groups:**

<table>
<thead>
<tr>
<th>Dominance Category¹</th>
<th>Relative Dominance of F/S Groups for Community Phases in the Reference State</th>
<th>Minimum expected number of species for dominant and subdominant groups is included in parentheses. Dominance based on ¹: Annual Production or Foliar Cover. Phase 1. ___</th>
<th>Phase 1. ___</th>
<th>Phase 1. ___</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subdominant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trace</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Biological soil crust dominance is determined based on cover, rather than production. If biological soil crusts are an expected dominant or subdominant group, the number of expected life forms (e.g., lichen, moss) is listed, rather than number of individual species.

13. **Dead or dying plants or plant parts:**

14. **Litter cover and depth:**

15. **Annual production:**

16. **Invasive plants:**

17. **Vigor with an emphasis on reproductive capability of perennial plants:**